An AREVA and Siemens Company

REPORT OF RADIOLOGICAL CHARACTERIZATION AND CONFIRMATORY SURVEY RESULTS

for the

SNAP ENVIRONMENTAL TEST FACILITY - BUILDING 4024

January 2008

REVISION 0

Prepared For:
The Boeing Company
Santa Susana Field Laboratory
5800 Woolsey Canyon Rd
Canoga Park, CA 91304

Prepared By:
AREVA NP Inc.
Federal D&D Services
7207 IBM Drive
Charlotte, NC 28262

AREVA

REPORT OF RADIOLOGICAL CHARACTERIZATION AND CONFIRMATORY SURVEY RESULTS

for the

SNAP ENVIRONMENTAL TEST FACILITY - BUILDING 4024

JANUARY 2008

Prepared by: James W. McDuffee for Date 1/10/08
John McGehee
Characterization/FSS Manager

Reviewed by: Peter Huntley Date 1/10/08
Peter Huntley
AREVA Radiation Safety Officer

Approved by: Don McGee Date 1/10/08
Donald McGee
Project Manager

Accepted by: Phil Rutherford Date 1/10/08
Phil Rutherford
Boeing Company Manager of Health, Safety and Radiation Services

Prepared By:
AREVA NP Inc.
Federal D&D Services
7207 IBM Drive
Charlotte, NC 28262

EXECUTIVE SUMMARY

Radiological characterization and confirmatory surveys were performed at the SNAP Environmental Test Facility, (SETF) April 6 through May 31, 2007. The objectives the characterization and confirmatory surveys was to confirm current radiological conditions of SETF clean DM (decommissioned materials) areas; activated test cells; former UST (underground storage tank, gas and liquid) area; drain systems, contaminated liquid and facility floor drains; solid waste storage system and compete a background study to assist with data evaluations.

The characterization and confirmatory surveys were completed in preparation for decontamination of two activated test cells, removal of contaminated liquid waste drain system piping, removal of facility floor drain system, and demolition and removal of the existing SETF, also known as Building 4024. Previous investigation within SETF Showed the presence of activated (radioactive) concrete within test cells B-102 and B-104. To further investigate the facility and site for the presence or absence of other residual contamination, a characterization and confirmatory survey was conducted. The data quality objectives for this characterization and confirmatory survey were established using the process outlined in Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

Field measurements on the structure included: direct alpha, direct beta, contact gamma, and 1 meter exposure rate measurements in addition to smear samples for removable contamination on surfaces and material samples for isotopic analysis within and around the SETF to determine if other contamination was present. Field measurements of the environs, soil areas around the SETF included: contact gamma and 1 meter exposure rate measurements in addition to soil samples for isotopic analysis within and around the SETF to determine if other contamination was present. A background study was performed consisting of the same types of measurements on structural surfaces and environs, but at locations outside of Area 4, where there was no history of radioactive material use.

The characterization and confirmatory surveys indicated there were no alpha, beta, and gamma radiation measurements outside of the activated test cells that showed contamination above surface contamination limits presented in Section 3.3 and SETF measurements were generally within the range of background measurements except for two locations. The two survey measurement locations (SMLs) were just at the outside northeast and southwest corners of the SETF each on concrete pads that showed fixed alpha and beta activity above background and minimum detectable concentration (MDC) of 60 dpm/100cm^2 alpha and 343 dpm/100cm^2 beta. At the northeast corner, SML 5 was 360 dpm/100cm^2 alpha and 684 dpm/100cm^2 beta and at the southwest corner, SML 8 was 179 dpm/100cm^2 alpha and 551 dpm/100cm^2 beta. Sampling and isotopic analysis of the locations showed Th-232, U-234, U235, and U-238 were present and detectable, but at levels a fraction of the derived concentration guideline level (DCGL) of 1,000 dpm/100cm^2 for Th-232 and 5,000 dpm/cm^2 for U-234, U235 and U238 for fixed surface contamination and a fraction of the bulk material DCGL for the listed isotopes. Smear sampling did not indicate the presence of removable contamination. Material samples collected from the surfaces were analyzed for the full suite of potential contaminants of concern (COC), but the analytical results did not indicate the presence of other potential COC. Other findings from the survey include:

- Piping to the former contaminated gas and liquid UST was still present in the area;
- Previous asphalt covering and broken pieces of concrete from the former liquid waste storage tank vault was present in the UST survey area; and
- It was reported by a current employee that a floor drain in the middle of Room B-101, basement

operating floor, was grouted over due to an elevated reading in the drain during previous equipment and materials removal operations.

Survey measurements and samples from within the gas and liquid waste UST piping and the accessible floor drains in Room B-101 were consistent with background level readings. However, the suspect floor drain was not accessible due to the grout covering. As such, data showing the absence or presence of PCOCs could not be obtained. During confirmatory survey of the UST area, survey measurements were performed on pieces asphalt and pieces of broken concrete as they were encountered. The measurement results were consistent with normal background levels. With the asphalt and concrete showing normal background, each piece was removed from trenching excavation spoils and placed in a location approved for DM storage. As with the concrete and asphalt, the soil associated with the trenching operation was surveyed; measurement results were consistent with normal background levels and the soil placed back in the trench excavation.

Based on the results of the characterization and confirmatory surveys, it is concluded that the D&D activities planned for the SETF activated test cells should continue as planned, but as detailed in Section 4, should be adjusted as follows for activated test cells B-102 and B-104:

- Completely remove the shield wall;
- Remove up to eight (8) inch depth of activated concrete from west, north and east walls;
- Remove up to ten (10) inch depth of activated concrete from south wall; and
- Remove up to six (6) inch depth of activated concrete from floor and ceiling surfaces

Also as planned, the aluminum liner and concrete rubble material generated from decontamination of the test cells is to be packaged and shipped to the Nevada Test Site (NTS) for disposal. In addition to the materials in the test cells for NTS disposal, it is recommended that other items be removed from the SETF utilizing the same controls as with the test cell decontamination, and that these materials also be packaged and disposed of at NTS. These items include:

- Piping for the former contaminated gas and contaminated liquid waste UST systems
- Floor drain systems and connecting piping in Room B-101, basement operating floor
- Dust collected from scabbling SML 5 and SML 8 surfaces to decontaminate the areas to background levels.

The basis for adding these items to the planned decontamination actions are discussed in further detail in Section 5 of this report. A separate report will be developed to present the results of post remediation surveys. The post remediation survey report will show that the planned decontamination was successful and that remaining materials generated by subsequent SETF demolition are suitable for disposal as DM. A Final Status Survey Plan and subsequent report will be developed separately to address the sampling and analysis requirements of a MARSSIM designed final status survey (FSS) that demonstrates successful attainment of the end state.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low as Reasonably Achievable
AMCG	Average Member of the Critical Group
Ave. Bkg.	Average background
Bkg.	Background
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
DCGL	Derived Concentration Guideline Level
DHS-RHB	California State Department of Health Services, Radiologic Health Branch
DM	Decommissioned Materials
DOE	U.S. Department of Energy
DQO	Data Quality Objective
dpm/100cm^2	disintegrations per minute per 100 square centimeters
EPA	U. S. Environmental Protection Agency
ICRP	International Council on Radiological Protection
LABC	local area background contribution
LBGR	Lower Bound of the Gray Region
MBC	material background contribution
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
mrem/yr	millirem per year
NCRP	National Council on Radiation Protection
NRC	U. S. Nuclear Regulatory Commission
NORM	naturally occurring radioactive material
µCi	microcuries
OSHA	Occupational Safety and Health Administration
pCi/g	picocuries per gram
PM	project manager
PCOC	potential contaminants of concern
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RCA	radiation control area
RCRA	Resource Conservation and Recovery Act
RWP	radiation work permit
SAP	Sample and Analysis Plan
SDMS	Survey Data Management System
SETF	SNAP Environmental Test Facility, Building 4024
SML	Sample/Measurement Location
SNAP	System for Nuclear Auxiliary Power
TEDE	total effective dose equivalent
TLD	thermo luminescent dosimeter
TSCA	Toxic Substances Control Act
UST	Underground Storage Tank
WBS	Work Breakdown Structure

1. INTRODUCTION

The Boeing Company (Boeing) awarded AREVA NP Inc., (AREVA) an Undefinitized Firm Fixed-Price Letter Contract No. 116285 (contract) January 22, 2007. The Scope of Work for the contract is to plan and perform the demolition and removal of the existing SNAP Environmental Test Facility, (SETF), also known as Building 4024. The facility was used for the testing of small nuclear reactors and induced radioactivity (i.e., activation products) remains within the building structure. The project is located within Area IV of the Santa Susana Field Laboratory, eastern Ventura County, California. The project execution requirements involve facility demolition including the complete removal of the subsurface concrete and associated utilities. The desired end state for the project consists of:

1. Verification the site meets the established site release criteria using MARSSIM-compliant survey methods and techniques of the remaining soil and/or bedrock, and
2. The excavation has been backfilled in compliance with the applicable requirements and the site re-graded to natural contours. Note that the term "site" as used here refers to the subsurface excavation and the backfilled locations.

The period of performance for the surveys described in this report was from February through March 30, 2007 for planning the work, and April through May 31, 2007 for performance of the planned work. During planning, AREVA developed the following:

- Sample and Analysis Plan for the SETF Radiological Characterization and Confirmation Survey, Rev 0, March 2007, AREVA
- Quality Assurance Project Plan for the SETF Survey, Rev 0, March 2007, AREVA
- Health and Safety Plan for the SETF Decommissioning, March 2007, AREVA
- Procedure Manual for the SETF Decommissioning, March 2007, AREVA

The Sample and Analysis Plan (SAP) and supporting documents were developed to guide the performance of radiological characterization and confirmatory surveys that are the subject of this report. The timing for performance of the survey was planned to occur prior to performance of decontamination activities for the SETF, to guide the performance of remedial action support surveys during performance of decontamination and demolition activities of the SETF. The objectives of the characterization and confirmatory surveys include completion of a background study; and confirmation of current radiological conditions of the following SETF areas:

1. Clean DM (decommissioning materials) areas
2. Activated test cells
3. Former UST (underground storage tank, gas and liquid) area
4. Drain systems, contaminated liquid and floor drains
5. Solid waste storage system

Data from the background study will be used to evaluate data from subsequent final status surveys. Data from SETF surveys can be used to assist with finalizing decontamination planning, environmental protection and worker health and safety evaluations, and confirm waste management assumptions. Results of the survey and background study can also assist with remedial action support survey data evaluations once activated portions of the test cells are removed. A separate report will be developed to document the remedial action support survey, to show that decontamination efforts were successful and that remaining portions of the test cells can be demolished with other SETF survey units and disposed of as DM.

2. BACKGROUND

Boeing West Hills and its predecessor organizations performed nuclear research and energy development activities at its Santa Susana Field Laboratory (SSFL) from about 1954 until the end of 1998. Activities sponsored by the Department of Energy (DOE) and its predecessor agencies, included engineering, research, development, and manufacturing operations.

The nuclear and energy development facilities, including the Energy Technology Engineering Center (ETEC) operations, were located in Area IV of the SSFL site, which is situated in the Simi Hills of southeastern Ventura County, California (Figure 2-1). The nuclear work concluded in the late 1980s. The D&D of all remaining SSFL facilities associated with DOE-sponsored activities is currently being performed under the ETEC Closure contract with the DOE. The SETF is owned by the U.S. DOE.

The SETF was designed and erected for testing SNAP reactors in a simulated operational environment. The facility was erected in 1960 and was then enlarged in 1962 to provide a second control room and increased operating equipment area. Four unshielded SNAP-type reactors were tested at the SETF. Following the end of testing, the reactor systems and their associated radioactive test equipment were removed. Additional decontamination and dismantlement operations were performed in 1978 and again in 2005.

2.1 SETF Facility Description

As constructed, the SETF consisted of three basic areas: the high bay, general support and mechanical/electrical support areas. A paved yard surrounded the main building where other above grade support structures and below grade components such as radioactive solid, liquid, and gas storage tanks were once buried as shown in the SETF site plan (Figure 2-2).

2.1.1 High Bay Area

The high bay area is the section of the building built above the subsurface cell complex and operating gallery. The high bay area is enclosed by a structural steel, mill-framed building; see Figure 2-3. The panels forming the siding have asbestos containing material (ACM) in the sealant used on the panels and must be handled as ACM. Removal of ACM including the performance of a survey to determine the presence of asbestos containing material is the responsibility of the contractor. To handle the cell roof plugs in the high bay floor, a still operational 20-ton gantry crane moves on rails that extend through a high bay door to approximately 40 feet east of the structure where outside storage cavities were constructed and still remain.

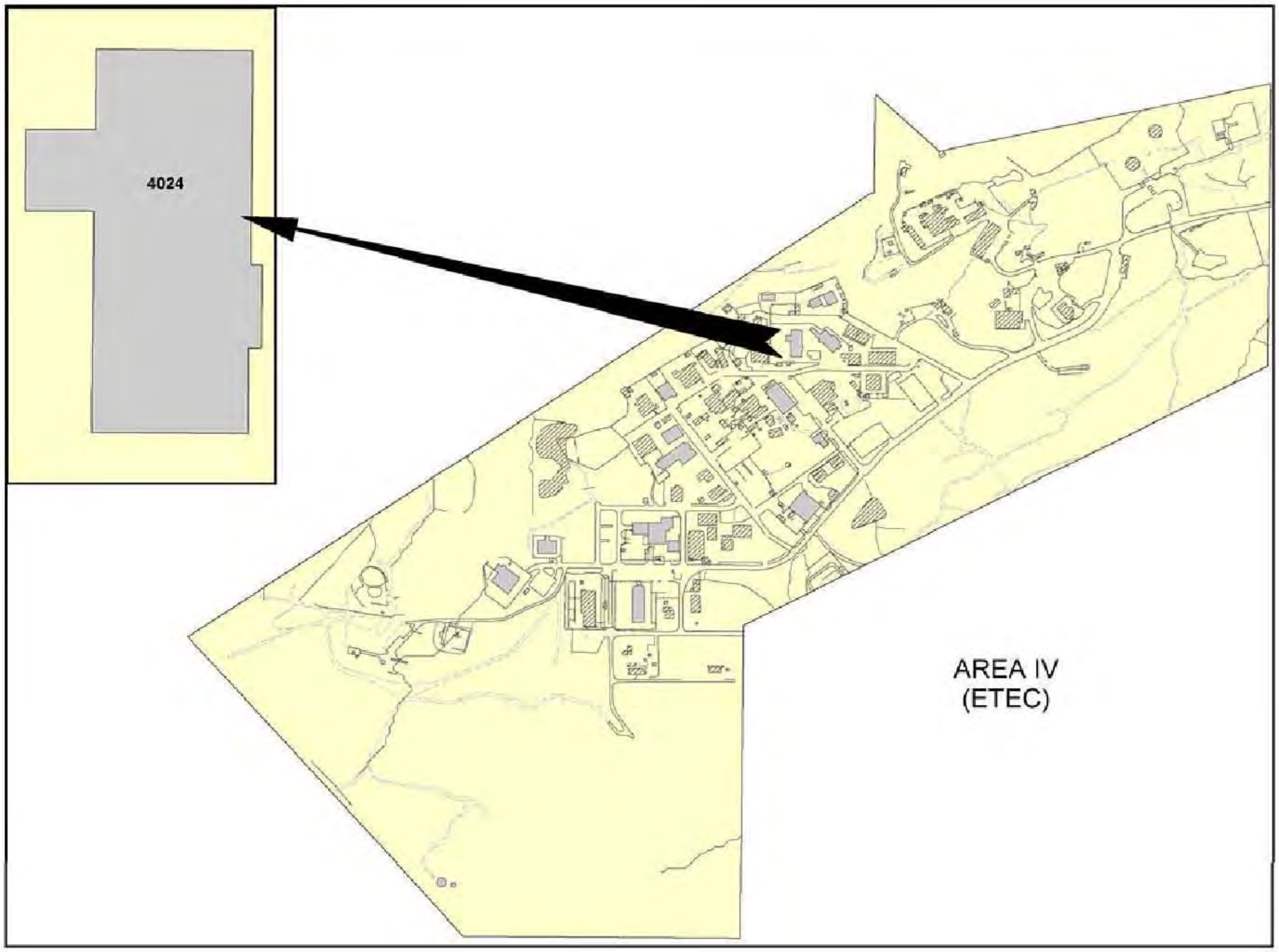


Figure 2-1, Location Map of SETF, Building 4024 at ETEC

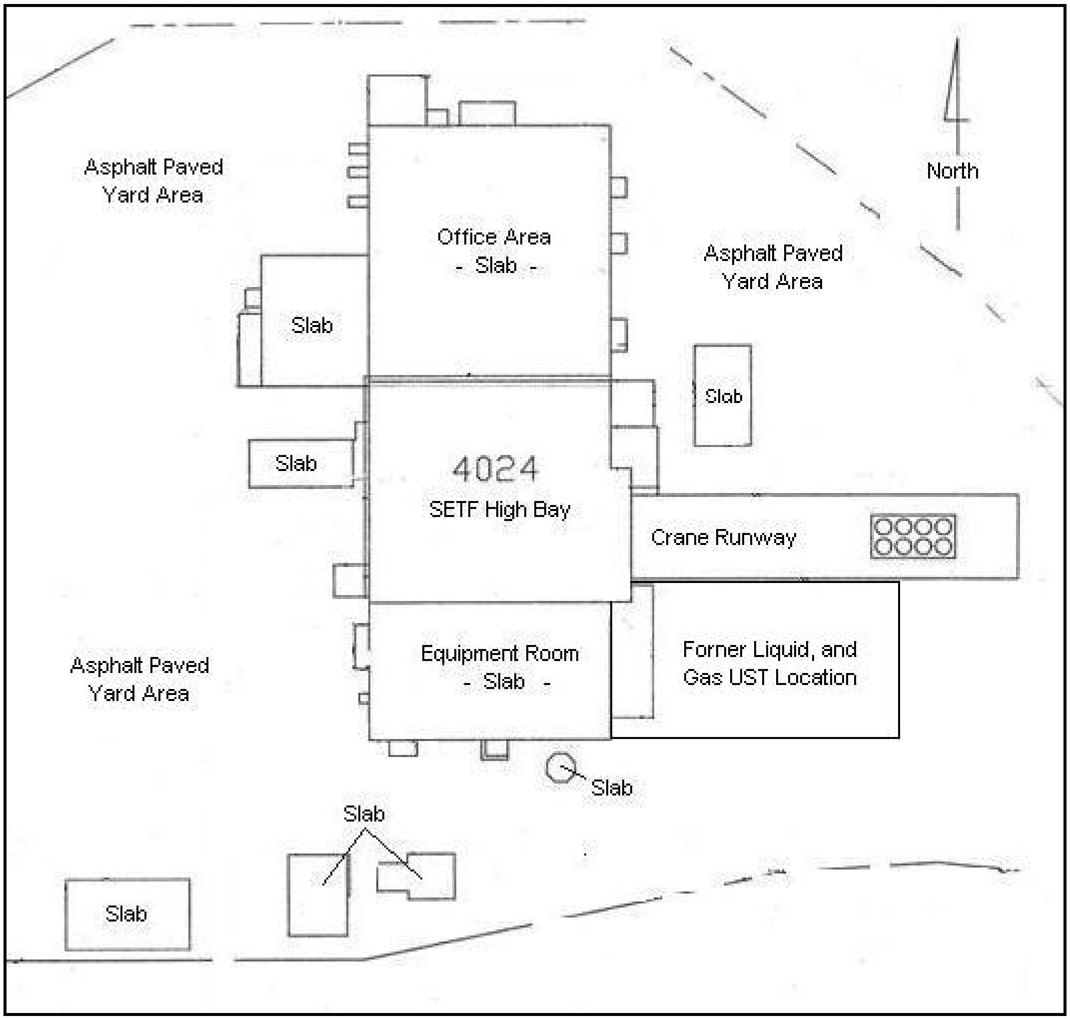


Figure 2-2, SETF Site Layout

Figure 2-3, SETF High Bay

The sub grade test cell complex (SGTCC) consists of the three parallel cells (two power test cells and the center transfer cell), a partial rear corridor which interconnects the cells, and the operating gallery, see Figure 2-4, Sub Grade Test Cell Complex. To insure gas tightness, the cells were completely lined on the inside with 3/16 inch-thick aluminum plate. This plate was seal welded to T-bar anchors in the structural concrete. The top of the cells' 8 foot thick roof is at ground level and serves as the high bay floor. The subsurface construction of the facility allowed advantage to be taken of the natural shielding for neutron and gamma radiation attenuation provided by the earth and rock on four sides of the complex. The below grade structure side and rear walls were back-filled with earthen fill materials. The floor was cast on the bedrock. The side wall structural concrete is nominally 3 feet thick, the rear wall concrete is 2 feet thick and the floor concrete varies from 6.5 to 8 feet thick as the rock elevation varies. Concrete walls which separate the three cells are 4-1/2 feet thick; the transfer cell's front wall is 4-1/2 feet thick; and the front walls of the two test cells are 9 feet thick. A 3-feet-thick concrete partial wall was built across the rear of each test cell, creating a common corridor. Nine floor storage vaults were constructed in the floor of the corridor, three at the rear of each cell.

The 4 by 7 feet access doors between the operating gallery and each cell were stepped plugs of the same thickness as the shield walls which they penetrate and provided for personnel or equipment access to the cells. Tracks were provided in the floor, for the self-powered plugs to roll on. Two of these doors remain in the lower operating gallery area of the facility. The roof of each cell is penetrated by a 9 feet diameter circular access port. The plugs filling this port are stepped for shielding purposes. To not exceed the capacity of the 20-ton gantry crane, the plugs are constructed in three layers to make up a total thickness of 8 feet. The center of the roof access plugs are penetrated by a 24 inch minimum diameter port with a single shield plug in each.

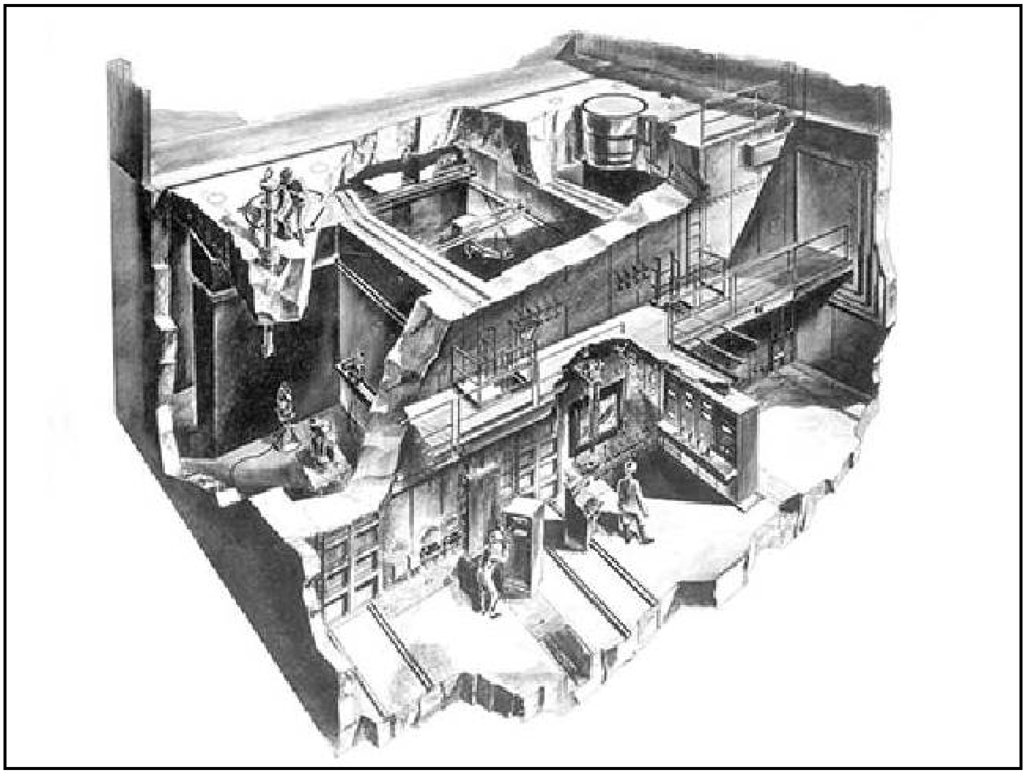


Figure 2-4, Sub Grade Test Cell Complex

The roof, front face and walls separating cells from one another are all pierced by 8 inch and 10 inch minimum diameter stepped ports. Two other types of cell penetrations were provided; these are electrical and instrumentation conduits and "through tubes." The aluminum conduits run from the cell liner out through the walls or roof. Aluminum bent-design through-tubes of two sizes, 1-1/2 and 2 inch diameter penetrated the various walls.

The operating gallery is at two levels. The lower level is at the same elevation as the cell floors 28 feet below grade. The upper level is formed by a bolted steel floor 14 feet above the lower floor. The west end is partitioned off by a concrete wall that extends from the lower floor to the high bay floor. Personnel access to the gallery floors and equipment rooms is provided by a single stairway. Material and equipment was moved to either floor of the operating gallery by a 5-ton bridge crane that is operational.

2.1.2 General Support and Operating Area

Immediately north of the high bay area was the general support and operating area which contained the reactor control rooms, change rooms, rest rooms, boiler and compressor room and a shop area. The above grade structures have been demolished and only the slab remains in this area. The removal of the general support and operating area concrete slab is within this project scope and will be managed as decommissioned material.

2.1.3 Mechanical/Electrical Support Area

South of and adjacent to the high bay area was the mechanical/electrical support area containing two rooms, the filter and radioactive gas compressor room and the electrical equipment room. The above grade building structure and all equipment was removed and only the concrete slab remains. The removal of the mechanical/electrical support area concrete slab is within this project scope and is expected to be managed as decommissioned material.

2.1.4 Yard Area

The yard is paved with asphalt which currently provides vehicle access to all sides of the building. Below ground radioactive waste storage facilities were once located in the area. The underground storage tanks (UST) removed during a 1977-78 D&D campaign were: three 6 feet diameter by 40ft long radioactive gas holdup tanks; and two buried 500 gallon liquid radioactive waste holdup tanks located east of the gas holdup. Documentation, survey results, written plans and photos taken during the removal of these components, were unavailable and the area was re-surveyed as a part of the characterization and confirmatory surveys between May 11 and May 31, 2007. Measurement and sample results from the survey were in the normal background range as detailed in Section 4.4. Other findings from the survey include: piping to the former contaminated gas and liquid USTs remains in place; and asphalt previously covering the area and broken pieces of concrete from the former liquid waste storage tank vault was present in the UST survey area.

Eight 3 feet diameter by 8.5 feet deep solid radioactive waste storage vaults, each with a 4.5 feet thick shield block cover are located on the SETF east side in the crane runway area. The vault covers were removed from the storage vaults to conduct characterization and confirmatory surveys, but each were found with approximately 4 ft. of water. The source of the water was most likely from rain water intrusion. Each vault cover received a radiological control survey as they were removed, then each were placed on herculite sheeting for temporary storage. Direct measurements and smear sample results from the radiological control survey of the eight vault covers were in the normal background range as detailed in Section XX. In addition, water samples collected for radiological control purposes and analyzed by gamma spectroscopy analysis did not detect any COCs. No further characterization and confirmatory surveys were conducted due to the DOE Stop Work Order issued May 25, 2007. The water was left as found and the vault covers were replaced.

Facility water was supplied by a 12 inch diameter water line crossing the southeast corner of the site. A looped system around the SETF was provided for fire protection, industrial demands, and domestic requirements. A sanitary sewer system collected non-radioactive sewage wastes from the building lavatories and carried it to the central sewer manhole in the northwest corner of the site. All utilities are to be disconnected and blanked off by Boeing prior to start of demolition. Removal of the disconnected subsurface utilities within the established project boundary is within this project scope. Asphalt, concrete foundations, etc. within the area is to be surveyed, removed and managed as a Decommissioned Material.

2.1.5 Site Lithology

A layer of fill, weathered bedrock or native soil covers the area to variable depths. The site is underlain by the upper cretaceous, arkosic-sandstone Chatsworth formation. Shallow groundwater may be present at the site. The shallow groundwater at the 4024 site has been sampled and analyzed by Boeing and found to be free of contamination.

2.2 Identity of Potential Contaminants

Radioactivity induced by testing SNAP reactors in the sub grade test cell complex was detected as documented in RS-00025, Building 4024 Concrete Sampling (Reference 7.5). The RS-00025 report provides the results for concrete sampling in the SETF, Building 4024 conducted in 2003. The activity of 1 inch depth cores ranged from no detectable activity to 105 pCi/g of Europium-152 (Eu-152) and 9.4 pCi/g of Cobalt-60 (Co-60), the primary contaminants of concern (COC).

The results from the RS-00025 survey and this characterization and confirmatory survey were used to predict which concrete needs to be removed with radiological controls and managed as radioactive waste and which can be removed as decommissioning materials without radiological controls and shipped to a Class 1 landfill. According to the Reference 7.6, Historical Site Assessment of Area IV Santa Susana Field Laboratory Ventura County, California (HSA), other potential radionuclide contaminants of concern (PCOC) in addition to Co-60 and Eu-152 include: Am-241, Cs-134, Cs-137, Eu-154, Fe-55, Fe-59, H-3, K-40, Mn-54, Na-22, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Th-228, Th-230, Th-232, U-234, U-235, and U-238. These additional PCOCs were tested for during the confirmatory survey.

2.3 Regulatory Authority and Guidance Documents

2.3.1 Facility Decommissioning

The decommissioning and demolition of the SETF Building 4024 will be performed as a non time critical removal action under the U.S. Department of Energy's (DOE's) incumbent CERCLA authority. Use of non-time critical removals for conducting decommissioning activities effectively integrates DOE lead agency responsibility, U.S. Environmental Protection Agency (EPA) oversight responsibility, and stakeholder participation. The DOE Decommissioning Program will utilize DOE expertise in devising and implementing appropriate solutions to decommissioning projects. Effective EPA oversight and stakeholder participation will be provided in compliance with applicable requirements. Decommissioning projects will retain sufficient flexibility to tailor activities to meet specific site needs, and achieve risk reduction and restoration expeditiously.

Regulations and guidance documents utilized for Sample and Analysis Plan development and for survey implementation include:

1. DOE O 5400.5, Radiation Protection of the Public and the Environment
2. Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
3. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1, August 2000
4. NUREG–1501, Background as a Residual Radioactivity Criterion for Decommissioning, NRC Draft Report for Comment, August 1994
5. NUREG–1506, Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria, NRC, August 1995
6. NUREG-1507, Minimum Detectable Concentrations With Typical Radiation Survey Instruments For Various Contaminants And Field Conditions, NRC, Draft Report for Comment, August 1995

2.3.2 Decommissioned Materials

The D&D strategy used in most prior decommissioning projects at the SSFL was to clean the facilities and/or materials to radiological release criteria approved by the DOE and the NRC-authorized California State Agency, Department of Health Services, Radiological Health Branch (DHS-RHB). Decontaminated facilities or materials would then be surveyed and released for unrestricted use by the agency with regulatory jurisdiction, DOE, NRC or DHS-RHB. The facility would then either be reused or demolished and disposed of in a Class III municipal landfill.

In 2002, the Governor of California issued a moratorium (Ref. 7.3, Executive Order No. D-62-02) on the disposal of waste materials originating from former radiological facilities that passed the approved numerical release criteria (Ref. 7.4, N001SRR140131) but potentially contained amounts of manmade radioactivity above background. These materials were defined as “decommissioned materials” (DM) and were no longer permitted to be disposed of in Class III or unclassified (unlined) waste disposal sites. Under the Governor’s moratorium, the materials below the release criteria from a released, demolished former radiological facility can only be disposed of at a Class I or Class II waste disposal facility when there is a potential for radioactivity to be present above background levels.

Boeing has established the following process for identifying materials that fall within the category of decommissioned materials: The Boeing Health, Safety and Radiation Services department first performs surveys to assure that contamination levels are below the designated criteria contained in N001SRR140131. Documentation is then provided to the DHS-RHB. The DHS-RHB then performs a verification survey, provides written concurrence, and the materials are then sent to a Class I hazardous waste facility.

Boeing shall coordinate with the DHS-RHB to obtain approval to ship DM to Class I or Class II landfills. This will entail providing DHS-RHB with AREVA supplied survey/sampling data showing that the remaining SETF structure is DM that meets approved cleanup standards, and facilitate DHS/RHB to perform a verification survey of the DM. AREVA shall be responsible for working with the DHS-RHB for the classification/confirmation of DM wastes. If the DHS-RHB decline to participate in the verification process, then the DOE will self-certify that the material meets the DM criteria based on the AREVA survey data.

N001SRR140131 contains both surface contamination limits (consistent with the limits of Reg. Guide 1.86 and DOE Order 5400.5) and soil concentration limits. Soil concentration limits can also be used for volumetric contamination limits of building debris, including concrete and rebar. AREVA will implement the ALARA process in its demonstration of DM. That is to say, the DHS-RHB will more readily accept material as DM if contamination levels, both surface and volumetric, are ALARA.

Based on surface area, volumes and survey data, a dose analysis of the DM for a land fill scenario will be prepared by AREVA. The dose analysis will demonstrate that the permit requirements of the Class I hazardous waste facility are met. The permit requires that the disposal of DM would not result in significant contamination of the environment as defined in California Health and Safety Code Part 9, Chapter 5, Article 1.

AREVA as the D&D contractor will encounter two categories of decommissioned materials on this project. The SETF high bay (down to the basement area, as indicated by survey markings on the walls) and the foundations for the General/ support and Mechanical/electrical support areas have already been surveyed by DHS-RHB and documented as meeting the DM criteria. The remainder of the SETF which will be managed as DM requires contractor survey, review by the RHB-DHS and verification survey by DHS-RHB. Alternately, the DOE will self-certify this material as DM if the DHS-RHB decline to participate.

3. SURVEY PROCESS

The Data Quality Objectives (DQOs) process was followed to plan and conduct the radiological surveys in accordance with the guidance provided in the MARSSIM (Ref., 7.10) The process was followed in order to determine the nature of the problem and collect the required data to effectively solve the problem.

3.1 Data Quality Objectives

As discussed in the SAP, the DQOs for this survey were as follows:

1. *State the problem*	Radioactive, activated concrete and metal rebar is present from SNAP reactor testing operations at SETF Building 4024 within SGTCC test cells, depth of activation is thought not to exceed 16 inches, and no other radioactive contamination is known to exist within to structure. However, because the activated concrete and metal is to be removed before structural DM of the SGTCC is removed; additional depth profiling is needed to confirm the absolute depth necessary to release the

	test cells as DM while maintaining structural integrity. In addition, confirmation of the radiological condition of the remaining SETF structure and environs as well as background reference areas applicable to each are needed before planned decontamination and demolition to ensure the desired end state for the SETF can be achieved.
2. *Identify the decision*	Determine the depth necessary to decontaminate and release the remaining test cells as DM, and confirm that radioactive contamination is not present in the SETF structure and environs. If contamination is present, characterize the nature and extent of contamination within the structure and environs, and determine the next steps to further characterize the surrounding soils.
3. *Identify inputs to the decision*	The following will be collected or performed to further characterize and/or confirm absence of contamination within the SETF: • Direct alpha and beta gross radiation measurements for total surface activity; • Contact and 1 meter gamma exposure rate measurements; • Smear samples for removable alpha and beta gross surface activity; • Sediment, soil and material samples for isotopic analysis (e.g., alpha and/or gamma spectroscopy; liquid scintillation counting, etc.,) • Concrete core samples in test cells for direct measurement and isotopic analysis to further define depth of activation • Background study at non-impacted locations to determine the levels of the radioactivity associated with the materials of construction and naturally-occurring radioactivity in sediments and soils in the surrounding environment. Operate instruments for background study and SETF survey direct measurements and sample analysis such that measurement and/or analysis sensitivities or minimum detectable concentrations (MDCs) are ALARA or, as a minimum less than the derived concentration guideline levels (DCGLs)
4. *Define the study boundaries*	For the SETF study structure and environmental areas: Test cells, perform measurements and core bore sampling to gain further information on the depth of activation to assist during removal of LLW from SETF test cell walls, floor and ceiling. For SETF areas already confirmed by DHS-RHB as decommissioned materials (DM), confirm that residual radioactivity above natural background from former operations at Building 4024 is not present. For the background study, the structural surfaces portion, measurements and samples were conducted in non-impacted buildings of similar age and materials of construction at the SSFL; and for the environmental

soil area portion, appropriate reference areas were found off the SSFL site. Each provided values representative of natural background radioactivity associated with the SETF materials of construction and naturally occurring radioactive materials (NORM) present in SETF environmental soil areas.

5. *Develop a decision rule* — The field measurements and sampling results from the survey will be compared with results from the background study and with site specific surface contamination limits and/or radionuclide specific derived concentration guideline levels. If data from the SETF structure and/or environmental area is above background and above the contamination limits, it will be considered to have been potentially impacted by activities from the former SNAP reactor testing or previous dismantlement and surveys to bound the depth and breadth of contamination conducted.

The sections that follow describe the survey and statistical methods that were used to achieve the DQOs.

3.2 Survey Objectives Achieved

The survey objectives achieved from implementing the Sample and Analysis Plan for the SETF Survey, Rev 0, March 2007, AREVA (SAP) Reference 7.6, were as follows:

- Obtained additional radiological characterization data to guide decontamination efforts in the activated portions of SGTCC, Test Cells B-102 and B-104
- Performed confirmatory surveys in areas of the SETF already confirmed by DHS-RHB as decommissioned materials (DM) suitable for disposal at Kettleman Hills Class I disposal site, included were:
    - High Bay first floor and basement, all areas except Test Cells B-102 and B-104
    - Paved yard area and floor slabs left from portions of SETF structure previously removed
- Performed confirmatory surveys in other areas/portions of the SETF where documentation of the radiological condition is needed, included were:
    - Environmental soil areas surrounding the paved yard
    - Location of the former contaminated gas and liquid waste underground storage tanks (UST), surface and subsurface soils
    - System piping remaining from the former contaminated gas and liquid waste USTs
    - SETF basement floor drain system in SGTCC, operating floor room B-101
    - Solid waste storage vault system
- Obtained background data from materials of construction on surfaces and environmental soil areas both of which are not impacted by use or storage of radioactive materials

The background data is used to assist with evaluations of survey data obtained from SETF surfaces and environmental soil areas to determine if materials are to be removed as low level radioactive waste (LLW), decommissioned material (DM), or suitable to release for unrestricted use after final status surveys are completed. By combining characterization and confirmatory survey results with the results of the previous RS-00025 survey, a complete characterization of the SETF site is available.

The survey results include measurements for gross total and removable surface radioactivity, dose rate, and material sampling for isotopic analysis performed and/or collected at random and biased locations on facility surfaces and in environ soil areas. The survey results also include gross measurement and isotopic analysis from core bore samples of the SETF test cell walls to gain further information on the depth of activation.

3.3 Derived Concentration Guideline Levels for Surveys

3.3.1 Surface Contamination DCGL

DCGLs (in units of dpm/100 cm2) were selected from Table 5 of N001SRR140131; to facilitate proper selection and setup of the survey instrumentation. The values meet requirements of DOE Order 5400.5, and N001SRR140131 specifies the acceptable surface contamination limits approved for use at the SSFL by the DOE and DHS-RHB; the limits are presented in Table 3-1. The DCGLs to be used for this survey are 100 dpm/100 cm2 above background for direct or total alpha surface contamination and 20 dpm/100 cm2 for removable alpha surface contamination. The beta-gamma surface contamination DCGL to be used for this survey is 5,000 dpm/100 cm2 above background for direct or total surface contamination and 100 dpm/100 cm2 for removable surface contamination. Note that the 100 dpm/100 cm^2 for removable beta surface contamination is less than the general beta-gamma limit of 1,000 dpm/100 cm^2 and the Sr-90 beta limit of 200 dpm/100 cm^2. These values will be the basis for measurement MDCs and comparison for direct measurements to determine acceptable residual radioactivity levels once corrected for the natural background. These values were also used in conjunction with personnel, instruments, equipment decontamination, and free release procedure to determine suitability to free release.

Table 3-1, Acceptable Surface Contamination Values[1]

Radionuclide	**Average Total** (dpm/100 cm^2) (Fixed + Removable)[2, 3]	**Maximum Total** (dpm/100 cm^2) (Fixed + Removable)[2, 3]	**Removable** (dpm/100 cm^2)[2, 4]
U-nat, U-235, U-238, and associated decay products	5,000 (alpha)	15,000 (alpha)	1,000 (alpha)
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5]	5,000	15,000	1,000
Tritium and tritiated compounds[6]	N/A	N/A	10,000

NOTES:

1. The values in Table 3-1 are from Ref. 7.4, Boeing document N001SRR140131 and are consistent with values contained in DOE O 5400.5 and 10 CFR Part 835, Appendix D. The values, with the exception noted in footnote 5, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for alpha-and beta-gamma-emitting nuclides apply independently.
2. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
3. The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.
4. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note--The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
5. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
6. Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a ``Total'' value does not apply.

3.3.2 Gamma Exposure Rate Measurements

Contact gamma and gamma exposure rate measurements at 1 meter above surfaces were performed during the survey for informational purposes. Measurement results are provided in counts per minute (cpm), and compared to background cpm values for evaluation purposes. To evaluate the exposure rate measurements, the mean of results of background study for surface soil and structural surfaces including asphalt, concrete and metal were used as background reference. During the evaluation each measurement result was compared to the material background applicable to the surface material. In addition to background comparison, each measurement result was compared to the material background ± 3 sigma of the data set to evaluate if the result was statistically different from natural background in accordance with guidance provided in Chapter 8 of the MARSSIM.

3.3.3 DCGLs for Soil or Bulk Decommissioned Materials

The DCGLs to be used to determine that decontamination of the activated SETF test cells has been successful for the SETF contaminants of concern (COC) are 1.9 pCi/g for Co-60, and 4.5 pCi/g for Eu-152. The values in Table 3-2 come from Section 3.5 of N001SRR140131 guidelines for residential soil. These DCGLs with ALARA principles will also be used to show that portions of the SETF remaining after cell decontamination is complete can be demolished and disposed of as DM.

In addition to the primary COCs, other radionuclides with potential to be present at the SETF were analyzed for during characterization and values from N001SRR140131 used as DCGLs. The DCGLs for the COCs, potential COCs and goal for analysis minimum detectable concentrations (MDC) are presented in Table 3-2 that follows. Existing dose-based DCGLs were used here because the DHS-RHB recommends a dose analysis be prepared for disposal of DM to landfills. The DCGLs below are based on a 15 mrem/y dose limit for a residential exposure scenario. By meeting these DCGLs plus ALARA, the actual effective dose for a landfill exposure scenario will be assured to be much less than the DHS-RHB landfill dose limit of 100 mrem/yr. A dose assessment of the decommissioned material will demonstrate that this objective is met.

A separate Final Status Survey Plan will be developed to address the sampling and analysis requirements of a MARSSIM designed final status survey (FSS) that demonstrates successful attainment of the end state. This FSS plan will include DCGLs based on a cancer incidence risk level of 1×10^{-6} for residential exposure scenario soil areas after the SETF structure has been removed.

Table 3-2, Acceptable Soil and Bulk DM DCGLs and MDCs

Radionuclide	Symbol	MDC (pCi/g)	DCGL (pCi/g)
Americium-241	Am-241	0.1	5.4
Cobalt-60	Co-60	0.1	1.9
Cesium-134	Cs-134	0.1	3.3
Cesium -137	Cs-137	0.1	9.2
Europium-152	Eu-152	0.5	4.5
Europium -154	Eu-154	1	4.1
Iron-55	Fe-55	20	629,000
Hydrogen-3	H-3	10	31,900
Potassium -40	K-40	1	27.6
Manganese-54	Mn-54	0.1	6.1
Sodium-22	Na-22	0.1	2.3
Nickel-59	Ni-59	2000	151,000
Nickel-63	Ni-63	10	55,300
Plutonium-238	Pu-238	0.1	37.2
Plutonium -239	Pu-239	0.1	33.9
Plutonium -240	Pu-240	0.1	33.9
Plutonium -241	Pu-241	5	230
Strontium-90	Sr-90	0.5	36
Thorium-228	Th-228	0.1	5
Thorium -232	Th-232	0.1	5
Uranium-234	U-234	0.1	30
Uranium -235	U-235	0.1	30
Uranium -238	U-238	0.1	35

3.4 Organization and Responsibilities

AREVA implemented an integrated management approach that included project management oversight and technical support. The AREVA Project Manager supported the onsite team to ensure successful project execution and completion. The onsite survey and sampling team, position descriptions, required training and experience is discussed in detail in Reference 7.7, Quality Assurance Project Plan for the survey.

3.5 Survey Instrumentation

Table 3-3 provides a list of the instruments, types of radiation detected and calibration sources used for the survey. The instruments were selected to ensure measurement sensitivities sufficient to detect the identified primary radionuclide at the minimum detection requirements. The Ludlum Model 2350-1 Data Logger instrument with a variety of detectors was used for direct measurements of total alpha and beta surface activity as well as for contact and 1 meter gamma exposure rate measurements. The Data Logger is a portable micro-processor computer based counting instrument capable of operation with ZnS scintillation, plastic scintillation, GM, and NaI(Tl) gamma scintillation detectors. The Data Logger is capable of retaining in memory the survey results and instrument/detector parameters for up to 1000 measurements. This data is then downloaded to a personal computer for subsequent reporting and analysis.

Detector selection depended on the survey to be performed, surface contour and survey area size. The project team used a 125 cm^2 Zinc Sulfide (ZnS) detector for integrated direct alpha measurements and a 125 cm^2 plastic scintillation detector and 15.5 cm^2 GM detector for integrated direct beta measurements and count rate for scan measurements. A 2" x 2" Sodium Iodide (NaI) gamma scintillation detector was used for contact and 1 meter gamma exposure rate integrated measurements; and count rate for scan measurements. Smears for removable alpha and beta activity were analyzed using a shielded Alpha/Beta Planchet Counter. Typical MDCs for the instrument/detector combinations are presented in Table 3-3, Portable Survey Instrumentation.

Isotopic quantification and identification will be performed on soil, sediment, and residue/debris samples sent offsite to the AREVA Environmental Laboratory (AREVA E-Lab). The AREVA E-Lab will analyze these samples using High Purity Germanium (HPGe) based gamma spectroscopy system to quantify gamma emitting radionuclides, liquid scintillation counting for quantifying beta emitting radionuclides and solid-state silicon charged particle detector based alpha spectroscopy system to quantify alpha emitting radionuclides.

Table 3-3, Portable Survey Instrumentation

Instrument/ Detector	Detector Type	Radiation Detected	Calibration Source	Typical MDC[1]	Measurement
Ludlum Model 2350-1 with 44-116, 43-89 detector or equal	Plastic Scintillator (125 cm^2)	Beta	^{99}Tc (β)	400	Direct beta, static
				2,000	Beta scan.
Ludlum Model 2350-1 with 43-90, 43-89 detector or equal	ZnS Scintillator (125 cm^2)	Alpha	^{230}Th (α)	65	Direct alpha, static
Ludlum Model 2350-1 with. 44-40 detector or equal	Shielded GM (15.5cm^2)	Beta	^{99}Tc (β)	2,300	Direct beta, static
				< 5,000	Beta scans.
Ludlum Model 2350-1 with. 44-10 detector or equal	NaI (Tl) Scintillator (2" x 2")	Gamma	^{137}Cs (γ)	1,281 cpm	Static MDCR for gamma exposure rate
				905 cpm	Scan MDCR Surveyor for gamma scans.
Ludlum Model 2929 Scaler w/Model 43-10-1 Sample Counter	Dual channel Shielded Phoswich Scintillator	Alpha & Beta	^{230}Th (α)	11	Alpha Smear
			^{99}Tc (β)	78	Beta Smear

Note 1: Units are dpm/100cm^2 unless otherwise specified.

3.5.1 Instrument Calibration

Data loggers and associated detectors were calibrated on an annual basis using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment. The calibration included: high voltage calibration; discriminator/threshold calibration; window calibration; alarm operation verification; and scaler calibration verification. The detector calibration included: operating voltage determination; calibration constant determination; and dead time correction determination.

Calibration labels showing the instrument identification number, calibration date, and calibration due date were attached to all portable field instruments. The user checked the instrument calibration label before each use, and performed pre-use response tests for each radiological control instrument. For the characterization and confirmatory survey instruments, the user checked the instrument calibration label before each use, and performed pre-use and post use response tests in accordance with procedures.

3.5.2 Sources

All sources used for calibration or efficiency determinations for the survey were representative of the instrument's response to the identified nuclides and were traceable to NIST. Radiation Protection Technicians controlled radioactive sources used for instrument response checks and efficiency determination. All sources were stored securely and accounted for during the survey.

3.5.3 Static Measurement Minimum Detectable Concentration

As a data quality objective, the instrument operating parameters were set such that static alpha and beta measurement MDCs were one half the DCGL, or at a minimum less than the DCGL in accordance with guidance provided in the MARSSIM. The MDC is defined as the smallest amount or concentration of radioactive material in a sample that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity and a 5% probability of falsely interpreting true activity as background. The MDC is dependent upon the counting time, geometry, sample size, detector efficiency and background count rate as explained in Reference 7.13, NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. The equation used for calculating the static MDC for field instrumentation is:

$$MDC = \frac{3 + 3.29\sqrt{R_b\, t_s\, (1 + \frac{t_s}{t_b})}}{E_T\, (\frac{A}{100}) * t_s}$$

Where:

- MDC = Minimum Detectable Concentration (dpm/100 cm^2)
- R_b = Background Count Rate (cpm)
- t_b = Background Count Time (min)
- t_s = Sample Count Time (min)
- A = Detector Area (cm^2)
- E_T = Total detector efficiency (MARSSIM Section 6.6.1)

And:

$$E_{T1} = \left(\frac{D_C}{S_C} * E_{S1} \right)$$

Where:

E_{T1} = total detector efficiency (NUREG-1507)

D_C = net detector counts (cpm)
S_C = source 2π emission rate (cpm) from source calibration certification
E_{S1} = source efficiency, unless directed to use experimentally proven value, use 0.25 for alpha measurements and beta measurements (beta energies from 0.15 to 0.4 MeV) or 0.5 for beta measurements (beta energies > 0.4 MeV)

If the source used for the detector efficiency determination was calibrated for total activity only (e.g., source 4π activity in dpm), the detector efficiency would be calculated as follows:

$$E_{T2} = \left(\frac{D_C}{S_D} * E_{S2} \right)$$

Where:

E_{T2} = total detector efficiency

D_C = net detector counts (cpm)
S_D = source 4π activity (dpm) from source calibration certification
E_{S2} = source efficiency, unless directed to use experimentally proven value, use 0.5 for alpha measurements and beta measurements (beta energies from 0.15 to 0.4 MeV) or 1.0 for beta measurements (beta energies > 0.4 MeV)

Prior to performing field measurements, the survey team calculated preliminary MDCs using the local area background and information from the background study.

3.5.4 Scan Survey Minimum Detectable Concentration

The scan MDC for structure surfaces was calculated according to the guidance provided in the MARSSIM Section 6.7.2.1, as follows:

$$ScanMDC = \frac{MDCR}{\sqrt{p}E_i E_s \left(\frac{A}{100}\right)}$$

Where:

$MDCR$ = Minimum detectable count rate

E_i = instrument efficiency
E_s = surface efficiency
p = surveyor efficiency
A = Detector Area (cm^2)

3.6 Number of Measurements

The number of measurements needed in an impacted survey unit was based on settings recommended in Reference 7.16, Appendix A, Section A.7, Volume 2 of NUREG-1757 and the MARSSIM Section 5.5. The settings for the number of measurements determination in a survey unit was as follows:

- The null hypothesis (H_0) was that residual radioactivity in the survey area and/or units exceed the release criterion.
- For the purpose of the characterization and confirmatory surveys, Type I error (α) was set at 0.05 or 5 percent and Type II error (β) was set at 0.05 or 5 percent.
- The lower bound of the gray region (LBGR) was conservatively set at 50% of the DCGL, LBGR could be adjusted to provide a value for the relative shift between the range of 1 to 3.
- The relative shift was conservatively set to 1.5.

Because the survey measurements were corrected for background and the sample analysis is radionuclide specific, the number of measurements was taken from the MARSSIM Table 5.5. This resulted in a value of "N" (prescribed number of samples/measurements) equal to 18 for each survey unit, with an additional 18 samples/measurement locations (S/ML) for the reference area. The values listed in MARSSIM Table 5.5 are increased by 20% to account for potentially unusable data.

3.6.1 Survey Package Development

For each survey unit, (e.g., background reference area, structural surfaces, and environmental soil areas) the survey team developed a survey package, or portfolio. The survey packages were the primary method of controlling and tracking the hard copy records of survey results. The characterization survey packages were developed according to the SAP, and are provided as Appendix C to this report as record of completed survey activities. Survey records were documented and maintained in the survey packages for each survey unit. Photographs and/or drawings were developed for each survey package depicting the survey area or survey unit, and drawings were annotated with the location of the survey measurement locations. As the survey progressed, the project team updated the survey package(s) with the survey data and results of any surveys and/or sample analyses performed. Refer to the SAP for further information on survey package development.

3.7 Survey Measurements and Sample Analysis

This section describes survey measurements, samples for isotopic analysis and protocols used for performing measurements during the characterization and confirmatory survey and background study. The protocols and order performed varied depending on whether the survey unit was a structural surface, environmental soil area or portion of a system. Each measurement was performed in accordance with the SAP, Reference 7.6, and with the applicable survey package general and specific survey instructions. Refer to the survey package instruction for more detailed information. Direct measurements were coded and logged into a Ludlum Model 2350-1 data logger with specific parameters for survey package, surface, material type, and measurement number. Refer to Attachment 1 for measurement code example for the Survey Data Management System (SDMS). Data were downloaded from the data loggers at the end of each day to the secure SDMS Measurement Database module. Smear samples were counted, results calculated in a computer spreadsheet, logged into and uploaded to the SDMS Sample Database module at completion of survey. Refer to Section 3.5 for individual detectors used.

3.7.1 Direct Surface Activity Measurements

Direct measurements for total alpha and beta surface activity were performed for structural surfaces and systems survey units. For the direct measurements, the detectors were positioned in an appropriate geometry on the surface to be measured and a 60 second scaler count logged, i.e., and integrated count. The measurements were performed on solid dry surfaces on asphalt, concrete and/or metal structural surfaces. Sample and measurement locations (SML) were marked on drawings depicting the survey unit.

In addition to the direct measurements, local area (or general area) background measurements were logged, three 60 second pre-survey and three 60 second post survey integrated count backgrounds for the survey unit at a minimum. The purpose of these measurements was to determine levels of terrestrial local area background contribution (LABC) on gross measurement results in the subject survey unit. For performance of LABC measurements, the active surface of the alpha or beta detector being used was shielded from alpha or beta radiation, and the measurement was of the gamma LABC. For the activated test cells, a 60 second shielded single point background integrated count measurement was performed at each direct measurement SML due to the activated concrete present.

3.7.2 Removable Surface Contamination Measurements

Smear samples for removable alpha and beta surface contamination were collected for structural surfaces and systems survey units at each of the locations where direct measurements were performed. The smear sample were collected by applying moderate pressure and wiping approximately 100 cm^2 area using standard radiation control cotton 47 mm smear media. The smear samples were counted on a Ludlum Model 2929 alpha and beta smear counter.

3.7.3 Gamma Radiation Measurements

Contact gamma measurements at SMLs and gamma exposure rate measurements one meter above SMLs on floor or above soil sample locations were performed for structural surfaces and environmental soil area survey units. Contact gamma measurements were performed for systems survey units. Both measurements are integrated counts, and measurement results in cpm are presented for each. As such, the only difference in the two measurements is the distance from a SML.

3.7.4 Samples for Isotopic Analysis

Soil and/or material samples were collected for isotopic analysis for structural surfaces, environmental soil areas, and systems survey units. For structural surfaces and systems survey units, the project team performed sampling as material (e.g., residue, silt, or sediment) was identified. The samples were collected such that survey package instructions and DQOs for analysis sensitivity could be satisfied and in order of priority, as follows:

- 2 kg soil/sediment samples for gamma spectroscopy
- 75 to 100 g minimum material samples for the full suite of analysis, for all potential COCs
- Residues on smears where indication of removable contamination is detected

Removable contamination was not detected during the survey, as such smears were not sent for isotopic analysis. However, soil samples and concrete wafers from core bore samples in the activated test cells were collected and sent for isotopic analysis, as well as a sample from the 3/16" aluminum cell liner, steel rebar within the wall structure, sediment from floor drains and gas and liquid waste system piping, and concrete dust from two locations showing activity above background.

Each sample collected was packaged and field screened by the project team personnel, chain of custody forms and sample shipping paperwork completed, and sent offsite to the AREVA Environmental Laboratory (E-Lab) for analysis.

A total of thirty eight (38) surface soil 0 to 15 cm depth samples were collected and sent to the E-Lab for the full suite of analyses for each of the potential COCs, included were: eighteen (18) background reference SMLs with one composite QA sample; and eighteen (18) soil area SMLs surrounding the SETF paved yard with one composite QA sample. The composite samples were comprised of an equal portion from each of the associated eighteen samples. Eighteen (18) subsurface soil samples with one QA sample from 8 to 12 ft. depth trenches were obtained from the area/location of contaminated gas and liquid systems underground storage tanks removed in 1978. The subsurface soil samples were sent to the E-Lab for gamma spectroscopy analysis for the primary COC, and one composite sample comprised of an equal portion from each of the eighteen samples for the full suite of analysis for each of the potential COCs.

During the survey of the test cells, core bore sample locations were identified from location of highest and lowest gamma count rate during scan surveys with the NaI(Tl) detector shielded and/or collimated. A 3" diameter a wet application diamond core drill was used to obtain five concrete cores, some up to 15" depth, and two concrete cores from the previous 2005 survey. Each of the seven core samples were evaluated by performing a gamma scan along the length of the core with the NaI(Tl) detector shielded and/or collimated for one inch field of view. Then wafers were cut using a wet application tile saw with diamond blade. The wafers and exposed core surfaces were then evaluated by direct measurements for alpha and beta surface activity. Each concrete wafer produced was sent to the E-Lab for gamma spectroscopy analysis for the primary COCs, and one concrete wafer exhibiting the highest radioactivity, with associated sample of 3/16" aluminum cell liner and steel rebar within the wall structure were sent to the E-Lab for the full suite of analysis for each of the potential COCs.

During a second survey of concrete dust samples were collected from two SMLs just at the outside northeast and southwest corners of the SETF each on a concrete pad that showed fixed alpha and beta readings above background and MDC. The samples were collected by scarifying approximately one square foot at each SML, and the sample collected in a primary filter of a two stage vacuum. The primary filter was changed for each sample, and the two samples were sent to the E-Lab for the full suite of analysis for each of the potential COCs.

During the survey of the floor drain, contaminated gas and liquid piping systems, sediment was collected as was found available in accessible opening to each system. Materials from the floor drain system in the SETF basement, Room B-101, were combined to make one composite sample. Also materials from contaminated gas and liquid piping systems were combined to make one composite sample. These two samples were sent to the E-Lab for the full suite of analysis for each of the potential COCs.

3.8 Data Evaluation and Review

Direct alpha and direct beta measurements collected during the characterization and confirmatory surveys were compared against the surface DCGLs, and soil or material sample analysis results were compared against the soil DCGL values. The background study performed for the surveys was used to determine the contribution of naturally occurring radioactivity (NORM) in building materials for the direct alpha and direct beta measurements. The study shows the NORM contribution to the survey results for concrete, metal and asphalt materials used for construction of the SETF and paved yard area.

3.8.1 Direct Measurement Conversion to Activity Per Unit Area

The following equation was used to convert direct alpha and direct beta measurement results to activities per unit area for comparison to the DCGL:

$$X_i = \frac{\left(\frac{C_{s+b}}{t_s}\right)}{E_T\left(\frac{A}{100}\right)}$$

Where:

X_i = individual measurement result in units of activity per unit area, dpm/100 cm^2

C_{s+b} = direct measurement result, gross counts

t_s = sample count time, minutes

E_T = total detector efficiency (MARSSIM Section 6.6.1)

A = detector area, cm^2

And:

$$E_{T1} = \left(\frac{D_C}{S_C} * E_{S1} \right)$$

Where:

E_{T1} = total detector efficiency (NUREG-1507)
D_C = net detector counts (cpm)
S_C = source 2π emission rate (cpm) from source calibration certification
E_{S1} = source efficiency, unless directed to use experimentally proven value, use 0.25 for alpha measurements and beta measurements (beta energies from 0.15 to 0.4 MeV) or 0.5 for beta measurements (beta energies > 0.4 MeV)

3.8.2 Summary Statistics

The mean activity level (or mean of values in a data set) for the survey measurement results and the standard deviation of the mean activity level (or mean counts) for the survey measurement results were calculated using all available measurement results for the surface surveyed, and the following equations:

$$\overline{X} = \frac{\sum x_i}{n}$$

Where:

X = the mean activity level, in reporting units or counts
x_i = individual measurement result I, in reporting units or counts
n = the number of measurement results, unit less.

and

$$s_x = \sqrt{\frac{\sum \left(\overline{X} - x_i \right)^2}{n-1}}$$

Where:

S_x = the standard deviation of the mean activity level, in reporting units or counts
X = the mean activity level
x_i = individual measurement result i, in reporting units or counts
n = the number of measurement results, unit less.

At the completion of the surveys conducted for each survey unit, measurement results were obtained and evaluated according to the survey DQOs. As provided by the MARSSIM guidance, the process to survey, measure, analyze data, and evaluate data according to the survey DQOs was repeated during the characterization and confirmatory survey. Because each DQO was achieved, the survey was considered complete.

3.8.3 Elevated Measurement Comparison

The Elevated Measurement Comparison (EMC) would be performed if any measurement from the survey unit that is equal to or greater than a DCGL or an investigation level indicates there is an area of relatively high concentrations that should be investigated—regardless of the outcome of the nonparametric statistical tests. The EMC is performed according to the guidance provided in the MARSSIM Section 8.5.1, as follows:

$$DCGL_{EMC} = A_m \times \mathrm{DCGL}_W$$

Where:

A_m is the area factor for the area of the systematic grid area.

4. SURVEY RESULTS

Radiological characterization and confirmatory surveys were performed at the SETF between April 6 and May 31, 2007. During the period characterization and confirmatory surveys were performed in environmental areas adjacent to and around the SETF, the existing SETF structure and in environmental and structural background areas.

4.1 Survey Units

As discussed in the SAP, the SETF survey area was divided into survey units to facilitate performance of characterization and confirmatory survey and the background study investigations.

Table 4-1, SETF Survey Units

Survey Package	Survey Unit Description	Report Section
	Background Study	4.2
G4024 401B1	Structures Background Reference Area	4.2.1
H4024 401B1	Environmental Soil Background Areas	4.2.2
	SETF Environmental Soil Areas	4.3
A4024 301C1	Soil Areas Adjacent to Paved Areas	4.3.1
A4024 101C1	Buried Waste Tank/Vault Location	4.3.2
	SETF Structures and Surfaces	4.4
C4024 301C1	High Bay and First Floor DM Areas	4.4.1
C4024 302C1	Basement Floor and Mezzanine DM Areas	4.4.2
C4024 303C1	Paved Yard Area and Slabs Remaining Around SETF	4.4.3
C4024 303C2	Follow-up Survey of Elevated Locations on Slabs	4.4.3.2
C4024 303C2	Follow-up Survey of Asphalt covering UST's	4.4.3.3
	SETF Activated Test Cells	4.5
C4024 102C1	SGTCC Test Cell B-104	4.5.1
C4024 101C1	SGTCC Test Cell B-102	4.5.2
	SETF Systems	4.6
E4024 101C1	Liquid Waste, Floor Drains, and Solid Waste Storage	4.6.1

Summary survey results are presented in the sections that follow. Detailed results are presented in Appendix A, Completed Data Packages.

4.2 Background Study Results

A background study was conducted in accordance with the SAP. The study included surveys of structural surfaces and environmental soil areas to determine contribution from terrestrial local area background contribution (LABC) levels from naturally occurring radioactive materials (NORM) in the environs surrounding a survey unit as well as with concentrations of NORM contained in building construction materials for materials background contribution (MBC) levels. In the summaries that follow in this section, the mean value presented for direct alpha and beta activity is a total surface activity measurement comprised of the LABC plus the MBC. For structural surfaces the values are presented as material specific MBC activity, and are used to correct SETF survey direct alpha and beta measurement results for specific materials of construction. For evaluation of direct alpha and beta measurement of SETF surfaces, the MBC values were subtracted from each alpha and/or beta measurement result to obtain net alpha and beta activity above background for evaluation and comparison to the DCGL. Each measurement result gross value, MDC, MBC and net value is presented in results listings in Appendix A. Because the background study MBC values include the LABC component, the net results from subtracting background study MBC from SETF survey measurements represents the best estimate of potential contamination after all background has been subtracted.

Measurements were performed on structural surfaces and environmental soil areas that have common characteristics with the measurements and samples collected from the SETF survey unit structural surfaces and environmental soil areas, except the areas were unaffected by radioactive material storage or operations. The background survey sample/measurement locations (SMLs) appeared to be of similar age and construction as the SETF. Because there were no radioactive material operations associated with the background reference areas, measurement results on asphalt, concrete and metal surfaces can be used as total background values (MBC + LABC).

Contact and 1 meter gamma exposure rate measurement data is provided for characterization and confirmatory survey information only. Exposure rate measurements are information only because there is not a DCGL for exposure rate measurements used in association with MARSSIM surveys. The contact and 1 meter gamma exposure rate measurement results are provided only to supplement direct alpha and beta measurement results and/or isotopic analysis results from soil and material samples.

As discussed previously in Section 3.3.2, contact and 1 meter exposure rate measurement results are provided in counts per minute (cpm). For evaluation of contact and 1 meter exposure rate measurements of SETF surfaces, the MBC values were compared to the results as representing background cpm values, but were not subtracted from SETF measurements. To evaluate the exposure rate measurements, the MBC (mean values) from background study for surface soil and structural surfaces including asphalt, concrete and metal were used as a background reference (Ave. Bkg.). During the evaluation each measurement result was compared to the MBC applicable to the surface material. In addition to MBC comparison, each measurement result was compared to the MBC plus or minus three sigma ($\pm 3\sigma$) variance of the data set to evaluate if the result was statistically different from natural background in accordance with guidance provided in Chapter 8 of the MARSSIM. However, if the standard deviation for the data set was greater than 20% of the mean of the results, the lesser 20% of mean was used for sigma for added conservatism with the MARSSIM guidance. Isotopic analyses of environmental soils from off site locations are presented to show radionuclide content for comparison to samples of SETF environmental soils.

4.2.1 G4024 401B1, Structures Background Reference Area and MBC

Measurements were taken for background contribution from materials of construction similar to SETF materials which included: asphalt, concrete and metal. The measurements were performed at the Coca Test Stand Building 240 in AREA-II of the SSFL site, approximately 0.9 miles from SETF. The area was similar to the SETF structure in age and in construction, and the area was not associated with the subject survey units. In addition to common characteristics with the SETF survey units; structural surfaces the Coca Test Stand areas have not been affected by radioactive material storage, use and/or operations. Detailed results of the survey, survey area map showing the location, and photographs of surfaces surveyed are presented in Appendix A Section 1.1.

The measurements performed included: direct alpha; direct beta; contact exposure rate; and exposure rate at 1 meter above the surface. The survey showed that asphalt and bare concrete materials contain NORM concentration sufficient for consideration during data evaluation and review as discussed in the SAP. The asphalt surface background data set is presented in Table 4-2. These values represent background activity (LABC + MBC) attributable to NORM in the material and environs, and cosmic ray contributions, and exclude potential contaminants from operations involving radioactive materials. During evaluation and review of SETF asphalt surfaces direct alpha and beta measurements were corrected for the asphalt background (mean value of MBC+LABC) to obtain net activity above background for comparison to the DCGL. Contact and 1 meter gamma exposure rates were used to compare SETF measurements to background.

Table 4-2, Asphalt Surface MBC+LABC

Measurement Type	**Direct Activity** (dpm/100cm^2)		**Exposure Rate** (cpm)	
Statistics	Alpha	Beta	Contact	1 Meter
No. of Measurements	18	18	18	18
Mean	**65**	**3,428**	**13,072**	**12,683**
Median	69	3,416	13,300	12,800
Standard Deviation	17	274	612	709
Range	71	875	2,050	2,600
Minimum	26	3,083	11,850	11,150
Maximum	97	3,957	13,900	13,750
Ave. MDC (Ave. MDCR*)	86	465	1,222	1,204

* Applies to exposure rate measurement result

The concrete surface background data set is presented in Table 4-3. These values represent background activity (LABC + MBC) attributable to NORM in the material and environs, and cosmic ray contributions, and exclude potential contaminants from operations involving radioactive materials. During evaluation and review of SETF concrete surfaces direct alpha and beta measurements were corrected for the concrete background (mean value of MBC+LABC) to obtain net activity above background for comparison to the DCGL. Contact and 1 meter gamma exposure rate were used to compare SETF measurements to background.

Table 4-3, Concrete Surface MBC + LABC

Measurement Type	**Direct Activity** (dpm/100cm^2)		**Exposure Rate** (cpm)	
Statistics	Alpha	Beta	Contact	1 Meter
No. of Measurements	18	18	18	18
Mean	**29**	**2,185**	**11,869**	**10,972**
Median	35	2,139	11,650	10,625
Standard Deviation	17	155	2,409	2,618
Range	61	533	5,950	7,150
Minimum	0	1,989	9,000	7,400
Maximum	61	2,523	14,950	14,550
Ave. MDC (Ave. MDCR*)	45	358	1,165	1,120

* Applies to exposure rate measurement result

The metal surface background data set is presented in Table 4-4. These values represent background activity (LABC + MBC) attributable to NORM in the material and environs, and cosmic ray contributions, and exclude potential contaminants from operations involving radioactive materials. However, for metal surfaces contribution from NORM is mostly LABC from the environs surrounding the survey unit. Typically metal does not contain significant concentration of NORM and direct alpha and beta measurements on SETF metal surfaces will not need correction for NORM in metal, but from NORM in the environs surrounding the survey unit. As such, during evaluation and review of SETF metal surfaces direct alpha and beta measurements were corrected for the metal background (mean value of MBC+LABC) to obtain net activity above background for comparison to the DCGL. Contact and 1 meter gamma exposure rate were used to compare SETF measurements to background.

Table 4-4, Metal Surface MBC + LABC

Measurement Type	**Direct Activity** (dpm/100cm^2)		**Exposure Rate** (cpm)	
Statistics	Alpha	Beta	Contact	1 Meter
No. of Measurements	18	18	18	18
Mean	**16**	**1,422**	**9,381**	**10,181**
Median	13	1,424	9,550	10,275
Standard Deviation	15	138	1,988	2,279
Range	52	533	6,100	6,150
Minimum	0	1,077	6,500	6,650
Maximum	52	1,611	12,600	12,800
Ave. MDC (Ave. MDCR*)	59	352	1,035	1,079

* Applies to exposure rate measurement result

The backgrounds (MBC+LABC) for asphalt, concrete and metal structure surfaces are presented in Table 4-5. These background values were used for material background correction for direct alpha and beta measurements and for contact and 1 meter gamma exposure rate background comparison for the SETF surveys.

Table 4-5, Structure Surfaces MBC + LABC

Material	**Direct Activity** (dpm/100cm^2)		**Exposure Rate** (cpm)	
Type	Alpha	Beta	Contact	1 Meter
Asphalt	65	3,428	13,072	12,683
Concrete	29	2,185	11,869	10,972
Metal	16	1,422	9,381	10,181

4.2.2 H4024 401B1, Environmental Soil Background Areas

Measurements were performed and samples collected for background contribution from environmental soil areas similar to SETF environmental soil areas. The measurements and samples were performed in accordance with the SAP and instructions provided in survey package: H4024 401B1, Environmental Soil Background Areas. The measurements and samples were collected at the following locations:

- North and east of the SSFL site, location off of Black Canyon Road
- East of the SSFL site, location off of Santa Susana Pass Road
- South and east of SSFL site, location off of Woolsey Canyon Road

The locations off the SSFL site were selected because the areas were similar to the environmental areas surrounding the SETF, and the areas were not associated with the subject survey units. In addition to common characteristics with the SETF survey units; the areas have not been affected by radioactive material storage, use and/or operations. Detailed results of the survey, maps showing the location, and photographs of survey locations are presented in Appendix A, Section 1.2, Survey Package: H4024 401B1, Environmental Soil Background Areas.

The measurements performed included: contact exposure rate, exposure rate measurements at 1 meter above the surface and surface (0 to 6” depth) soil samples for isotopic analysis. The survey showed that environmental soils contain concentrations of NORM sufficient for consideration during data evaluation and review as discussed in the SAP. The contribution from NORM in the soil and cosmic ray contributions (LABC + MBC) to contact and 1 meter gamma exposure rate measurements is presented in Table 4-6 that follows.

Table 4-6, Surface Soil MBC + LABC

Measurement Type	**Exposure Rate** (cpm)	
Statistics	Contact	1 Meter
No. of Measurements	18	18
Mean	**15,756**	**15,406**
Median	15,550	14,975
Standard Deviation	1,280	1,278
Range	5,500	4,550
Minimum	13,550	14,000
Maximum	19,050	18,550
Ave. MDCR	1,342	1,327

During evaluation of SETF environmental surveys, each measurement result was compared to the background applicable to the surface material. In addition to background comparison, each measurement result was compared to the mean ± 3 sigma of the background data set to evaluate if the result was statistically different from natural background in accordance with guidance provided in Chapter 8 of the MARSSIM. The radionuclides detected and their concentrations in the natural background soil samples were determined by radionuclide specific analysis (e.g., alpha and gamma spectroscopy, liquid scintillation etc.). Summary results from the analysis of eighteen (18) surface soil samples are presented in Table 4-7 that follows.

Table 4-7, Radionuclides Detected in Background Reference Surface Soil

Symbol	**Activity** (Ave pCi/g)	**Range** (pCi/g)		**Std. Dev.** (1 sigma)	**No. >/= MDC out of 18 total**	**Ave.MDC** (pCi/g)	**MDC Goal** (pCi/g)
		Min	**Max**				
Cs-137	0.027	-0.017	0.086	0.030	9	0.019	0.1
K-40	21.294	19.540	23.190	1.028	18	0.183	0.1
Th-232	0.067	0.03	0.114	0.24	17	0.030	1.6
U-234	0.618	0.390	0.810	0.111	18	0.025	2.0
U-235	0.041	0.006	0.076	0.021	12	0.026	0.1
U238	0.581	0.410	0.750	0.101	18	0.022	0.37

4.3 SETF Environmental Soil Areas

Radiological characterization and confirmatory surveys were performed in environmental areas adjacent to and around the SETF. Objectives of the surveys included; establish as found conditions before SETF decontamination and demolition activities; and confirm whether or not residual radioactivity above natural background from former operations at Building 4024 was present in the immediate environs. Two survey packages were developed to implement requirements of the SAP; survey package A4024 101C1 and survey package A4024 301C1 are discussed in the following sections.

4.3.1 A4024 301C1, Soil Areas Adjacent to Paved Areas

Survey package A4024 301C1, Soil Areas Adjacent to Paved Areas, was developed for the survey of the soil areas surrounding the SETF asphalt paved yard. The measurements performed included: gamma scan; contact gamma and gamma exposure rate measurements at 1 meter above the surface; and 0 to 15 cm depth surface soil samples for isotopic analysis. Eighteen (18) SMLs were selected to encompass the SETF paved yard area. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Detailed results of the survey and maps showing the locations are presented in Appendix A, Section 2.1. Summary results of contact and 1 meter gamma exposure rate measurements are presented in Table 4-8 that follows.

Table 4-8, Survey Results for Surface Soil Adjacent to Paved Areas

Measurement Type	**Exposure Rate** (cpm)	
Statistics	Contact	1 Meter
No. of Measurements	18	18
Mean	15,025	14,361
Median	14,975	14,125
Standard Deviation	1,259	1,268
Range	4,950	4,450
Minimum	12,900	12,600
Maximum	17,850	17,050
Ave. Background	15,756	15,406
Ave. MDCR	1,310	1,281
No. > Ave. Bkg.	4	5
No. > Ave. Bkg.+3σ	0	0

The same instrument was used for this location as with the background areas. Gamma scans performed for 9 m^2 around each SML indicated there were no elevated readings. There were four (4) contact gamma and five (5) 1 meter exposure rate measurements performed within the scanned area that showed results above average background. However, as shown in Table 4-8, the mean of results for each measurement type were below the average background, and no results were greater than Ave. Bkg.+3σ. Results were within the range of natural background. Surface soil sample were collected at each SML. Summary results from the analysis of eighteen (18) surface soil samples are presented in Table 4-9 that follows.

Table 4-9, Sample Analysis Results for Surface Soil Areas Adjacent to Paved Areas

Symbol	**Activity** (Ave pCi/g)	**Range** (pCi/g)		**Std. Dev.** (1 sigma)	**No. > MDC**	**Ave.MDC** (pCi/g)	**DCGL**(pCi/g)	**No. > DCGL**
		Min	**Max**					
Cs-137	0.075	-0.012	0.746	0.183	8	0.018	9.2	0
K-40	22.681	20.410	27.720	2.168	18	0.140	27.6	0
Ni-59	720	-1090	720	509.24	1	1493	151,000	0
Th-232	0.139	0.063	0.320	0.071	18	0.028	5	0
U-234	0.568	0.292	0.910	0.157	18	0.024	30	0
U-235	0.058	0.016	0.101	0.024	16	0.025	30	0
U-238	0.546	0.42	0.870	0.169	18	0.021	35	0

4.3.1.1 Conclusion

In accordance with the SETF Sample and Analysis Plan samples were obtained and analyzed and the survey objectives were achieved. This characterization data may be used to determine if the soil area surrounding the SETF asphalt paved yard is suitable for use as clean fill material after the SETF structure has been removed.

4.3.2 A4024 101C1, Buried Waste Tank/Vault Location

Survey package A4024 101C1, Buried Waste Tank/Vault Location., was developed for the survey of the soil areas in the location of the former underground storage tanks (UST) for SETF gas and liquid waste. Confirmatory surveys were performed in location adjacent to and southeast of the SETF to establish as found conditions before SETF decontamination and demolition activities. The surveys consisted of surveying the asphalt covering; surveys of the surface soil; and trenching operations to obtain measurements and subsurface samples to a 12.5 ft. depth.

4.3.2.1 Surface Soil Survey

The area was prepared by first surveying and confirming that asphalt covering the area was radiologically clean DM, refer to this report, Section 4.4.3.3, C4024 303C2, Survey of UST Area Asphalt Covering. Once surveyed and confirmed as DM, the asphalt covering was removed from the area and stored using equipment and operators provided by Boeing. A triangular grid reference system with random starting point was developed using Visual Sample Plan (VSP) and used to establish SMLs. The drawing generated with VSP identified twenty (20) possible points for the eighteen (18) SMLs needed to satisfy the MARSSIM statistical model. Measurements were performed at each of the 20 SMLs, and subsurface soil samples obtained from 18 SMLs.

The surface soil area was surveyed in accordance with the SAP, procedures and instructions provided in the survey package. The measurements performed included: gamma scan; contact gamma and exposure rate measurements at 1 meter above the surface. Surface 0 to 15 cm depth soil samples were to be collected for isotopic analysis at any location showing elevated readings that were twice background. Detailed results of the survey and maps showing the locations are presented in Appendix A, Section 2.2. Summary results of contact and 1 meter gamma exposure rate measurements are presented in Table 4-10.

Table 4-10, Surface Soil Survey Results for Buried Waste Tank/Vault Location

Measurement Type	**Exposure Rate** (cpm)	
Statistics	Contact	1 Meter
No. of Measurements	20	20
Mean	14,325	13,448
Median	14,250	13,250
Standard Deviation	487	510
Range	1,900	1,950
Minimum	13,500	12,750
Maximum	15,400	14,700
Ave. Background	15,756	15,406
Ave. MDCR	1,279	1,240
No. > Ave. Bkg.	0	0
No. > Ave. Bkg. + 3σ	0	0

The same instrument was used for this location as the background areas. Gamma scans performed for 9 m^2 around each SML indicated there were no elevated readings. Contact gamma and 1 meter exposure rate measurements performed within the scanned area showed there were no measurement result above average background and results were within the range of natural background. As such, discretionary surface soil samples were not necessary or collected.

4.3.2.2 Subsurface Soil Sample Collection

Eighteen (18) subsurface samples to a 12.5 ft. were obtained from the UST area by trenching method using backhoe equipment and operators provided by Boeing. During trenching operations pieces asphalt and pieces of broken concrete were encountered. It was concluded that the asphalt and concrete was from removal of the USTs, and placed back in the excavation during restoration. Radiological control surveys were performed on the asphalt and pieces of broken concrete as they were encountered and results were consistent with normal background levels. Because the asphalt and concrete showed normal background, each piece was removed from trenching excavation spoils and placed in a location approved for DM storage. As with the concrete and asphalt, the soil associated with the trenching operation was surveyed; measurement results were consistent with normal background levels and the soil was placed back in the trench excavation after each subsurface sample was obtained. Each of the eighteen (18) samples was analyzed for gamma only. One composite sample was obtained from the eighteen samples and was analyzed for COCs and PCOCs Summary results from the analysis of the composite subsurface soil sample are presented in Table 4-11 that follows.

Table 4-11, Subsurface Soil Sample Analysis Results for Buried Waste Tank/Vault Location

Symbol	**Activity** (pCi/g)	**MDC** (pCi/g)	**No. >/= MDC**	**DCGL** (pCi/g)	**No. > DCGL**
K-40	21.990	0.130	1 of 1	27.6	0
Th-232	1.080	0.034	1 of 1	5	0
U-234	0.577	0.004	1 of 1	30	0
U-235	0.046	0.005	1 of 1	30	0
U-238	0.596	0.004	1 of 1	35	0

4.3.2.3 In accordance with the SETF Sample and Analysis Plan samples were obtained and analyzed and the survey objectives were achieved. This characterization data may be used to determine if the soil area for Buried Waste Tank/Vault Location is suitable for use as clean fill material after the SETF structure has been removed.

4.3.3 Subsurface Soil Survey

After the trenching operations were completed, a follow on survey was conducted of subsurface soils in the UST area. The area was excavated to expose and gain access to gas and liquid waste storage system piping still present in the area. Refer to this report Section 5.1 for results and details from the SETF systems piping surveys. The excavated subsurface soil area was surveyed, measurements performed included: gamma scan; contact gamma and exposure rate measurements at 1 meter above the surface. Surface 0 to 15 cm depth soil samples were to be collected for isotopic analysis at any location showing elevated readings that were twice background. Detailed results of the survey and maps showing the locations are presented in Appendix A, Section 2.2. Summary results for contact gamma and 1 meter gamma exposure rate measurements are presented in Table 4-12 that follows.

Table 4-12, Subsurface Soil Survey Results for Buried Waste Tank/Vault Location

Measurement Type	**Exposure Rate** (cpm)	
Statistics	Contact	1 Meter
No. of Measurements	18	18
Mean	16,719	15,311
Median	16,500	15,050
Standard Deviation	1,259	869
Range	4,300	2,700
Minimum	15,000	14,100
Maximum	19,300	16,800
Ave. Background	15,756	15,406
Ave. MDCR	1,382	1,323
No. > Ave. Bkg.	12	7
No. > Ave. Bkg. + 3σ	0	0

Gamma scans performed for 9 m^2 around each SML indicated there were no elevated readings. There were twelve (12) contact gamma and seven (7) 1 meter exposure rate measurements performed within the scanned area that showed results above average background. However, as shown in Table 4-12 the mean of results for contact results were less than Ave. Bkg.+1σ, the 1 meter result was below the average background, and no results were greater than Ave. Bkg.+3σ. Results were within the range of natural background. As such, no further subsurface soil samples were necessary or collected.

4.3.3.1 Survey Unit Conclusion

Samples and measurements were of sufficient quantity to confirm that residual radioactivity above natural background from former operations and removal of the tanks was not present in survey unit. However, other findings from the survey include: piping to the former contaminated gas and liquid waste storage systems was still present area; and previous asphalt covering and broken pieces of concrete from the former liquid waste storage tank vault was present in the UST survey area.

In conclusion, the survey objectives were achieved for the SETF soil area surrounding the former gas and liquid waste storage systems. However, it is recommended that the pipes that remain from the gas and liquid waste storage systems be removed, segregated, packaged and disposed of at NTS. In addition, as broken pieces of asphalt and concrete are encountered from removal of the piping, the materials be surveyed to ensure radiological status as DM and disposed of as appropriate. Other than this condition, the soil area surrounding the former gas and liquid waste storage systems was shown to be suitable to use as clean fill material after the SETF structure has been removed.

4.4 SETF Structures and Surfaces

Confirmatory surveys were performed of SETF structures surfaces that consisted of measurements and samples of sufficient quantity to confirm that residual radioactivity above natural background from former operations at Building 4024 was not present in areas already confirmed by DHS-RHB as decommissioned materials (DM). Objectives of the surveys included; establish as found conditions before SETF decontamination and demolition activities; and confirm that residual radioactivity above natural background from former operations at Building 4024 was not present on SETF surfaces with exception to the activated test cells. Three survey packages were developed to implement requirements of the SAP; survey package C4024 301C1, C4024 302C1 and C4024 303C1 as discussed in the following sections.

4.4.1 C4024 301C1, High Bay and First Floor DM Areas

Survey package C4024 301C1, High Bay and First Floor DM Areas, was developed for the survey of SETF first floor structural surfaces. The survey unit includes first floor level interior surfaces of floor, lower walls below 2 meters, upper walls and exterior lower wall surfaces. The measurements performed included: beta scans; direct measurements for total beta and alpha activity; smear samples for removable alpha and beta activity; contact gamma measurements; exposure rate measurements at 1 meter above the surface; and material samples for isotopic analysis. Detailed results of the survey and drawings showing SMLs are presented in Appendix A, Section 3.1. Summary results of survey measurements are presented in Table 4-13 that follows.

Table 4-13, Survey Results for High Bay and First Floor DM Area

Measurement Type	Direct Activity (net dpm/100cm^2)		Removable Activity (net dpm/100cm^2)		Exposure Rate (gross cpm)	
Statistics	Alpha	Beta	Alpha	Beta	Contact	1 Meter
No. of Measurements	32	32	32	32	18	18
Mean	1.2	-76.9	0.9	-11.8	9,842	9,931
Median	-0.9	-88.7	1.3	-6.2	10,100	10,000
Standard Deviation	16.8	150.9	1.8	22.7	2,008	1,359
Range	77.8	752.3	6.8	87.2	7,050	5,950
Minimum	-16.0	-531.7	-1.0	-59.5	6,750	7,450
Maximum	61.8	220.7	5.8	27.7	13,800	13,400
Ave. Background	20.5	1,684.3			10,901	10,664
Ave. MDC (Ave. MDCR*)	56.9	333.2	10.9	76.3	1,060	1,065
DCGL (No.> Bkg.*)	100	5,000	20	100	3	2
No.> DCGL (No.>Bkg.+3σ*)	0	0	0	0	0	0

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to locations with the highest potential for contamination and/or uniformly distributed over the survey unit. Beta scans were performed for 9 m^2 around each SML. Direct alpha and beta measurements were performed at locations exhibiting the highest readings within the scan area, or were performed at the approximate center of the scan area when scan readings were uniform as was the case for this survey. Contact gamma, exposure rate measurements at 1 meter above the surface and smear samples for removable alpha and beta activity were also performed at each SML. Material samples for isotopic analysis were not collected because there were no elevated measurement results. Because there were multiple materials surveyed the “direct activity” background subtracted were averaged and presented as “Ave. Background.” Refer to the Appendix A results listing for the background applied to individual measurements.

The characterization and confirmatory survey showed that the mean of the results from direct and removable alpha and beta measurements were less than measurement MDC and DCGLs except one direct alpha measurement exceeded the MDC. Of the direct and removable alpha and beta measurements there was one (1) direct alpha measurement above MDC, but the variance between the result and MDC was less than 1σ, and remaining results were within the range of natural background. There were three (3) contact gamma and two (2) 1 meter exposure rate measurements performed that showed results above average background. However, as shown in Table 4-13 the mean of results for contact and 1 meter measurement was below the average background, and no results were greater than Bkg.+3σ and were within the range of natural background. Survey objectives were achieved and the SETF first floor structure was shown to be suitable to demolish and dispose of as DM.

4.4.2 C4024 302C1, Basement Floor and Mezzanine DM Areas

Survey package C4024 302C1, Basement Floor and Mezzanine DM Areas, was developed for the survey of SETF basement and mezzanine level structural surfaces. The survey unit included: interior floor and lower walls below 2 meters in all basement areas except for the activated test cells. The measurements performed included: beta scans; direct measurements for total beta and alpha activity; contact gamma measurements; exposure rate measurements at 1 meter above the surface; and smear samples for removable alpha and beta activity. Material samples for isotopic analysis were discretionary and none were collected. Detailed results of the survey and drawings showing SMLs are presented in Appendix A, Section 3.2. Summary results of survey measurements are presented in Table 4-14 that follows.

Table 4-14, Survey Results for Basement Floor and Mezzanine DM Area

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)	
Statistics	Alpha	Beta	Alpha	Beta	Contact	1 Meter
No. of Measurements	19	19	18	18	19	19
Mean	-7.6	-156.0	-0.5	-15.5	13,079	13,813
Median	-11.7	-275.7	-1.4	-15.2	12,600	13,300
Standard Deviation	14.4	412.1	1.4	17.6	4,246	4,158
Range	51.9	1,664.3	4.6	69.2	13,250	14,700
Minimum	-29.0	-878.3	-1.4	-51.2	8,150	8,650
Maximum	22.9	786.0	3.2	18.0	21,400	23,350
Ave. Background	26.3	2,024.4			11,345	10,805
Ave. MDC (Ave. MDCR*)	52.1	341.5	12.1	75.9	1,222	1,256
DCGL (No.> Bkg.*)	100	5,000	20	100	13	15
No.> DCGL (No.>Bkg.+3σ*)	0	0	0	0	3	3

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to locations with the highest potential for contamination and/or uniformly distributed over the survey unit. Beta scans were performed for 9 m^2 around each SML. Direct alpha and beta measurements were performed at locations exhibiting the highest readings within the scan area, or were performed at the approximate center of the scan area when scan readings were uniform as was the case for this survey. Contact gamma, exposure rate measurements at 1 meter above the surface and smear samples for removable alpha and beta activity were also performed at each SML. Because there were multiple materials surveyed the "direct activity" background subtracted were averaged and presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements.

The characterization and confirmatory survey showed that most direct or removable alpha and beta measurement or smear sample results were below MDC except for two direct beta results that exceeded average MDC, but by less than two standard deviations. There were no direct or removable alpha and beta measurement or smear sample results above DCGL, and each result was within the range of natural background. There were thirteen (13) contact gamma and fifteen (15) 1 meter exposure rate measurements performed that showed results above average background. As shown in Table 4-14 the mean of results for contact and 1 meter measurement was also above the average background level, and three (3) each contact and 1 meter exposure rate results were greater than Bkg.+3σ. However, the mean of results for contact and 1 meter exposure rate was each less than Ave. Bkg.+3σ. The standard deviation for contact and 1 meter exposure rate results were greater than 20% of the mean of results for this data set, and the lesser value of 2,616 cpm and 2,763 cpm (20% of the results mean) was used as sigma. No material samples were available or collected for the survey. Upon review of the measurement locations in Appendix A drawings, the elevated results at SML 3 and SML 7 were caused by contribution from the activated test cell, but not for SML No. 4 on the basement floor. Elevated contact gamma measurements were also seen during survey of the basement floor drains in the vicinity of SML No. 4. Refer to Survey Package E4024 101C1 in Section 5.1 of this report for information regarding the floor drain survey.

In conclusion, the survey objectives were achieved for the SETF basement and mezzanine level structural surfaces. However, for the reasons stated in Section 5.1 of this report, it is recommended that the basement floor drain system and pipes that remain from the contaminated liquid waste system be removed, segregated, packaged and disposed of at NTS. Other than this condition, the basement and mezzanine level structure was shown to be suitable to demolish and dispose of as DM.

4.4.3 C4024 303C1, Paved Yard Area and Concrete Slabs Remaining Around SETF

4.4.3.1 Initial Survey

Survey package C4024 303C1, Paved Yard Area and Concrete Slabs Remaining Around SETF, was developed for the survey of SETF ground level asphalt paved yard and remaining structural concrete slab surfaces. The survey unit included: asphalt paved areas surrounding the SETF and concrete floor slabs from former structures removed in 2005. The measurements performed included: beta scans; direct measurements for total beta and alpha activity; contact gamma measurements; exposure rate measurements at 1 meter above the surface; and smear samples for removable alpha and beta activity. Material samples for isotopic analysis were discretionary and collected at two locations showing elevated direct alpha activity. Detailed results of the survey and drawings showing SMLs are presented in Appendix A, Section 3.3. Summary results of survey measurements are presented in Table 4-15 that follows.

Table 4-15, Survey Results for Paved Yard Area and Remaining Concrete Slabs

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)	
Statistics	Alpha	Beta	Alpha	Beta	Contact	1 Meter
No. of Measurements	18	18	22	22	22	22
Mean	20.2	-182.2	0.6	-7.7	13,711	13,068
Median	-12.4	-318.7	0.2	-9.7	13,775	12,950
Standard Deviation	99.2	425.1	1.8	16.7	1,296	1,477
Range	407.9	1,467.0	4.5	60.8	4,700	6,300
Minimum	-47.7	-782.7	-1.0	-30.4	11,550	9,300
Maximum	360.2	684.3	3.5	30.4	16,250	15,600
Ave. Background	49.0	2,875.6			12,635	12,061
Ave. MDC (Ave. MDCR*)	60.4	342.9	11.3	76.8	1,252	1,222
DCGL (No.> Bkg.*)	100	5,000	20	100	18	17
No.> DCGL (No.>Bkg.+3σ*)	2	0	0	0	0	0

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to locations with the highest potential for contamination and/or uniformly distributed over the survey unit. Beta scans were performed for 9 m^2 around each SML. Direct alpha and beta measurements were performed at locations exhibiting the highest readings within the scan area, or were performed at the approximate center of the scan area when scan readings were uniform. Contact gamma, exposure rate measurements at 1 meter above the surface and smear samples for removable alpha and beta activity were also performed at each SML. Material samples consisting of concrete dust for isotopic analysis were collected from two SMLs with elevated measurement results. Because there were multiple materials surveyed the "direct activity" background subtracted were averaged and presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements.

Except for two SMLs, the characterization and confirmatory survey showed the direct alpha and beta measurements were less than measurement MDC and DCGLs. Of the direct alpha and beta measurements there were two (2) direct alpha and beta results above MDC, two (2) direct alpha results above DCGL, both alpha results greater than 1σ above DCGL, and one alpha result greater than 3σ above DCGL. Removable alpha and beta smear sample results were each less than measurement MDC and DCGLs. There were eighteen (18) contact gamma and seventeen (17) 1 meter exposure rate measurements performed that showed results above average background, and the mean of results for contact and 1 meter measurement were each above average background. However, as shown in Table 4-15 no result or mean of results were greater than Bkg.+3σ and each were within the range of natural background.

The two SMLs with elevated direct alpha results were just at the outside northeast and southwest corners of the SETF each on concrete pads that showed fixed alpha measurement results greater than the alpha MDC of 60 dpm/100 cm^2 and the 100 dpm/100cm^2 DCGL. At the northeast corner, SML 5 was 360 dpm/100 cm^2 and at the southwest corner, SML 8 was 179 dpm/100cm^2 alpha. The mean of results for the eighteen direct alpha measurements was 20 dpm/100cm^2 and below the DCGL. The corresponding direct beta measurements were above the MDC of 343 dpm/100cm^2 but below the 5,000 dpm/100cm^2 beta DCGL. SML 5 was 684 dpm/100cm^2 beta and SML 8 was 551 dpm/100cm^2 beta. Smear samples did not indicate the presence of removable contamination above 11.3 dpm/100cm^2 alpha MDC and 77 dpm/100cm^2 beta MDC. Each contact gamma and 1 meter exposure rate measurement was within the range of natural background (i.e., Bkg. $\pm$ 3σ).

A follow-up survey was developed to further investigate the two elevated SMLs. In addition, to prepare for subsurface soil sampling survey of the former USTs for gas and liquid waste storage systems, a more rigorous survey was developed to show asphalt covering of the 36 ft. by 60 ft. area on the east side of the SETF could be removed and placed in a DM storage area.

4.4.3.2 C4024 303C2, Follow-up Survey for Elevated SMLs on Concrete Slabs

A follow-up survey was developed to further investigate two elevated locations detected during the initial survey of concrete slabs outside the SETF. First, material samples for isotopic analysis were collected at the two locations showing elevated direct alpha activity. Samples were collected from the SMLs by scarifying approximately one ft^2 area with a chisel type bit and electric rotary hammer, the dust generated was collected in a clean primary bag filter of a two stage industrial vacuum, and then transferred to a sample container. Once the samples were collected, nine measurements on and around each elevated SML were performed that included: direct measurements for total beta and alpha activity; contact gamma measurements; exposure rate measurements at 1 meter above the surface; and smear samples for removable alpha and beta activity. The results of survey measurements are presented in Table 4-16 that follows.

Table 4-16, Measurement Results for Follow-up Survey for Elevated SMLs

Measurement Type	**Direct Activity** (net dpm/100cm²)		**Removable Activity** (net dpm/100cm²)		**Exposure Rate** (gross cpm)	
Statistics	Alpha	Beta	Alpha	Beta	Contact	1 Meter
No. of Measurements	18	18	18	18	18	18
Mean	152.6	1,999.7	0.7	-13.7	11,764	11,844
Median	148.3	1,926.3	-0.7	-11.1	11,850	12,125
Standard Deviation	78.9	388.9	2.0	18.3	753	1,116
Range	276.8	1,544.3	4.6	58.0	2,400	3,750
Minimum	5.6	1,175.0	-0.7	-45.6	10,500	9,800
Maximum	282.4	2,719.3	3.9	12.4	12,900	13,550
Ave. Background	29.0	2,185.0			11,869	10,972
Ave. MDC (Ave. MDCR*)	82.9	644.2	10.4	77.8	1,159	1,163
DCGL (No. > Bkg.*)	100	5,000	20	100	9	15
No. > DCGL (> Bkg.+3σ*)	14	0	0	0	0	0

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Because there were only concrete materials surveyed the "direct activity" background subtracted was the concrete background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. The two initial SMLs, No. 5 and No. 8, each showed a greater than 50% reduction in fixed alpha activity from the initial measurement results from the sampling technique. At the northeast corner, initial SML 5 (follow-up No. S5-1) was 161 (from 360) dpm/100 cm^2 alpha and at the southwest corner, SML 8 (follow-up No. S8-1) was 66 (from 179) dpm/100cm^2 alpha. However, the mean of results for the eighteen direct alpha measurements surrounding the two elevated SMLs was 153 dpm/100cm^2 alpha and ranged to a maximum of 282 dpm/100cm^2 alpha. Fourteen (14) of the eighteen (18) direct alpha measurements were greater than the alpha MDC of 83 dpm/100 cm^2 and the 100 dpm/100cm^2 DCGL. All eighteen (18) of the corresponding direct beta measurements were above the MDC of 644 dpm/100cm^2 but all were below the 5,000 dpm/100cm^2 beta DCGL with the maximum result 2,719 dpm/100cm^2 beta. Smear samples did not indicate the presence of removable contamination above 10.4 dpm/100cm^2 alpha MDC and 78 dpm/100cm^2 beta MDC. There were nine (9) contact gamma and fifteen (15) 1 meter exposure rate measurements performed that showed results above average background, and the mean of results for 1 meter measurement were above average background. However, no result or mean of results were greater than Bkg.+3σ. Results from the analysis of materials samples from the two (2) elevated SMLs are presented in Table 4-17 that follows.

Table 4-17, Elevated SML Concrete Dust Sample Analysis Results

Symbol	**Activity** (Ave pCi/g)	**Range** (pCi/g)		**Std. Dev.** (1 sigma)	**No. >/= MDC**	**Ave.MDC** (pCi/g)	**DCGL** (pCi/g)	**No. > DCGL**
		Min	**Max**					
C0-60	0.186	0.022	0.350	0.022	1	0.138	1.9	0
Cs-137	O.470	0.190	0.749	0.395	1	0.126	9.2	0
Eu-152	1.124	0.097	2.150	1.452	2	0.159	4.5	0
H-3	2.170	0.120	4.220	2.899	1	0.940	31,900	0
K-40	15.080	13.90	16.260	1.669	2	1.410	27.6	0
Pu-238/240	0.018	0.009	0.026	0.012	1	0.036	33.9	0
Sr-90	0.168	0.154	0.181	0.019	2	0.093	36	0
Th-228	0.540	0.430	0.650	0.156	2	0.250	5	0
Th-232	0.450	0.390	0.510	0.085	2	0.069	5	0
U-234	0.394	0.352	0.435	0.059	2	0.008	30	0
U-235	0.047	0.042	0.052	0.007	2	0.010	30	0
U-238	0.378	0.335	0.420	0.060	2	0.009	35	0

Sampling and isotopic analysis of the locations showed the above isotopes were present and detectable, but at levels a fraction of the derived concentration guideline level (DCGL) of 5,000 dpm/100cm2 for fixed surface contamination and a fraction of the bulk material DCGL . Smear sampling did not indicate the presence of removable contamination. Material samples collected from the surfaces were analyzed for the full suite of potential contaminants of concern (COC), but the analytical results did not indicate the presence of other potential COC.

4.4.3.3 C4024 303C2, Follow-up Survey of UST Area Asphalt Covering

A follow-up survey was developed to prepare for a subsurface soil sampling survey of the former USTs for gas and liquid waste storage systems. The survey was developed to show asphalt covering of the 36 ft. by 60 ft. area on the east side of the SETF could be removed and placed in a DM storage area. A triangular grid reference system with random starting point was developed using Visual Sample Plan (VSP) and used to establish SMLs. The VSP generated drawing identified twenty (20) possible points for the eighteen (18) SMLs needed to satisfy the MARSSIM statistical model. Measurements were performed at each of the 20 SMLs as follows: beta scans were performed for 9 m^2 around each SML; direct alpha and beta measurements were performed at locations exhibiting the highest readings within the scan area, or were performed at the approximate center of the scan area when scan readings were uniform; contact gamma, exposure rate measurements at 1 meter above the surface and smear samples for removable alpha and beta activity were also performed at each SML. Material samples for isotopic analysis were discretionary and were not collected because there were no elevated measurement results. The results of survey measurements are presented in Table 4-18 that follows.

Table 4-18, Measurement Results for UST Area Asphalt Covering

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)	
Statistics	Alpha	Beta	Alpha	Beta	Contact	1 Meter
No. of Measurements	20	20	20	20	20	20
Mean	-17.9	938.6	0.7	-16.3	13,738	13,450
Median	-13.1	923.3	1.6	-15.2	13,775	13,525
Standard Deviation	19.5	279.6	1.4	21.4	687	719
Range	69.2	1,029.6	4.6	77.4	2,400	2,700
Minimum	-56.4	516.3	-0.7	-53.9	12,250	11,800
Maximum	12.8	1,545.9	3.9	23.5	14,650	14,500
Ave. Background	65.0	3,428.0			13,072	12,683
Ave. MDC (Ave. MDCR*)	63.9	583.6	10.4	77.8	1,253	1,240
DCGL (No. > Bkg.*)	100	5,000	20	100	17	17
No. > DCGL (> Bkg.+3σ*)	0	0	0	0	0	0

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas, except for the direct beta detector where a Ludlum Model 43-89 was used. This detector is equivalent to the Ludlum Model 44-116 when setup for beta only. Because there was only asphalt materials surveyed the "direct activity" background subtracted was the asphalt background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. The characterization and confirmatory survey showed that the mean of the results from direct and removable alpha and beta measurements were less than DCGLs and each below measurement MDCs except for direct beta results. Nineteen (19) of the twenty (20) direct beta measurements were greater than the MDC of 584 dpm/100cm^2 ranging to 1,546 dpm/100cm^2 with each direct beta result below 5,000 dpm/100cm^2 DCGL. There were seventeen (17) each of contact gamma and 1 meter exposure rate measurements performed that showed results above average background and the mean of results for contact and 1 meter measurement were also above the average background. However, there were no contact or 1 meter results greater than Bkg.+3σ and each were within the range of natural background. The survey objectives were achieved, and the asphalt covering former USTs for gas and liquid waste storage systems was shown to be suitable to remove and dispose of as DM. Once surveyed and confirmed as DM, the asphalt covering was removed from the area and stored in an approved DM storage area using equipment and operators provided by Boeing.

4.4.3.4 Conclusion

In conclusion, the survey objectives were achieved for Survey package C4024 303C1, Paved Yard Area and Concrete Slabs Remaining Around SETF. However, for the reasons stated above, and per ALARA policy, it is recommended that initial SML 5 and SML 8 concrete slab locations be decontaminated, and associated materials be segregated, packaged and disposed of at NTS.

Other than this condition, the SETF ground level asphalt paved yard and remaining structural concrete slab surfaces were shown to be suitable to demolish and dispose of as DM.

4.5 SETF Activated Test Cells

Survey package C4024 101C1, SGTCC Test Cell B-102 and C4024 102C1, SGTCC Test Cell B-104 were developed for the survey of SETF activated test cells. The objective of the survey was to perform measurements and collect samples of sufficient quantity to confirm nature and depth of activation radioactivity from former operations. The survey units included floor, lower walls below 2 meters, upper walls, ceiling, sump, and storage tube surfaces. The measurements performed included: gamma scans; direct measurements for total beta and alpha activity; contact gamma measurements; smear samples for removable alpha and beta activity; and concrete core samples. Concrete core samples were collected from the west cell B-104 because measurement results indicated the highest activation levels. The core samples were evaluated for depth of activation that can be used to guide decontamination planned for both test cells. Detailed results of the survey and drawings showing SMLs are presented in Appendix A, Section 4.

4.5.1 C4024 102C1 SGTCC Test Cell B-104

Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to locations with the highest and lowest activation determined by gamma scan using a collimated NaI(Tl) detector, shielded for a 2 inch diameter field of view. Gamma scans were performed for each surface in the test cell and SMLs marked at locations of highest and at the lowest count rate. Contact gamma, and direct alpha and beta measurements were performed at the marked locations. Smear samples for removable alpha and beta activity were also performed at each SML. The results of survey measurements of test cell surfaces are presented in Table 4-19 that follows.

Table 4-19, Measurement Results SGTCC Test Cell B-104

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)
Statistics	Alpha	Beta	Alpha	Beta	Contact
No. of Measurements	18	18	18	18	18
Mean	-3.5	8,439.3	-0.4	-10.6	37,669
Median	-7.4	8,978.0	-1.0	-8.3	37,350
Standard Deviation	13.3	3,702.4	1.1	16.4	18,789
Range	34.6	13,904.0	2.3	63.6	73,400
Minimum	-16.0	2,327.3	-1.0	-34.6	14,100
Maximum	18.6	16,231.3	1.3	29.0	87,500
Ave. Background	16.0	1,422.0			9,381
Ave. MDC (Ave. MDCR*)	50.7	652.2	11.3	74.9	2,075
DCGL (No. > Bkg.*)	100	5,000	20	100	18
No. > DCGL (> Bkg.+3σ*)	0	14	0	0	11

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Because there were only metal materials surveyed the "direct activity" background subtracted was the metal background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. The characterization and confirmatory survey showed that direct beta measurements results were each greater than the measurement MDC of 652 dpm/100cm^2 and 14 direct beta result greater than 5,000 dpm/100cm^2 DCGL ranging to 16,231 dpm/100cm^2 beta. There were eighteen (18) contact gamma exposure rate measurements performed that showed results above average background. The contact gamma mean of results was also above average background and greater than Bkg. +3σ ranging to 87,500 cpm, more than ten (10) times average background. However, results from direct alpha measurements were less than measurement MDC and DCGLs, and removable alpha and beta smear sample results were each less than measurement MDC and DCGLs.

4.5.2 Core Bore Sample Results for Test Cell B-104

Survey results were evaluated and seven locations identified for further depth of activation profiling. Five of the locations identified during the gamma scan were core sampled, and two core samples were selected from available core samples obtained during the 2005 survey. The core bore samples obtained were collected using a vacuum based core drill with 3" diameter diamond bit. A 3½ inch diameter bimetal hole saw was first used to remove the 3/16 inch aluminum cell liner, then the exposed concrete was core drilled. Water was used during each step of the process, and was collected in a 55 gal. drum, and/or an industrial wet vacuum and transferred to the storage drum for reuse. At the end of the campaign, all water was transferred to a plastic lined B-25 box for evaporation. Five cores were obtained from the following locations: upper west wall, upper north wall, floor and two locations on the lower south wall. Two core samples selected from the core samples obtained during the 2005 survey were one from the upper north wall and one from the upper south wall.

The core bores once obtained were handled as follows: drawings were developed to depict measurement and wafer locations for each core; the cores were marked for location and orientation to cell interior surface and stored in clean plastic wrappers; and the cores were moved to a low background area where axial gamma measurements were performed. The axial gamma measurements were performed along the length of each core sample with a collimated NaI(Tl) detector to indicate depth of activation. The axial gamma measurements were further focused to one inch intervals along the core length by placing two standard lead bricks (2"x 4" x 6") end to end and one inch apart between the core and the detector. Once the axial gamma measurements were complete and results evaluated, the cores were sliced into approximate ½ inch thick slices (wafers) using a wet process circular tile saw with a 9 inch diameter diamond blade. The recently acquired five core samples were sliced into approximate ½ inch thick slices (wafers) as follows: first wafer was from cell wall surface to ½ inch depth; the second a ½ inch wafer in from the cell surface where end of activation depth was indicated by the axial gamma scan; and on three of the core samples, the third wafer was from 14 to 14 ½ inches from the cell surface. On the two the 2005 core samples, ½ inch thick wafers were cut as follows: first wafer was a ½ inch wafer in from the cell surface to where end of activation depth was indicated by the axial gamma scan; and on the upper south wall core sample, the second wafer was from 14 to 14 ½ inches from the cell surface. Each wafer was marked for location and had direct alpha and beta and contact gamma measurements performed on each end, and were sent to the AREVA E-Laboratory for isotopic analysis. Results of direct survey measurements are presented in Table 4-20 that follows.

Table 4-20, Measurement Results for Core Sample Evaluation

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)
Statistics	Alpha	Beta	Contact
No. of Measurements	64	64	64
Mean	0	3,338	5,769
Median	-5	2,648	4,505
Standard Deviation	35	2,365	4,375
Range	165	14,493	28,850
Minimum	-29	1,003	2,700
Maximum	136	15,496	31,550
Ave. Background	29	2,185	3,325
Ave. MDC (Ave. MDCR*)	167	858	812
DCGL (No. > Bkg.*)	100	5,000	49
No. > DCGL (> Bkg.+3σ*)	2	13	17

*Applies to exposure rate measurement result

Core sample evaluation measurement summary results showed that each direct beta measurements results were greater than the measurement MDC of 858 dpm/100cm^2 and thirteen (13) direct beta result greater than 5,000 dpm/100cm^2 DCGL ranging to 15,496 dpm/100cm^2 beta. There were forty nine (49) contact gamma exposure rate measurements performed that showed results above shielded general area background. The mean of results for contact gamma was also above shielded general area background and seventeen (17) results greater than shielded general area background +3σ ranging to 31,550 cpm. However, results from direct alpha measurements were less than measurement MDC. Smear samples for removable alpha and beta activity were not collected on core samples. As shown in drawings presented in Section 4 of Appendix A, the depth of activation in Test Cell B-104 is as follows:

- West Wall, 8 inches
- North Wall, 8 inches
- South Wall, 10 inches
- East wall, 8 inches
- Floor Surface, 6 inches

The concrete core samples were obtained from the test cell locations showing the highest activation, therefore the depths are considered to be conservative. Based on a review of all of the direct measurements of the intact cores, wafers and isotopic analysis of selected wafers it will be necessary to remove approximately 8 inches depth of concrete on west, north and east walls; 10 inches depth on the south wall; and 6 inches depth from the floor and ceiling surfaces of each test cell. This approach will result in background levels for surfaces of the structure remaining once decontamination actions are completed. Isotopic results from all of the core wafer samples are presented in Table 4-21 that follows.

Table 4-21, Core Sample Analysis Results

Symbol	**Activity** (Ave pCi/g)	**Range** (pCi/g)		**Std. Dev.** (1 sigma)	**No. >/= MDC**	**Ave.MDC** (pCi/g)	**DCGL** (pCi/g)	**No. > DCGL**
		Min	**Max**					
Co-60	4.692	0.011	24.60	6.843	13 of 14	0.336	1.9	6
Cs-134	0.096	-0.120	0.81	0.252	0 of 14	0.480	3.3	0
Cs-137	0.084	-0.070	0.43	0.147	0 of 14	0.364	9.2	0
Eu-152	29.107	-0.070	134.90	42.084	13 of 14	0.272	4.5	7
Eu-154	1.749	-0.600	8.70	2.803	8 of 14	1.108	4.1	2
K-40	5.247	0.110	21.90	6.883	7 of 14	3.970	27.6	0
Mn-54	-0.008	-0.400	0.52	0.217	0 of 14	0.531	6.1	0
Na-22	0.245	-0.780	3.20	0.884	1 of 14	0.708	2.3	1

The data collected indicates that the depth of concrete activation is not uniform on the walls within the test cells. The walls within the test cells will be remediated to the nominal depths stated above and areas with the highest direct readings will require additional remediation to a greater depth as indicated by the core samples. For instance sample NWH1-2 collected at a depth of 8 inches indicates Eu-152 at 5.75pCi/g is slightly above the DCGL of 4.5. However the sample from 14 inches is 0.8 pCi/g, which is far below the DCGL. During remediation additional surveys and sampling will be performed to ensure the concrete that remains meets the release criteria.

4.5.3 Sump and Storage Tube Surfaces

Direct alpha and beta measurements were performed at locations within the sump and storage tubes. Contact gamma were also performed at each SML, but because ground water had infiltrated the sump and storage tubes, water samples were the only samples collected for isotopic analysis. The water samples were collected to determine if the water was suitable for release to the sanitary sewer system. The isotopic analysis results from the water samples showed there was no detectable radioactivity. The results of survey measurements from sump and storage tube surfaces are presented in Table 4-22 that follows.

Table 4-22, Sump and Storage Tube Measurement Results

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)
Statistics	Alpha	Beta	Alpha	Beta	Contact
No. of Measurements	7	7	7	7	7
Mean	-23.4	-126.2	-0.7	-3.3	4,527
Median	-29.0	12.3	-1.0	-6.9	4,595
Standard Deviation	6.9	336.1	0.9	14.3	463
Range	13.0	997.0	2.3	38.7	1,310
Minimum	-29.0	-776.7	-1.0	-23.5	3,790
Maximum	-16.0	220.3	1.3	15.2	5,100
Ave. Background	23.4	1,858.0			10,803
Ave. MDC (Ave. MDCR*)	25.9	348.9	11.3	73.9	719
DCGL (No. > Bkg.*)	100	5,000	20	100	0
No. > DCGL (> Bkg.+3σ*)	0	0	0	0	0

*Applies to exposure rate measurement result

The characterization and confirmatory survey showed that the mean of the results and all measurements for direct and removable alpha and beta were less than the measurement MDC and DCGLs. There were contact gamma exposure rate measurements performed that showed each result less than average background. Survey objectives were achieved and the SETF first floor structure was shown to be suitable to demolish and dispose of as DM. Results of the water samples showed that there were no COC detected and the water was suitable for release to the sanitary sewer system.

4.5.4 C4024 101C1 SGTCC Test Cell B-102

Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to locations with the highest and lowest activation determined by gamma scan using a collimated NaI(Tl) detector, shielded for a 2 inch diameter field of view. Gamma scans were performed for each surface in the test cell and SMLs marked at locations of highest and at the lowest count rate. Contact gamma, and direct alpha and beta measurements were performed at the marked locations. Smear samples for removable alpha and beta activity were also performed at each SML. The results of survey measurements are presented in Table 4-23 that follows.

Table 4-23, Measurement Results SGTCC Test Cell B-102

Measurement Type	**Direct Activity** (net dpm/100cm^2)		**Removable Activity** (net dpm/100cm^2)		**Exposure Rate** (gross cpm)
Statistics	Alpha	Beta	Alpha	Beta	Contact
No. of Measurements	18	18	18	18	18
Mean	-1.6	6,385.7	0.3	-5.1	30,308
Median	-7.4	5,618.0	-1.0	-5.6	25,450
Standard Deviation	16.2	2,905.4	1.6	16.0	13,433
Range	51.9	9,850.7	4.5	52.6	50,600
Minimum	-16.0	2,967.3	-1.0	-34.6	14,900
Maximum	35.9	12,818.0	3.5	18.0	65,500
Ave. Background	16.0	1,422.0			9,381
Ave. MDC (Ave. MDCR*)	49.2	742.8	11.3	74.8	1,861
DCGL (No. > Bkg.*)	100	5,000	20	100	18
No. > DCGL (> Bkg.+3σ*)	0	10	0	0	8

*Applies to exposure rate measurement result

The same instruments were used for this location as the background areas. Because there were only metal materials surveyed the "direct activity" background subtracted was the metal background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. As shown in Table 4-22, the test cell B-102 is similar to test cell B-104 in that each contact gamma measurement is greater average background. In addition, the mean of results for contact gamma is approximately three times average background vs. four times average background for B-104. The characterization and confirmatory survey showed that direct beta measurements results were each greater than the measurement MDC of 743 dpm/100cm^2 and ten (10) direct beta results were greater than 5,000 dpm/100cm^2 DCGL ranging to 12,818 dpm/100cm^2 beta. There were eighteen (18) contact gamma exposure rate measurements performed that showed results above average background. The mean of results for contact gamma was also above average background and greater than Bkg.+3σ ranging to 65,500 cpm, more than six (6) times average background. However, results from direct alpha measurements were less than measurement MDC and DCGLs, and removable alpha and beta smear sample results were each less than measurement MDC and DCGLs.

4.5.5 Test Cell Conclusion

Based on the results of the characterization and confirmatory surveys, and the analysis of the concrete core samples taken from Test Cell B104 (see Appendix A Section 4.1 of this report), it is concluded that the D&D activities planned for the SETF activated test cells should continue as planned, but should be adjusted as follows for each test cell:

- Completely remove the shield walls from Test Cells B102 and B104 (see Figure 4-5)
- Remove an average of eight (8) inch depth of activated concrete from west, north and east walls; removal of additional material may be required in localized areas as determined by confirmatory surveys,
- Remove an average of ten (10) inch depth of activated concrete from south wall; removal of additional material may be required in localized areas as determined by confirmatory surveys, and
- Remove an average of six (6) inch depth of activated concrete from floor and ceiling surfaces, removal of additional material may be required in localized areas as determined by confirmatory surveys,

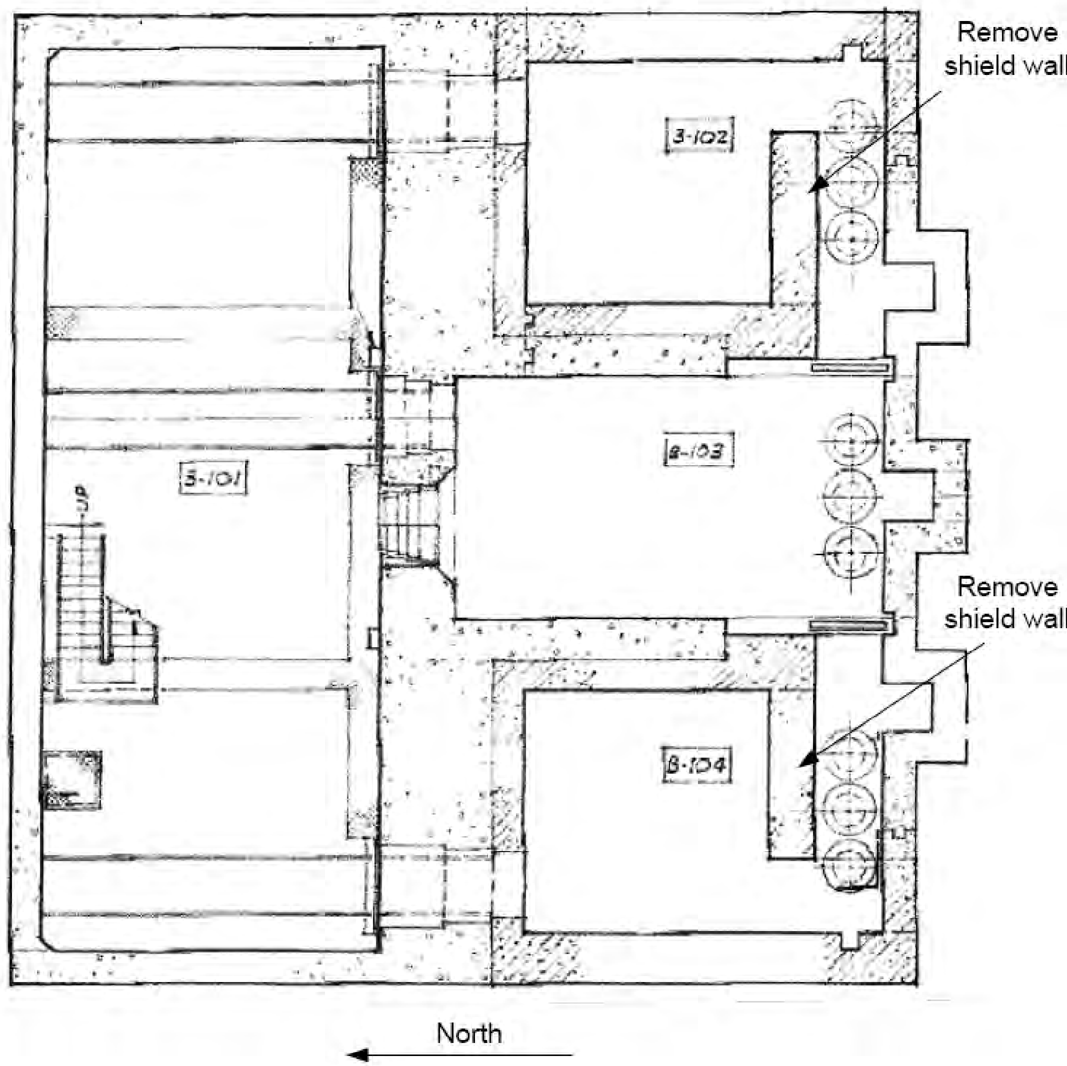
Also as planned, the aluminum liner and concrete rubble material generated from decontamination of the test cells is to be packaged and shipped to the Nevada Test Site (NTS) for disposal.

4.6 E4024 101C1 SETF Systems, Gas & Liquid Waste, Floor Drains, and Solid Waste Storage

Survey package E4024 101C1, SETF Systems, Gas & Liquid Waste, Floor Drains, and Solid Waste Storage was developed for the survey of these systems at the SETF. The objective of the survey was to perform measurements and collect samples of sufficient quantity to confirm presence or absence of radioactivity from former operations in the systems. The systems surveyed included accessible portions of the piping that remained from gas and liquid waste storage systems and the floor drain system located in the basement of SETF in room B-101. The measurements performed included: direct measurements for total beta activity; contact gamma measurements; smear samples for removable alpha and beta activity; and a composite material sample from each system surveyed. Detailed results of the survey and drawings showing SMLs are presented in Appendix A, Section 5.

Figure 4-5, Test Cells

Figure 4-5



4.6.1 Floor Drains

Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was based on accessibility to floor drain locations. Direct beta and contact gamma measurements were performed at each SML as well as a smear sample for removable alpha and beta activity. One composite material sample was collected for isotopic analysis. The sample was composed of sediment collected from each of the SMLs except for SML No. 5 which was not accessible. It was reported by a current employee that the floor drain at SML No. 5 in the middle of Room B-101 was grouted over due to an elevated reading in the drain during previous equipment and materials removal operations. The results of survey measurements are presented in Table 4-24 that follows.

Table 4-24, Measurement Results from SETF Floor Drains

Measurement Type	**Direct Activity** (net dpm/100cm^2)	**Exposure Rate** (gross cpm)
Statistics	Beta	Contact
No. of Measurements	5	5
Mean	3,056	14,380
Median	3,056	14,050
Standard Deviation	617	3,613
Range	1,366	8,050
Minimum	2,297	10,100
Maximum	3,663	18,150
Ave. Background	1,422	9,381
Ave. MDC (Ave. MDCR*)	1,979	1,282
DCGL (No. > Bkg.*)	5,000	5
No. > DCGL (> Bkg.+3σ*)	0	2

*Applies to exposure rate measurement result

Because there were only metal materials surveyed the "direct activity" background subtracted was the metal background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to accessible locations for interior surfaces of the drain system. Direct beta measurements, contact gamma exposure rate and smear samples for removable alpha and beta activity were performed at each SML. The characterization and confirmatory survey showed that each of the five (5) direct beta measurements results were greater than the measurement MDC of 1,979 dpm/100cm^2 but each were less than 5,000 dpm/100cm^2 DCGL ranging to 3,663 dpm/100cm^2 beta. There were no removable alpha and beta smear sample results above MDC or DCGL. Each of the five (5) contact gamma exposure rate results were above average background and the mean of the results was also above the average background level. Two (2) contact results were greater than Bkg.+3σ at SML 4 and

SML 5. Results from the analysis of the composite sediment sample are presented in Table 4-25 that follows.

Table 4-25, Floor Drain Composite Sediment Sample Analysis Result

Symbol	**Activity** (pCi/g)	**2 Sigma Uncertainty**	**MDC**	**>/= MDC**	**DCGL** (pCi/g)	**No. > DCGL**
Co-60	0.006	0.0210	0.0380	1	1.9	0
Cs-137	2.22	0.0480	0.0350	1	9.2	0
K-40	7.95	0.430	0.460	1	27.6	0
Th-232	2.98	0.520	0.120	1	5	0
U-234	1.47	0.210	0.0520	1	30	0
U-235	0.122	0.0750	0.0800	1	30	0
U-238	1.37	0.210	0.0700	1	35	0

Isotopic analysis of the floor drain composite sediment sample showed the above listed isotopes were present and detectable at levels a fraction of the bulk material DCGL for the identified isotopes. The sample was analyzed for the full suite of potential contaminants of concern (COC), but the analytical results did not indicate the presence of other potential COC. However, data showing the absence or presence of COCs could not be obtained at SML No. 5. The floor drain at SML No. 5 was not accessible due to the opening was closed with a grout covering.

4.6.2 Gas & Liquid Waste System Piping

Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was based on accessibility to the locations where gas and liquid waste system piping remained. Direct beta and contact gamma measurements were performed at each SML as well as a smear sample for removable alpha and beta activity. One composite material sample was collected for isotopic analysis. The sample was composed of sediment collected from each of the SMLs. The results of survey measurements are presented in Table 4-26 that follows.

Table 4-26, Measurement Results from SETF Gas & Liquid Waste System Piping

Measurement Type	**Direct Activity** (net dpm/100cm^2)	**Exposure Rate** (gross cpm)
Statistics	Beta	Contact
No. of Measurements	8	9
Mean	3,056	10,183
Median	3,018	10,050
Standard Deviation	1,162	1,783
Range	2,960	6,350
Minimum	1,614	7,650
Maximum	4,574	14,000
Ave. Background	1,422	9,381
Ave. MDC (Ave. MDCR*)	2,347	1,079
DCGL (No. > Bkg.*)	5,000	6
No. > DCGL (> Bkg.+3σ*)	0	0

*Applies to exposure rate measurement result

Because there were only metal materials surveyed the "direct activity" background subtracted was the metal background and is presented as "Ave. Background." Refer to the Appendix A results listing for the background applied to individual measurements. Measurements and samples were performed in accordance with the SAP, procedures and instructions provided in the survey package. Selection of SMLs was biased to accessible locations for interior surfaces of the system. Direct beta measurements, contact gamma exposure rate and smear samples for removable alpha and beta activity were performed at each SML. The characterization and confirmatory survey showed that five (5) of the eight (8) direct beta measurements results were greater than the measurement MDC of 2,347 dpm/100cm^2 but each were less than 5,000 dpm/100cm^2 DCGL ranging to 4,574 dpm/100cm^2 beta. There were no removable alpha and beta smear sample results above MDC or DCGL. Refer to Appendix A for results for the removable data. Six (6) of the nine (9) contact gamma exposure rate results were above average background and the mean of the results was also above the average background level. However each of the contact results were less than Bkg. +3σ. Results from the analysis of the composite sediment sample are presented in Table 4-27 that follows.

Table 4-27, Gas & Liquid Waste System Piping Composite Sediment Sample Analysis Result

Symbol	Activity (pCi/g)	2 Sigma Uncertainty	MDC	No. >/= MDC	DCGL (pCi/g)	No. > DCGL
Cs-137	0.592	0.015	0.0150	1	9.2	0
K-40	20.9	0.300	0.180	1	27.6	0
Th-228	0.650	0.310	0.510	1	5	0
U-234	1.28	0.100	0.0098	1	30	0
U-235	0.062	0.023	0.0093	1	30	0
U-238	1.28	0.100	0.011	1	35	0

Isotopic analysis of the gas and liquid waste system piping composite sediment sample showed the identified isotopes were present and detectable at levels a fraction of the bulk material DCGL for the identified isotopes. The sample was analyzed for the full suite of potential contaminants of concern (COC), but the analytical results did not indicate the presence of other potential COC.

4.6.3 Solid Waste Storage Vaults

The vault covers were removed from the storage vaults to conduct characterization and confirmatory surveys, but each were found with approximately 4 ft. of water. The source of the water was most likely from rain water intrusion. Each vault cover received a radiological control survey as they were removed, then each were placed on herculite sheeting for temporary storage. Direct beta/gamma measurements with a Ludlum Model 3 count rate meter with pancake GM detector were in the normal background range. Results from smear samples collected did not indicate the presence of removable contamination above 11 dpm/100cm^2 alpha MDC and 75 dpm/100cm^2 beta MDC. Water samples collected for radiological control purposes and analyzed by gamma spectroscopy analysis did not detect any COCs. No further characterization and confirmatory surveys were conducted due to the DOE Stop Work Order issued May 25, 2007. The water was left as found and the vault covers were replaced.

4.6.4 SETF Systems Conclusion

In conclusion, the survey objectives were only partially achieved for Survey package E4024 101C1 SETF Systems, Gas & Liquid Waste, Floor Drains, and Solid Waste Storage. Preparations began for the solid waste storage system survey planned, but operations were interrupted by a stop work order as previously noted. The solid waste storage system should be surveyed as planned. Also, it is recommended that other items be removed from the SETF utilizing the same controls as with the test cell decontamination, and that these materials also be packaged and disposed of at NTS. These items include:

- Piping for the former contaminated gas and contaminated liquid waste UST systems

- Floor drain systems and connecting piping in Room B-101, basement operating floor

The floor drain systems and connecting piping in Room B-101 should be removed and packaged as LLW because of contamination reportedly was grouted within the drains at SML No. 5, as previously noted, and elevated contact gamma measurement results confirm the report. The piping for the former contaminated gas and contaminated liquid waste systems should be removed and packaged as LLW because the system conveyed radioactive gas and liquid waste to the USTs.

5. QUALITY ASSURANCE AND QUALITY CONTROL

AREVA's Quality Assurance/Quality Control (QA/QC) Programs were implemented to ensure that all quality and regulatory requirements were satisfied while conducting the surveys. Activities affecting quality were controlled by procedures and Reference 7.7, Quality Assurance Project Plan for SETF Surveys, Rev 0, March 2007, AREVA (QAPP). The documents included the following Quality Control measures as an integral part of the survey process.

5.1 General Provisions

5.1.1 Selection of Personnel

Project management and supervisory personnel were required to have extensive experience with AREVA procedures and the QA/QC plan and be familiar with the requirements of this Survey and Sampling Plan. Management had prior experience with the radionuclide(s) of concern and a working knowledge of the instruments used to detect the radionuclides on site.

AREVA selected supervisory personnel to direct the survey based upon their experience and familiarity with the survey procedures and processes. Likewise, Health Physics technicians who performed the surveys were selected based upon their qualifications and experience.

5.1.2 Written Procedures

All survey tasks essential to survey data quality were controlled by standard operating procedures (SOPs) and the SAP (Ref 7.6). A list of plans and procedures is provided in the QAPP.

5.1.3 Instrumentation Selection, Calibration, and Operation

AREVA selected instruments proven to reliably detect the radionuclides present at the SETF facility. Instruments were calibrated by AREVA approved and qualified vendors under approved procedures using calibration sources traceable to the NIST. All detectors were subject to daily response checks when in use.

Procedures for calibration, maintenance, accountability, operation, and quality control of radiation detection instruments implemented the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.

5.1.4 Survey Documentation

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

5.1.5 Chain of Custody

Procedures established responsibility for the custody of samples from the time of collection until results were obtained. All samples shipped off site for analysis were accompanied by a chain-of-custody record to track each sample.

5.1.6 Independent Review of Survey Results

The survey package and survey data from each area received an independent review to verify all documentation was complete and accurate.

5.1.7 Training

All project personnel received site-specific training to identify the specific hazards present in the work and survey areas. Training included a briefing and review of the SAP, AREVA procedures, the QAPP and the Site Health and Safety Plan (HASP). Copies of all training records were maintained on site through the duration of on-site activities. During site orientation and training, survey personnel became familiar with site emergency procedures.

5.1.8 Sample Analysis

In order to meet the MARSSIM objective for variance and precision, the survey team performed quality assurance checks on 5% of all sample analyses in accordance with the SAP. The QC samples include: split samples and/or duplicate or replicate samples of each type of sampled material (e.g. soil, concrete) obtained and analyzed.

The AREVA Environmental Laboratory QA/QC program was in effect for the analysis of samples. In order to meet the MARSSIM objective for variance in bias, the AREVA E-Lab performed quality assurance checks on 5% of all sample analyses performed for each type of sample and analytical analysis performed. Bias in the sample analysis process was determined quantitatively by the analysis of blank samples, matrix spike sample and/or laboratory control sample (LCS) spiked by the analytical laboratory.

6. REFERENCES

6.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment

6.2 Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), May 22, 1995

6.3 Executive Order No. D-62-02, Cleanup and Abatement Order (CAO) No. R9-2002-330: Moratorium on Disposal of Low-Level Radioactive Wastes, Governor, State of California, issued September 29, 2002

6.4 N001SRR140131, Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL, Boeing, 1999

6.5 Team Product Document No: RS-00025, Building 4024 Concrete Sampling, Boeing 12/15/04

6.6 Sample and Analysis Plan for the SETF Survey, Rev 0, March 2007, AREVA

6.7 Quality Assurance Project Plan for the SETF Survey, Rev 0, March 2007, AREVA

6.8 Health and Safety Plan for the SETF Decommissioning, March 2007, AREVA

6.9 Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California

6.10 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1, August 2000, EPA402-R-97-016 Rev1 (NUREG-1575 Rev

6.11 Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), Part I, July 2004, EPA402-B-04-001A (NUREG-1576)

6.12 NUREG–1501, Background as a Residual Radioactivity Criterion for Decommissioning, NRC, Draft Report for Comment August 1994

6.13 NUREG–1506, Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria, NRC, August 1995

6.14 NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NRC, Draft Report for Comment August 1995

6.15 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Vol. 1, Decommissioning Process for Materials Licensees, Decommissioning Process for Materials Licensees, Revision 2, September 2006

6.16 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Vol. 2, Decommissioning Process for Materials Licensees, Characterization, Survey, and Determination of Radiological Criteria, Revision 1, September 2006

6.17 American National Standard Institute (ANSI) Standard ANSI N323-1978, Radiation Protection Instrumentation Test and Calibration."

6.18 ANSI N42.17A-1989, American National Standard Performance Specifications for

Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions – Description

7. ATTACHMENTS

Attachment 1: Survey Data Management System Location Code Example

8. APPENDICES

Appendix A Completed Data Packages

Appendix B Completed Survey Packages

Appendix C Analytical Data and Quality Control

Attachment 1, Survey Data Management System Location Code Example

LC 1 **Survey Group and Survey Area ID**	**LC 2** **Survey Unit Class/ Survey Unit ID and Survey Reason**	**LC 3** **Surface Category / Material Code**	**LC 4** **Detector Type / Survey Count Type/ Background Mode**	**LC 5** **Room No. / Survey Grid ID**	**LC 6** **Survey Point / Measurement Location**
Positions (P) 1 - 5	**Positions (P) 1 - 5**	**Positions (P) 1 - 5**	**Positions (P) 1 – 5**	**Positions (P) 1 - 5**	**Positions (P) 1 - 5**
C | 4 | 0 | 2 | 4	**1 | 0 | 1 | C | 1**	**F | L | 1 | M | 1**	**B | 0 | 2 | F | A**	**B | - | 1 | 0 | 2**	**0 | 0 | 0 | 0 | 1**
P1 - A 1 character code to identify the survey group. e.g. **A** - Impacted Environs **B** - Non-Impacted Environs **C** - Impacted Structures **D** - Non-Impacted Structures **E** - Impacted Systems **F** - Non-Impacted Systems **G** – Background Structures **H** – Background Environs *P2, 3, 4 & 5 (4 character) code to identify the survey area. e.g.* **A4024** – SETF Environmental Soil Areas **C4024** – SETF Building 4024 Structure *The LC1 code is also used to designate the source number during Source Checks. e.g.* **EZ259** – AREVA SETF project assigned source number	*P1 - A 1 character code to identify the survey unit classification. e.g.* **1**... – Class 1 **2**... – Class 2 **3**... – Class 3 **4**... – Non-Impacted *P2 & 3 - A 2 character code to identify the survey unit. e.g.* **01**... – Test Cell B-102. **02**... – Test Cell B-104 *P ,4 & 5 - A 2 character code to identify the survey reason. e.g.* **Bx** - Background Survey **Cx** – Characterization **Ix** – Investigation **Fx** - Final Status Survey **Px** –Remedial Action Srvy **Qx** – QA/QC **Sx** - Scoping Survey **Vx** - Verification Survey **x** will be a numeric sequence starting with **1.** *The LC2 code is also used to designateDRT01 or DRT02 during Source Checks. Detector Response Test, Pre/Post*	*P 1, 2 & 3 - A 3 character code to identify the survey surface. e.g.* **FLx** – Floor **WLx** – Wall Lower **WUx** – Wall Upper **MAx** – Misc. E & M **MIx** – Interior of Equipment and Materials **LAx** – Open Land Area **SAx–** Surface Soil (0-6") **SBx–** Subsurface Soil (6-12") **SYx –** System **ESx** – System Exterior **ISx** – System Interior **x** will be a numeric sequence starting with **1.** *P ,4 & 5 - A 2 character code to identify the type of Material* e.g. **A1** – Asphalt **B1** – Brick **C1** –Concrete (Bare) **C2** – Concrete (Painted) **D1 –** Cinder Block (Bare) **D2 –** Painted Cinder Block **G1** – Misc. Material **M1** – Metal **P1** – Porcelain **R1** – Sediment **S1** – Soil **T1** – Ceramic Tile **W1** – Water	*P1, 2 & 3 - A 3 character code to identify the survey detector. e.g.* **A03 - 43-90 Alpha** **A04 - 43-89A Alpha** **B01 - 44-40B** **B02 - 44-116** **B08 - 43-37** **B14 - 43-89B** **G01 - 44-10 Contact** **G02 - 44-10 1 Meter** *P4 - A 1 character code to identify the type of count. e.g.Source Check (SC) Types:* **A** – Pre Use SC Bkg **B** – Pre Use SC Count **C** – Post SC Bkg **D** – Post SC Count **F** – Field Count **G** – Field Bkg **S** – Field Scan *P 5 - A 1 character code to identify background subtract method for direct measurements,e.g.* **A –** Average background **N – N**ot required **S –** Single background per reading	*P1, 2, 3, 4 & 5 –Can be a 5 character code to identify the survey grid ID, room number or system number.* Or, if not used, can enter ZZZZZ	*5 character counter to track measurement or sample numbers as required.*

Appendix A

Completed Data Packages

Survey Package	Survey Unit Description	Section
	Background Study	1.0
G4024 401B1	Structures Background Reference Area	1.2
H4024 401B1	Environmental Soil Background Areas	1.3
	SETF Environmental Soil Areas	4.3
A4024 301C1	Soil Areas Adjacent to Paved Areas	4.3.1
A4024 101C1	Buried Waste Tank/Vault Location	4.3.2
	SETF Structures and Surfaces	4.4
C4024 301C1	High Bay and First Floor DM Areas	4.4.1
C4024 302C1	Basement Floor and Mezzanine DM Areas	4.4.2
C4024 303C1	Paved Yard Area and Slabs Remaining Around SETF	4.4.3
C4024 303C2	Follow-up Survey of Elevated Locations on Slabs	4.4.3.2
C4024 303C2	Follow-up Survey of Asphalt covering UST's	4.4.3.3
	SETF Activated Test Cells	4.5
C4024 102C1	SGTCC Test Cell B-104	4.5.1
C4024 101C1	SGTCC Test Cell B-102	4.5.2
	SETF Systems	4.6
E4024 101C1	Liquid Waste, Floor Drains, and Solid Waste Storage	4.6.1