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Technical Report
Final Facility Decommissioning
Teledyne Brown Engineering
Westwood, New Jersey
U.S. NRC License Nos. 29-00055-06, 29-00055-15, and SNM-107
NJSL License No. 10123

1.0 Introduction

Earth Sciences Consultants, Inc. (Earth Sciences) has been retained by Teledyne Brown Engineering (Teledyne) to provide technical assistance for the final facility decommissioning of their former radiological testing facility located at 50 Van Buren Avenue, Westwood, New Jersey (Figure 1). Teledyne has completed the facility decommissioning to terminate Nuclear Regulatory Commission (NRC) License Nos. 29-00055-15 and SNM-107 and remove the radiological control requirements imposed by License No. 29-00055-06 for the Westwood, New Jersey facility. This report demonstrates that residual radioactive material at the facility satisfies the criteria established by the NRC for license termination and release of the site for unrestricted use.

The site of the Teledyne facility consisted of a vacant unimproved land parcel prior to 1964. Lamb Investment Corporation constructed a one-story cement block building on the site in July 1964. Isotopes, Inc. was the original tenant and signed the first lease for the building in July 1964. Teledyne, Inc. purchased Isotopes, Inc. in 1968 and the facility operated under the name of Teledyne Isotopes until 1996. In 1996, Teledyne Isotopes changed its name to Teledyne Environmental, Inc. dba Teledyne Brown-Engineering-Environmental Services. Also in 1996, Teledyne, Inc. and Allegheny Ludlum Corporation combined to form Allegheny Teledyne Incorporated. Teledyne Environmental, Inc. continued to conduct business as Teledyne Brown Engineering. Teledyne Brown Engineering ceased the majority of their operations at the facility in November 2000 when the radiochemistry laboratory relocated to Knoxville, Tennessee. Teledyne's Radiological Services Department (RSD) operations relocated to Emerson, New Jersey in January 2001.

Teledyne performed various operations at the facility during its tenure. These operations included precious metals decontamination, nuclear fuels analysis, geochronometry, radiological safety services (health physics and instrument calibrations), nuclear measurements (environmental and in-plant radiochemistry, and gamma spectroscopy laboratories), Sodium Iodide (NaI) crystal manufacturing,

phosphor and dosimeter manufacturing, Thermoluminescent Dosimeter (TLD) instrument manufacturing, and personnel and environmental dosimetry services.

1.1 Summary of Decommissioning Activities

Teledyne's RSD continues to provide health physics and radioactive waste disposal services. The department also continues to operate its' warehouse at 103 Woodland Avenue, Westwood, New Jersey and has relocated its offices to Emerson, New Jersey from the 50 Van Buren Avenue, Westwood, New Jersey facility. The licensed activities performed by Teledyne' RSD include decontamination and decommissioning of facilities under the jurisdiction of the NRC and the State of New Jersey, radiation safety surveys and radwaste brokerage services.

Teledyne initiated decommissioning activities in November 2000. Earth Sciences was retained by Teledyne to conduct characterization and final radiological surveys of the existing building. Teledyne's RSD performed remediation activities, radiological sample analyses, and radiological material management for the facility decommissioning. Radiological sample analyses were also conducted by Teledyne's Knoxville, Tennessee laboratory.

Specific decommissioning building surveys that were performed included building interior surfaces for fixed alpha activity, fixed beta/gamma activity, gamma exposure rate, removable alpha activity, removable beta/gamma activity, and removable Tritium and Carbon-14 activities using appropriate instrumentation and/or laboratory analysis. These surveys were performed to demonstrate compliance to criteria for unrestricted release of the site under NUREG/CR-5849 and REG Guide 1.86.

Areas of the facility were cleared of radiological materials (samples, sources, etc.) and furnishings and equipment prior to commencing radiological survey activities. Select laboratory hood units and associated ventilation ductwork as well as select laboratory countertops, sinks, and drains were also removed (for proper disposal) prior to conducting radiological survey activities. In addition, radiologically contaminated areas of the facility identified during the radiological survey process were remediated to levels that met release criteria for unrestricted use. Remedial activities conducted included the removal of the following types of contaminated building components and ancillary facilities: tile and wooden flooring, carpeting, drain line piping; and isolated areas of concrete flooring and wall structures.

1.2 Report Structure

The remainder of this document provides a description of the site and a summary of facility operations (Chapter 2.0), a summary of site facilities (Chapter 3.0), a summary of the facility decommissioning activities including remediation efforts (Chapter 4.0), and a summary of final survey procedures and findings (Chapter 5.0). Chapter 6.0 summarizes the decommissioning activities performed for NRC license termination and release of the site for unrestricted use.

A strategy document prepared by Teledyne for the facility decommissioning is contained in Appendix A. Relevant correspondence items are contained in Appendix B. Building decommissioning survey data summary tables (including statistical evaluations) are presented in Appendix C. Building decommissioning survey documentation is contained in Appendix D. Analytical data reports including chain-of-custody documentation for the building decommissioning surveys are contained in Appendices E through H.

2.0 Site Description and Summary of Operations

This chapter provides a general description of the Teledyne site and a summary of facility operations.

2.1 Site Description

The Teledyne facility is located at 50 Van Buren Avenue in the Borough of Westwood, Bergen County, New Jersey (Figure 1). The facility resides on approximately 5 acres of land and consists of a single-story cement-block construction building. The building has approximately 47,500 square feet (4,420 square meters) of floor space. The site includes some grassy areas as well as macadam covered parking areas and a driveway. The site configuration and structures remain essentially as they were when it was originally developed. The site, building, and surrounding areas are shown on Figure 2.

2.2 Summary of Facility Operations

Teledyne maintains a number of NRC Broad Scope Byproduct Materials Licenses, one NRC Special Nuclear Material License and one State of New Jersey License for these operations. The licenses and their operations are listed below:

- NRC 29-00055-06 – Nuclear Measurements, Radiological Safety Services, NaI Crystal Manufacturing, TLD Instrument Manufacturing, and Dosimetry Services
- NRC 29-00055-15 – Precious Metals Decontamination
- NRC SNM-107 – Nuclear Fuels Analysis

Under licensed operations, the facility handled mixed fission and activation product radionuclides in addition to natural, depleted, and enriched Uranium, natural Thorium, Carbon-14, Tritium, and small quantities of transuranics. These radionuclides were in the form of client laboratory samples, sealed sources, and product material. Activities using these materials were conducted in controlled areas. Personnel and equipment were monitored before leaving controlled areas and each area was routinely surveyed and decontaminated to acceptable levels as needed.

Teledyne also performed geochronometry and phosphor and dosimeter manufacturing operations at the facility. These operations did not utilize radioactive materials.

3.0 Summary of Site Facilities

This chapter provides a summary of the site facilities based upon a review of available information (files, maps, etc.) and discussions with former employees. The facility building consisted of approximately 50 percent offices and 50 percent laboratories and was divided into three sections western, central, and eastern (Figures 2, 3, 4, and 5). Building sections were further divided into zones. Site facilities are summarized by building section and zone as well as facility type.

3.1 Western Section

The western section of the facility is comprised of approximately 1,540 square meters of floor space divided equally between two Building Zones, 1 and 2.

3.1.1 Building Zone 1

Building Zone 1 consists of 30 rooms encompassing approximately 770 square meters of floor space within the southern portion of this building section (Figure 3). This building zone housed the following facilities:

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Offices	Rooms 101, 103, 105, 107, 109, 111, 113, 115–121, 123, 125, and 127	None	Administrative and Managerial
Men's and Women's Restrooms	Rooms 112 and 114	None	Personal Hygiene
TLD Badge Service Area	Rooms 108 and 108A	Sealed Strontium-90 Sources in Room 108A	Processed TLD Badges from Power Plants and Other Industrial Facilities
Alpha and Beta Activity Counting Laboratory	Room 124A and Supporting Room 124	Sealed (Alpha, Beta, and Gamma) Sources and Media Samples in Room 124A	Counted Low-Level Media Samples for Gross Alpha and Beta Activities
Break Room	Room 110	None	Employee Break and Lunch Area
TLD Instrument Demonstration Laboratory	Room 102C and Supporting Rooms 102, 102A, and 102B	Sealed Strontium-90 Sources in Room 102C	Tested and Demonstrated Facility Manufactured TLD Readers

There is no record of radiological contamination outside of controlled areas for rooms in Building Zone 1.

3.1.2 Building Zone 2

Building Zone 2 consists of 20 rooms encompassing approximately 770 square meters of floor space within the northern portion of this building section (Figure 3). This building zone housed the following facilities:

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Alpha Spectroscopy Laboratories	Rooms 202, 204B, and 204C and Supporting Room 202B	Alpha Emitting Spike Solutions, Tracers and Media Samples	Prepared and Counted Media Samples
Tritium Laboratories	Rooms 202A and 202C and Supporting Room 202D	Tritium Spikes and Media Samples; Carbon-14	Prepared and Counted Media Samples. Carbon-14 dating in Room 202A
Gas Analysis Laboratories	Rooms 203 and 204	Teletrace Samples (Tritium, Carbon-14, and Krypton-85)	Analysis of Sample Gases
Teletrace Counting Laboratory	Room 204A	Teletrace Samples (Tritium and Krypton-85)	Analysis of Sample Gases and Liquids
Radium Laboratory	Room 203	Radium-226 Spike Solutions and Water Samples	Analyzed Samples for Radium-226 by Emanation
Furnace Room	Room 206A	None	Ashed Vegetation
Iodine Laboratory	Room 207	Spike Solutions (Iodine-129, Iodine-131, and Iodine-125) and Environmental Samples	Prepared and Analyzed Environmental Samples
Sample Receiving	Room 208	Media Samples	Received Media Samples for Laboratory Analysis
Preparatory/Staging Area for Environ-mental Chemistry	Room 209	Media Samples	Weighed and Stored Sample Mounts Prior to Counting
Environmental Uranium Laboratory	Room 209A	Uranium Spike Solutions and Environmental Samples	Analyzed Environ-mental Samples for Uranium by Laser Fluorimetry
Strontium and Radium 228 Laboratory	Room 210	Spike Solutions (Strontium-89, Strontium-90, Technetium-99, etc.) and Media Samples	Prepared and Analyzed Media Samples
Alpha and Beta Laboratory	Room 210A	Spike Solutions (Amercium-241 and Cesium-137) and Environmental Samples	Prepared Environmental Samples for Gross Alpha and Beta Analysis

There is no record of radiological contamination outside of controlled areas for rooms in Building Zone 2.

3.2 Central Section

The central section of the facility is comprised of approximately 1,260 square meters of floor space divided between two Building Zones, 3 and 4.

3.2.1 Building Zone 3

Building Zone 3 consists of 24 rooms encompassing approximately 610 square meters of floor space within the southern portion of this building section (Figure 4). This building zone housed the main building entrance, reception area, accounting offices, a TLD baking and spare parts storage area, a conference room, a restroom, and other administrative and managerial type offices. According to site personnel, no radioactive materials were used or stored in this building zone.

3.2.2 Building Zone 4

Building Zone 4 consists of 23 rooms encompassing approximately 650 square meters of floor space within the northern portion of this building section (Figure 4). This building zone housed the following facilities:

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Carbon-14, Tritium, and Strontium-90 Laboratories	Room 401	Standards and Environmental Samples	Prepared Environmental Samples for Laboratory Analysis
Electrical Supply	Room 402	None	Utility
Sample Storage	Room 403	Environmental Samples	Stored Samples
Maintenance	Rooms 404 and 417A	None	Shop Area (Room 404) and Office (Room 417A)
TLD Instrument Manufacturing	Rooms 405 and 405A	Carbon-14 Light Sources in Room 405	Assembled and Serviced TLD Reading Instruments
TLD Phosphors Laboratory	Rooms 406 and 406A	None	Prepared Phosphors (Scintillators) for TLD Manufacturing
Janitorial	Room 407	None	Stored Janitorial Supplies
Electronics Laboratory	Rooms 408 and 408A	None	Assembled Electronic Components for TLD Reading Instruments

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
TLD Manufacturing	Room 409	None	Stored Materials for Phosphor Production
Crystal Assembly	Rooms 410, 410A, 411, 413, and 415	Gamma Emitting Sealed Check Sources in Rooms 411 and 415	Manufactured NaI Crystals for Instrumentation Detectors; Final Assembly of Detectors
Shipping and Receiving	Rooms 412, 412A, 414, and 417	Sealed Sources and Media Samples in Protective Shipping Packages	Shipped and Received Media Samples, TLDs, TLD Instruments, Crystals, Supplies, etc.

There is no record of radiological contamination outside of controlled areas for rooms in Building Zone 4.

3.3 Eastern Section

The eastern section of the facility is comprised of approximately 1,510 square meters of floor space divided between three Building Zones, 5, 6, and 7.

3.3.1 Building Zone 5

Building Zone 5 consists of 23 rooms encompassing approximately 570 square meters of floor space within the southwestern portion of this building section (Figure 5). This building zone housed the following facilities:

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Offices	Rooms 501, 503, 505, 507, 509, and 509A	None	Administrative and Managerial
Alpha Spectroscopy Laboratory	Room 502 and Supporting Room 504A	Alpha Emitting Check Standards and Media Samples in Room 502	Counted Media Samples
Gamma Spectroscopy Laboratory	Room 504 and Supporting Rooms 506 and 506A	Gamma Emitting Check Standards and Media Samples in Room 504	Counted Media Samples
Environmental TLD Laboratory	Room 508	None	Read Out of Environmental TLDs
Sample Storage/ Counting Room	Room 510	Activation Products in Topaz Gemstones	Storage of Samples/Counted Irradiated Topaz Gemstones
Health Physics	Rooms 511, 511A, 511B, 511C, 513, and 513A	Sealed Cesium-137 Source in Room 513	Offices and Storage; Occasional Instrument Calibration

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Health Physics Laboratory	Room 512	Sealed Plutonium-239 and Strontium-90 Check Sources	Alpha and Beta Counting; Instrument Storage
Health Physics Laboratory	Room 516	Tritium and Carbon-14 in Samples	Loaded Swipe Samples for Liquid Scintillation Counting
Break Room	Room 514	None	Employee Break and Lunch Area

There is no record of radiological contamination outside of controlled areas for rooms in Building Zone 5.

3.3.2 Building Zone 6

Building Zone 6 consists of 25 rooms encompassing approximately 770 square meters of floor space within the northern portion of this building section (Figure 5). This building zone housed the following facilities:

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Men's and Women's Restrooms	Rooms 601 and 603	None	Personal Hygiene
In-Plant Radiochemistry Laboratory	Room 602	Mixed Fission Products, Enriched Uranium	Prepared and Analyzed Media Samples
Gamma Spectroscopy Laboratories	Rooms 605, 606, and 606A and Supporting Room 608	Gamma Emitting Check Sources and Calibration Standards and Media Samples	Prepared and Analyzed Media Samples
Radon Laboratory	Rooms 607, 609, and 612	Gamma Emitting Check Sources and Media Samples	Prepared and Analyzed Samples
Utility	Room 610	None	Utility
TLD Manufacturing	Room 611	None	Stored Supplies TLD
Geochemistry Laboratories	Rooms 613 and 615	None	Prepared Non-Radiological Media Samples for Analyses
Low Enriched Uranium Preparation Laboratory	Room 614A	Low Enriched Uranium-235, Mixed Fission Products	Prepared Media Samples for Laboratory Analysis
Geochronometry Laboratories	Rooms 614B, 614C, and 619	None	Prepared Geologic Samples for Dating

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
Mass Spectroscopy Laboratory	Room 617	Enriched Uranium-235 Standards and Media Samples	Counted Samples
Storage	Room 620A	None	Stored Records
Source Room	Room 620B	Sealed Sources and Tracers (Tritium, Cobalt-60, Cesium-137, and Americium-241)	Storage, Instrument Calibration, and TLD Irradiation
Waste Chemical Storage	Room 620C	None	Stored Chemicals Used in Facility Operations

There is no record of radiological contamination outside of controlled areas for rooms in Building Zone 6.

3.3.3 Building Zone 7

Building Zone 7 consists of 8 rooms and a loft area encompassing approximately 380 square meters of floor space within the southeastern portion of this building section (Figure 5). This building zone primarily housed Precious Metals Decontamination Rooms and highly enriched uranium preparation laboratories.

Facility	Room(s)	Use of Radioactive Materials	Operational Summary
High Enriched Uranium Preparation Laboratories	Rooms 702 and 702A	Uranium-235	Prepared and Weighed Enriched Uranium Samples
Precious Metals Decontamination Laboratories	Rooms 703, 705, and 705A	Uranium-235 and Plutonium-239 in Rooms 705 and 705A	Received Samples (Room 703) and Performed Precious Metals Decontamination Efforts
Electrical Room	Room 704	None	Electrical Room for Precious Metals Operations
Storage	Room 701	Uranium-235 and Plutonium-239	Storage of Precious Metals Decontamination Buttons
Storage	Loft	Uranium-235 and Plutonium-239	Housed High-Efficiency Particulate Air (HEPA) Filter Units and an Air Scrubber

The precious metals decontamination was performed in a sealed glove box in Room 705. Most of the uranium sample preparation was performed in hoods with one step of the process performed in an oven. The loft housed the HEPA filter units and an air scrubber for the operations conducted in Zone 7. It should be noted that Building Zone 7 was operated at negative pressure compared to Zones 1 through 6.

A radiological spill occurred on the concrete floor of the Precious Metals Decontamination facility in 1984. Teledyne remediated the floor to below the fixed and removable contamination levels set for unrestricted use as specified in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination." A final report on the decontamination of the Precious Metals facility was submitted to the NRC on May 11, 1984. Following agency approval of the decontamination effects, Teledyne repaired the concrete floor and placed a new multi-layered resin floor over the existing concrete floor.

4.0 Decommissioning Activities

This chapter provides a summary of the scoping and characterization surveys completed as part of the facility decommissioning. Decontamination efforts performed as a result of the scoping and characterization surveys are also presented in this chapter. For clarification purposes, the term "radiological contamination" as used in this report implies that a material or surface exhibited radioactivity levels above the unrestricted release criteria established for the site.

4.1 Pre-Characterization Decontamination Efforts

Teledyne personnel, using process knowledge of the operations conducted a 50 Van Buren Avenue and the results of routine facility surveys, removed equipment and structures known to be or suspected of being contaminated above release limits for unrestricted use prior to Earth Sciences performing characterization surveys. Teledyne performed routine surveys in the past as required by the NRC licenses and in accordance with policies and procedures specified in the Teledyne Radiation Safety Code and Quality Control Manual.

The building areas decontaminated included Zone 6 (Rooms 602 and 614A) and Zone 7 (Rooms 702, 702A, 703, 705, and 705A). Decontamination consisted of the removal of laboratory hoods, benches, sinks, HEPA filter housing, a scrubber, glove boxes, and associated ductwork and piping. Samples and containers of radioactive material were also removed. All wastes and materials collected from the decontamination efforts were packaged in 30- or 55-gallon drums or B-25 steel boxes for disposal as radioactive waste.

Non-environmental samples, leachates, analytical mounts, check sources, and radioactive standards were collected from Rooms 124A, 209A, 403, 602, and 606 and packaged in drums or B-25 steel boxes for disposal as radioactive waste. Radioactive materials and sealed sources in the source storage and instrument calibration facility (Room 620B) were packaged as radioactive waste for proper disposal.

4.2 Scoping and Characterization Surveys

A preliminary assessment of the radiological conditions at the facility was completed through the use of scoping surveys. The surveys were both randomly performed throughout the facility and biased toward potentially contaminated areas. Scoping surveys were designed to be performed quickly, and as such, primarily utilized scanning methodologies in place of fixed point surveys.

Once radiological contamination was identified, characterization surveys were performed to more precisely define the extent and magnitude of radiological contamination present. The primary goal of performing the characterization surveys was to provide the data necessary for planning the appropriate steps for release of the area for unrestricted use.

The scoping surveys performed within the building generally consisted of beta floorscans, gamma exposure rate scans, a limited number of fixed point alpha and beta/gamma surveys, and removable alpha and beta/gamma samples. Beta floorscans were performed using a beta floorscan instrument which consisted of a 434 cm^2 gas proportional detector calibrated for gross beta detection at a 0.5 inch height above the floor surface and were performed at a rate of one detector width per second (approximately 6 to 8 inches) over the accessible floor surface. Gamma floorscans were performed using a 2-inch-by-2-inch Sodium Iodide detector calibrated for gross gamma count rate at 0.5 inch above the floor surface and were performed at a rate of 0.4 meter per second (about 18 inches) over the accessible floor surface. Audible clicks and needle deflection observations were utilized to identify potential areas of radiological contamination.

Characterization surveys were completed with the consideration that the data collected may be used as final survey results or to supplement the final survey results. As such, characterization survey procedures and results that represent final survey data are presented in Chapter 5.0 of this report.

4.2.1 Wastewater Collection Systems

This section presents a summary of the wastewater collection systems assessment activities. A survey of the facility's wastewater collection systems focused on floor drains, sink drains, and drain line cleanouts.

4.2.1.1 Documentation of the Integrity and Location of Facility Wastewater Collection System

The location and integrity of the facility's collection system associated with the floor drains and sinks were documented using line locator and video inspection techniques. A Gen-Eye JJR Pipe Inspection and Locator System, equipped with a 2-inch-diameter mini-cam, was used to perform these activities.

The layout of the aboveground and below ground collection systems is presented in Figure 6. As shown on Figure 6, the majority of the below ground collection system is situated beneath Building Zone 6. Many of the facility laboratory areas previously housing sinks contained aboveground piping which in some cases carried process wastewaters from the units more than 30 feet, and through several rooms, before eventually connecting to the below ground collection system.

Documentation of the integrity and location of the below ground wastewater collection system included visually inspecting approximately 472 feet of a potential 526 feet of piping. Therefore, approximately 90 percent of the underground wastewater collection system was video inspected. The majority of the below ground piping was 3 inches in diameter and constructed of copper. The main line in the hallway of Building Zone 6 was 6 inches in diameter and was constructed of copper. Some of the piping could not be inspected due to obstructions (i.e., sediment buildup, water at pipe entry). The portions of the below ground collection system that were not able to be video-taped due to access problems are also presented in Figure 6.

A total of 26 locations in Building Zones 2, 4, and 6 were utilized as access points to investigate the integrity of and locate the underground collection system associated with former laboratory areas at the facility. Several floor drains were identified in former laboratory-related areas. The floor drain collection lines were less than 2 inches in diameter at the point of entry and were too small to be accessed by the video inspection system. As shown in Figure 6, the floor drains are in close proximity to underground piping associated with the sinks and only minor amounts of piping are associated with them. The floor drain piping connects with other underground piping associated with the sinks, typically within 4 feet of origin.

In general, the below ground collection system appeared to be in good condition. The majority of the piping in Building Zone 6 did have buildup on the interior of the piping that prevented detailed inspection. However, no significant structural deterioration of the below ground piping was noted. The interior of the below ground piping in Building Zones 2 and 4 exhibited little visual evidence of material buildup.

There were three locations where it appeared the structural integrity of the below ground piping was potentially compromised. These locations, as presented in Figure 6, are as follows:

- Building Zone 6 between the trench and the south wall of Room 610. At this location, it appears as though the 3-inch-diameter piping is offset approximately 1 inch as a connecting joint. Room 610 was a utility room with no record of radioactive material usage.
- Building Zone 6 outside Room 602 where the piping connects to a main sanitary sewer line (8-inch). The location is approximately 8- to 10-feet beyond the north wall of the building. A possible crack, estimated to be several inches long, was identified in the base of the pipe. Room 602 was a radiochemistry laboratory.

- Building Zone 2 outside Room 208 where the piping connects to the main sanitary sewer line (8-inch). The location is approximately 8- to 10-feet beyond the north wall of the building. A possible crack, estimated to be several inches long, was identified in the base of the pipe. Room 208 was a sample receiving area. The source of wastewater associated with this drainline was a utility sink located in Room 208 and several sinks located in Rooms 210 (Strontium and Radium 228 laboratory) and 210A (alpha and beta preparation laboratory). The sink basins, drain piping, and associated traps were surveyed for the presence of radiological material. Results of the survey did not indicate the presence of radiological materials above release criteria.

In addition to the process-related underground collection system associated with the building, approximately 200 feet of the main sanitary sewer (8-inch) line was video inspected. The sanitary sewer line parallels the north end of the building about 10 feet beyond the building wall and trends east/west (Figure 2). The stretch of below ground piping inspected is located adjacent to Building Zones 2, 4, and 6, and is the piping to which the underground collection system from within the building, as well as discharge from a former concrete wastewater neutralization vault. The sanitary sewer line appeared to be in good condition and no evidence of a breach of the structural integrity of the pipe was observed.

4.2.1.2 Radiological Characterization

One main drain line in Building Zone 6 was determined to be radiologically contaminated from a feeder point in Room 614A to and including a subsurface concrete neutralization vault. The drain line and vault were removed. Details of the removal of the drain line and vault are provided in the following sections.

Radiological characterization of the wastewater collection systems focused on the facility's key (main-trunk lines) horizontal sanitary drain lines as well as floor drains, sinks, and cleanouts. Characterization activities consisted of surveying the wastewater collection system for the presence of radioactive material at any accessible location. Radiological surveys consisted of direct measurements and smear samples (alpha, beta/gamma, Tritium, and Carbon-14) for removable surface contamination. A summary of the final survey results is presented in Table 2.

4.3 Remediation Activities

Results of the scoping and characterization activities indicated that several areas of the facility were radiologically contaminated and required remediation. These areas, and the resultant decontamination activities, are discussed below.

4.3.1 Building

As previously mentioned, Teledyne personnel familiar with facility operations removed select laboratory hood units and associated ventilation ductwork as well as select laboratory benches and bench tops, glove boxes, and sinks prior to the commencing characterization activities. These laboratory components were either surveyed for release or packaged for disposal at an approved radioactive material disposal facility. The results of the building scoping and characterization survey activities showed that several remaining building structures and surfaces were radiologically contaminated. Remedial activities conducted included the removal of the following types of building components:

- Building Zone 6, Room 602 – small areas of floor tile and portions of the east and south wall structures.
- Building Zone 6, Room 606 – small areas of drywall on the north and west wall structures.
- Building Zone 6, Rooms 614A, 614B, and 614C – small areas of floor tile, concrete floor surface, and drywall wall surfaces.
- Building Zone 7, Loft – approximately 25 percent of the loft's wooden floor structure.
- Building Zone 7, Rooms 700, 701, 702, 702A, 703, 704, 705, and 705A – areas of the resin-covered concrete floor surfaces, drywall surfaces, and miscellaneous laboratory component surfaces (countertops, hoods, etc.).

Each of these areas was remediated (i.e., floor tile, drywall, benchtop, etc. removed) and resurveyed for residual radioactive material. Results of the post-remedial surveys are presented as final survey data in Chapter 5.0 of this report.

4.3.2 Room 614A Drain Line Removal to Vault

Laboratory operations historically performed in Room 614A included sample preparation of low to moderately enriched uranium fuel for analysis with a mass spectrometer. The main clients were fuel fabricators for the nuclear power industry. Primary and secondary coolants were also prepared in this laboratory for $^{11}B/^{10}B$ ratios and total boron content. The primary and secondary coolants contained less than µCi quantities of mixed fission products.

The decontamination of Room 614A was performed by Teledyne personnel familiar with the facility and required the removal of the laboratory hoods and associated ductwork, benches and bench tops, and sinks prior to commencing surveying. Sink drains were removed down to floor level.

Samples of the pipe scale from the remaining drain lines associated with this room were collected to determine if they were contaminated above the applicable release criteria. Analyses of the samples was performed by Teledyne's radiochemistry laboratory for uranium by alpha spectroscopy. The analysis determined that the scale within the drain lines contained 2- to 7.5-picocuries per gram (pCi/g) or 1- to 3.5-micrograms per gram of Uranium-235. This activity was consistent with the level of enriched uranium in samples analyzed in the laboratory. The source of the contamination appeared to be a drain from a laboratory bench sink in the center of Room 614A.

As shown in Figure 6, the drain line in Room 614A proceeded in a southwesterly direction toward the interior southern wall of the room. Feeder lines from the north wall (outer wall) and western wall of Room 614A entered the drain line prior to it reaching the interior southern wall of the room. At this point, wall sinks in benches along this interior southern also entered the drain line. The drain line proceeded beneath Room 617 and connected to a main drain line trunk located beneath the Zone 6 hallway and a drain line running east-west beneath Room 617. As shown in Figure 6, the main drain line trunk proceeded beneath the Zone 6 Hallway and veered north beneath Room 602. This drain line entered the subsurface neutralization vault located beyond the northern exterior wall of Room 602 prior to discharging to the main facility sanitary line and ultimately the Publicly Owned Treatment Works.

Smear samples were taken from the interior surfaces of the drain line to determine the extent of removable contamination as it was removed in 3- to 4-foot increments. Samples were counted in a Ludlum Model 2929 Dual Scaler for gross alpha and gross beta/gamma activity. Removable gross alpha contamination levels at the suspected source point in Room 614A exceeded 500 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) and diminished as the drain line entered the main drain line trunk located beneath the line trunk in the Zone 6 hallway. A sample collected from the main drain line trunk indicated that gross alpha removable contamination still exceeded applicable release criteria. The Teledyne radiochemistry laboratory confirmed by alpha spectrometry that the radiological contamination inside the drain line was Uranium-235.

As a result, the main drain line trunk was removed down the Zone 6 hallway. Samples were collected at regular intervals from the drain line interior, but gross alpha results continued to indicate that the contamination exceeded applicable release criteria. Feeder drain lines in Room 614A and Zone 6 hallway were also sampled (to account for contaminant backwash) and removed as necessary. The drain lines segments were packaged for disposal as radioactive waste.

During the excavation of the drain line in Room 614A, cracks in the cast iron pipe were observed. However, the main drain line trunk in the Zone 6 hallway and Room 602 appeared to be in good condition during removal and no evidence of a breach of the structural integrity of the piping was observed. As a result, soil samples were collected from the excavation trench in Room 614A and analyzed for uranium by alpha spectroscopy. Uranium-235 soil contamination was identified within the excavation trench in Room 614A. Soil samples collected in the excavation trench along the Zone 6 hallway and Room 602 indicated levels of Uranium-235 in agreement with natural soil activities (approximately 10^{-2} pCi/g) (Appendix H-1).

To further evaluate soil radiological conditions beneath Room 614A, soil core samples were taken adjacent to the trenching in Room 614A and analyzed for uranium by alpha spectroscopy (Figure 7). The results of the analysis indicated natural soil concentrations of Uranium-235 in the surrounding soil (Appendix H-2). During past laboratory operations, the Uranium-235 was converted to U_3O_8 during sample analysis, which was insoluble in water. The clayey soil found below grade probably impeded contaminant mobility.

The contaminated soil in the Room 614A trench was excavated and packaged for disposal at an approved radioactive material disposal facility. Final clearance samples were collected from the sidewalls and bottom of the trenching (approximately 1 foot below grade) in Room 614A following the excavation of contaminated soil (Figure 7 and Appendix H-3). A sample collected near the southern interior wall where the drain line entered Room 617 exhibited a Uranium-235 activity concentration of 4 pCi/g. Samples collected between this point and the source of the initial contamination exhibited activities ranging from normal Uranium-235 concentrations to 1 pCi/g. The limit in surface soil to ensure an exposure to the public of less than 25 mRem/year is 8 pCi/g Uranium-235 (NRC Generic Screening Value). The most restrictive New Jersey Department of Environmental Protection Soil Remediation Standard for Uranium-235 (for unrestricted use) is 7 pCi/g (N.J.A.C. 7:28-12, Table 1A). A gamma spectroscopy analysis of the soil samples indicated insignificant levels of Cesium-137 and Cesium-134 in one of the samples (Appendix H-3).

4.3.3 Removal of Wastewater Neutralization Vault

The concrete vault, located north of the building (Figure 2) was a subsurface flow-through neutralization structure consisting of two chambers filled with limestone chips to neutralize wastewater. The vault formerly received wastewater from a radiological laboratory within Building Zone 6.

During characterization, the vault chambers contained a wet gravelly sludge, to a depth of approximately 4.75- to 5-feet below the top of the vault, overlain with a few inches of water. The dimensions of the vault chambers were, respectively, 6.75 feet in diameter by 5.5 feet deep, and 5 feet in diameter by 5 feet deep. The vaults were linked by a 4-inch diameter steel or cast-iron pipe. The total estimated volume of sludge in the two chambers was, respectively, 174.5 cubic feet and 93.3 cubic feet. Thus, the total volume of sludge in the chambers was estimated at approximately 270 cubic feet, or approximately 10 cubic yards. The sludge material was found to contain elevated concentrations of radiological constituents including fission and activation products, as well as enhanced Uranium and natural Thorium.

On September 20, 2000, the soil around the vault chambers was excavated to a depth of approximately 9 feet below ground surface. Groundwater was encountered at a depth of approximately 4 feet below ground surface. During excavation and staging activities, excavated materials were contained and/or staged to avoid runoff and airborne dispersal of the materials. The contents of the two vault chambers were removed by vacuum on September 21, 2000, and contained in a total of 28 drums. The materials were found to be mostly (approximately 85 percent) solids but also contained some liquids and sludges. The liquids were decanted into two 30-gallon containers. Samples of the waste materials for each of the three media (solid, waste, and sludge) were collected for disposal characterization purposes.

Upon emptying of the vault chambers, a crane was used to lift out each chamber. The first (smaller) chamber was removed in one piece. The larger chamber split into two pieces upon removal by the crane. The bottom piece was broken up further and removed with a backhoe. All excavated materials including the chamber pieces and debris were wrapped in plastic pending disposal. The ultimate total size of the excavation was 16.5-feet-by-10-feet-by-9-feet deep.

Upon vault removal, the excavation was surveyed for residual radioactive materials and post-excavation samples were collected for radiological analysis. A 100 percent coverage gross gamma scan was performed to confirm the absence of residual radioactive materials. This involved scanning with a sodium iodide detector for each square meter of accessible wall surface of the excavation. The data from the gross gamma scan was also used to bias sampling locations towards the highest potential radiation areas, if encountered. All scan results, however, were within the background range of 2,000 to 2,500 counts per minute.

Five soil samples were collected from the excavation floor and 10 soil samples from the excavation sidewalls. The soil sampling locations were equally spaced along the walls and floor of the excavation to

provide a representative distribution of samples of the residual soils. The samples were analyzed for radiological activity by Teledyne's radiochemistry laboratory. All results were found to be within natural background activities.

A copy of a report detailing the vault removal and confirmatory survey and sampling activities is contained in Appendix B of this decommissioning report.

5.0 Final Survey Procedures and Findings

This chapter of the decommissioning report provides a summary of the final surveys completed for the Teledyne facility. The objective of the final surveys was to demonstrate that the radiological conditions at the facility satisfy the NRC guidelines and that the facility can, therefore, be released from licensing restrictions for future use without radiological controls. This section also establishes the key radionuclides of concern, release guidelines, and survey equipment and procedures used for the facility decommissioning.

5.1 Identification of Key Radionuclides of Concern and Release Guidelines

Teledyne prepared a decommissioning strategy prior to the initiation of radiological survey activities. This document established the radionuclides of concern and release guidelines for the site (Appendix A). The key radionuclides and release criteria were determined by Teledyne based on previous survey knowledge, operating history, and engineering judgement. The radionuclides of concern and release guidelines established for the facility are presented below.

5.1.1 Key Radionuclides of Concern

Teledyne established a facility-wide list of radionuclides of concern for the decommissioning and a focused list for select areas of the building based upon process knowledge. Licensed operations began at the site in 1964. Under licensed operations, the facility handled mixed fission and activation product radionuclides in addition to natural, depleted, and enriched Uranium, natural Thorium, Carbon-14, and small quantities of transuranics. These radionuclides were in the form of client samples, sealed sources, and process material.

5.1.2 Acceptable Surface Radiological Levels

Based upon the combination of the established radionuclides of concern, the acceptable surface radiological levels (unrestricted use) utilized for the facility are presented in Table 3 and summarized below. Units are dpm/100 cm^2.

Acceptable Surface Radiological Levels
Total Surface Radiological Levels
• Alpha – 100 dpm/100 cm^2 average value and 300 dpm/100 cm^2 maximum value
• Beta/Gamma (except Strontium-90) – 5,000 dpm/100 cm^2 average value and 15,000 dpm/100 cm^2 maximum value
• Strontium-90 – 1,000 dpm/100 cm^2 average value and 3,000 dpm/100 cm^2 maximum value

Removable Surface Radiological Levels
• Alpha – 20 dpm/100 cm^2
• Beta/Gamma (except Strontium-90) – 1,000 dpm/100 cm^2
• Strontium-90 – 200 dpm/100 cm^2

These criteria were based on the NRC document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material," Policy and Guidance Directive FC 83-23 (August 1987). Note that the more restrictive alpha limit for transuranics was used to guide the final survey process. However, more appropriate total and removable surface radiological limits for alpha were used to evaluate survey results for select rooms based on the facility operational history and/or characterization survey results. The more restrictive beta/gamma limit for Strontium-90 was also identified. However, the majority of Strontium-90 was contained in sealed sources or as part of samples containing additional fission fragments at limiting activity levels relative to Strontium-90. In rooms where Strontium-90 contamination is possible, the survey results were evaluated against the more restrictive limit.

5.1.3 Gamma Exposure Rate Level

The gamma exposure rate established for the site was 5 microroentgen per hour (uR/hr) above natural background at 1 meter from the surface with a maximum value of 10 uR/hr. This gamma exposure rate was applicable to building interior lower surfaces.

5.2 Survey Procedures

This section defines the procedures utilized to conduct the final surveys of the facility. A summary of the instrumentation used to complete the final surveys is also presented in this section.

5.2.1 Background Study

A background study, consisting of a minimum of six survey locations for each type of building material was performed for the purposes of establishing site-wide background levels. These locations were outside the building, but still within the property controlled by Teledyne and are referred to as the off-site background results. Six locations were chosen on brick surfaces and six on concrete surfaces. These locations were measured for fixed alpha activity, fixed beta-gamma activity, and gamma exposure rate at 1 meter. Additionally, in-air background measurements were collected at the start of each final clearance survey. These measurements were compared to the off-site background results and were incorporated into the data analysis phase of the project providing they met two criteria. First, there had to be no obvious relationship of the in-air background measurement to any radioactive material stored in or near

the survey area (commonly referred to as shine). Second, the in-air measurements had to be within two standard deviations of the off-site background results. Using this method, a reasonably accurate average background result was established and utilized to obtain net results for each survey location. The construction of the building ensured that brick and/or concrete was the primary building material which would influence survey results and thus, no differentiation of influence materials was deemed necessary for background subtraction of the survey locations. The application of the collected data will be further described in Section 5.3.1 of this report.

5.2.2 Survey Area Classification

Each area of the facility was assigned a classification based upon the known or suspected historical use of radioactive material as defined within NUREG/CR-5849. An area was classified as "affected" if radioactive material was used in an unencapsulated form or if radioactive contamination was found during characterization surveys. Areas where no radioactive material was used or stored were classified as "unaffected." The area classification dictated the number and type of surveys performed. Historical drawings and interviews with current and past employees were utilized in an attempt to most appropriately classify the history of an area. Survey class descriptions are:

Affected Areas

- High Level Risk – Areas in which greater than 1 millicurie of an alpha emitter or 10 millicuries of beta-gamma emitters, except for Tritium, were present. For Tritium, the presence of 1 curie represented a high-risk area.
- Medium Level Risk - Areas in which greater than 10 microcuries of an alpha emitter or 100 microcuries of beta-gamma emitters, except for Tritium, were present. For Tritium, the presence of 10 millicuries represented a medium-risk area.
- Low Level Risk – Areas in which less than 10 microcuries of an alpha emitter or 100 microcuries of beta-gamma emitters, except for Tritium, were present. For Tritium, the presence less than 10 millicuries represented a low-risk area.

Unaffected Areas

- No Essential Risk - Areas in which radioactive materials were neither stored or used. These areas included the administrative and managerial offices, data processing areas, conference rooms, rest rooms, kitchen areas, and some common hallways.

Table 1 presents the room listings and survey class assignments for the facility. Each survey unit was divided into the following survey components: 1) Lower Surfaces, which included the floor surface(s), wall surfaces up to 2 meters from the floor, and miscellaneous horizontal surfaces; and 2) Upper Surfaces, which included the remaining wall surfaces, the ceiling surface(s), any miscellaneous surfaces, and ventilation system internal surfaces. The density of the surveys and the minimum number of data locations was based on survey unit classification (affected vs. unaffected) and survey unit size. Table 4 presents a description of each survey class as well as the types and quantities of surveys performed for each classification.

5.2.3 Building Surveys

Building surveys included interior surfaces of the building and followed a basic pattern of information collection, location identification, and survey procedure. Essentially, the progression of the survey process was as follows:

(1) Established basic radiological history of each area of the building.

(2) Classified each area (affected or unaffected) as to the potential for contamination based upon the known or suspected history of the area. The classification and size of each area determined the number of survey points and the types of measurements (Table 4).

(3) Performed scoping surveys to quickly determine potential areas of concern. These surveys consisted of floor scans for beta-gamma emitters. Floor scans for alpha contamination were performed in areas where alpha contamination was known or suspected.

(4) Identified the extent of areas requiring decontamination through characterization surveys.

(5) Performed final surveys or decontaminated an area as needed prior to performing final surveys.

The basic set of measurements taken for a typical final survey (per defined grid) were:

- 100 Percent Scan - Beta/gamma scan to determine areas of "elevated activity" in each grid area. The scan was conducted with a gas proportional detector. The active surface of the detector probe was passed over the area of the grid within approximately 1 centimeter of the surface at a rate of travel not exceeding 3 inches of linear motion per second (one probe width). The average and maximum count rates per minute were logged on the survey record.

  NOTE: If the maximum count rate was significantly greater than the average, the fixed count measurements and smear samples were biased (taken at the max count location). If not, the fixed count measurements and smear samples were systematic (taken at each grid intersection).

- Measurement of fixed contamination - Alpha and beta/gamma fixed count, on contact for 1 minute at each area of "elevated activity" as determined during the beta scan described above. Activity measurements were obtained for a period of 1 minute at each location using a gas proportional detector and a meter capable of simultaneous alpha and beta/gamma detection. Results of each measurement were logged in the survey record.

- Beta/Gamma count rate per minute - Activity measurements were obtained as an average result for a period of 1 minute at each location using a pancake-type Geiger-Muller tube attached to a rate meter. Results of each measurement were logged in the survey record. These results were collected for reference only and are not included as part of the data analysis.

- Measurement of removable gross alpha and gross beta/gamma contamination – Smear samples of 100 cm^2 area were taken to determine alpha and beta removable activity in dpm per 100 cm^2 in each grid area. Smears counted on an automatic counter on-site by Teledyne laboratory personnel.

- Measurement of removable Tritium and Carbon-14 contamination - Smear samples of 100 cm^2 area were taken to determine Tritium and Carbon-14 removable contamination. The smears were counted by liquid scintillation counting, where appropriate, by Teledyne laboratory personnel.

- Measurement of removable gamma contamination – Smear samples of 100 cm^2 taken for removable alpha and beta/gamma characterization were also counted via gamma spectroscopy.

- Gamma radiation exposure rate at 1-meter height. Gamma exposure rate measurements were obtained using a gamma scintillation detector and rate meter calibrated to read in μR/hr. Results of each measurement were logged in the survey record.

- Media samples for laboratory analysis were collected as appropriate.

5.2.3.1 Identification of Survey Point Locations

Each survey point was assigned an identification number properly referencing the room where the survey was performed. A standard Cartesian grid system was implemented within each room to assure each point could be accurately located again if necessary**.**

5.2.3.2 Survey Layout

Survey areas were defined by Zone, Unit, and Subunit as follows:

- *Zone*: The largest area identifier. It identified an area by building layout.

- *Unit*: A zone that was subsequently divided into smaller areas based upon the potential for contamination. Units were uniform in that they comprised areas of the same survey classification.

- *Subunit*: The smallest area identifier. A subunit was essentially a single room within an area but it did not exceed the maximum size of a *unit* based upon survey classification.

The room identifier assigned by Teledyne has been used for the final status survey project. This consists of a numeric designation that reflects the zone in which a room resides (e.g., Room 204 is within Zone 2). Several rooms are contained within a suite of rooms and the room number may be appended with an alphabetical suffix (e.g., 204A). Room designations as identified in this report reflect the conditions of the building at the time of surveying. Room designations are presented in Table 1 and shown on the facility building zone maps presented as Figures 3, 4, and 5.

5.2.3.3 Survey Point Grid Designations

The grid designations for each survey point were based on a standard Cartesian grid (X, Y) system where the point of origin (0,0) was at the northern-most west corner of a room for floors and ceilings. This means survey points on floors and ceilings typically had positive X and negative Y numbers, but all positive/negative combinations were possible except for negative X and positive Y values.

The point of origin (0,0) for walls was defined as the lowest left corner of the wall, with a wall being identified based on the compass point location (north, south, etc.). A room could have multiple walls to a compass point if they are physically divided by a separation or another wall from floor to ceiling. In that case, the left-most wall becomes "*Compass point* Wall 1", e.g., North Wall 1, and the next wall to the right becomes "*Compass point* Wall 2", e.g., North Wall 2 and so on until each wall on that compass point was identified. Each wall had a unique point of origin (0,0).

Utilizing the aforementioned methodology, each room was marked with a 2-meter-by-2-meter grid over the floor surface and each wall. The 2-meter-by-2-meter grid spacing is based on the ability to detect 25 percent of the applicable guideline value for the type of survey, e.g., alpha or beta/gamma. Selected rooms and/or areas were marked with a 1-meter-by-1-meter grid. In areas where the ceiling was potentially contaminated, the floor points provided X and Y coordinates for the ceiling as well. Survey points were selected at points of elevated scan results or at grid intersects.

If residual radioactive material was identified in levels exceeding release criteria, the area was decontaminated and then resurveyed at 1-meter grid spacing throughout the decontaminated area and at least 2-meters from the extents of the decontaminated area.

5.2.4 Instrumentation

A summary of the minimum instrumentation used at the facility for the decommissioning surveys performed is provided below. The selection was based on using instruments that would provide an adequate response to demonstrate compliance with the acceptable release criteria. Other objectives in selecting instruments included special features such as digital displays and/or data logging capabilities that could eliminate or reduce the possibility of human error. Minimal detectable activity (MDA) were calculated for each instrument type utilizing methods taken from NUREG/CR-5849 and are provided in Table 5.

Health Physics Instruments		
Instrument Manufacturer and Model	**Detector Model/Type**	**Radiation Detected**
Ludlum 2360	43-68 Gas Proportional	Total Alpha and Total Beta/Gamma
Ludlum 2224	43-68 Gas Proportional	Total Alpha and Total Beta/Gamma
Ludlum 3	44-9 GM Tube	Total Beta/Gamma
Ludlum 2929	43-10 Scintillation	Removable Alpha and Removable Beta/Gamma
Ludlum 19	Internal NaI Scintillation	Gamma Exposure
Ludlum 2221	44-10 NaI Scintillation	Total Gamma
Ludlum 2350-1	Various	Probe dependent

Monitoring instruments were calibrated at least annually or when returned to a qualified facility for service. Calibrations were performed by an independent organization, which provided a current calibration certificate for each instrument. Maintenance of instruments was performed by an independent outside source certified by the instrument manufacturer. Periodic maintenance was performed as recommended by the manufacturer. Instruments were stored in a secure location away from radioactive contamination. Each day that an instrument was used, it was tested for proper functioning by the use of a check source or certified radioactivity source. An appropriate response to the source had to be obtained prior to the instrument being placed in service. An inappropriate response resulted in the instrument being taken out of service and sent for calibration or maintenance. Instrument performance, calibration, and maintenance records were maintained by the site health physics supervisor.

5.3 Building Survey Data Evaluation Procedure

This section encompasses the progression of the data analysis from the background value determinations to the survey data conversion into standardized units. It also describes the application of various formulae to the data results for comparison to the applicable guideline values.

5.3.1 Background Value Determinations

This section briefly describes the methodology used in determining the background values employed for the analysis of the survey data.

5.3.1.1 Alpha and Beta Background Activity Values

A value in dpm/100 cm^2 was calculated from the total counts for each measurement accumulated over a 1-minute duration using the following formula.

Formula 1

$$Activity\ (dpm/100\,cm^2) = \frac{\frac{counts}{t(\text{minutes})}}{E\left(\frac{cpm}{dpm}\right) \bullet \frac{A\left(cm^2\right)}{100}}$$

Where:

t = count time in minutes

E = efficiency in cpm/dpm, and

A = Area of the detector in cm^2.

Background Activity Values		
	Alpha (dpm/100 cm^2)	**Beta/Gamma (dpm/100 cm^2)**
Average	10.14	716.84
Standard Deviation	11.30	214.92

An average of these measurements was calculated by utilizing the "*AVERAGE*" function within *Microsoft Excel 2000*. The results are as follows. The standard deviation was calculated by using the "*STDEVP*" function within *Microsoft Excel 2000* and applying it to the data set. The elevated standard deviation of the alpha results was a result of the low values of the analyzed data.

5.3.1.2 Gamma Exposure Rate Background Value

The gamma exposure rate background value is an average of the background study gamma exposure rates as described in Section 5.2.1 and the in-air gamma exposure rates collected at the start of each survey. As with the other background values utilized in the analysis of the survey data, the gamma exposure rates must meet the criteria of not being influenced by any radioactive material stored in or near the survey area and being within two standard deviations of the background study average value. An average of these measurements was calculated using the "*AVERAGE*" function within *Microsoft Excel 2000.* The standard deviation was calculated by using the "*STDEVP*" function within *Microsoft Excel 2000* and applying it to the data set. The calculated values are as follows:

Background Gamma Exposure Rate (μR/hr)	
Average	7.87
Standard Deviation	2.10

5.3.2 Survey Point Data Result Calculations

Alpha Fixed Activity, Beta/Gamma Fixed Activity, and Beta/Gamma Scan Activity (average and maximum) were calculated using Formula 1 above (dpm/100 cm^2) and subtracting the average background-study dpm/100 cm^2 value.

The net Gamma Exposure rate at 1 meter was derived by subtracting the average Gamma background exposure rate from the point-specific exposure rate for a net result.

Removable alpha and beta/gamma activity were the output of an automatic counter that provided results in dpm/100 cm^2 based upon the current calibration settings.

5.3.3 Data Set Evaluation

The data was evaluated for compliance to the established release criteria for alpha fixed activity, beta/gamma fixed activity, beta/gamma scan activity (average and maximum values), gamma exposure rate at 1 meter, alpha removable activity, beta/gamma removable activity, Tritium removable activity and Carbon-14 removable activity. Beta/gamma measurements and alpha and beta floorscans were collected as part of the survey routine, but were used only for on-site guidance during remediation activities. Equations for the summary calculations were taken from NUREG/CR-5849 as necessary. The formulas for the calculations are as follows:

Item	Formula / Comments	Reference
Standard Deviation of Data Set	$\sqrt{\frac{n\sum x^2 - (\sum x)^2}{n^2}}$	*Microsoft Excel 2000* function "*STDEVP*"
Mean of Data Set	$\bar{x} = \frac{1}{n_s}\sum_{i=1}^{n_s} x_i$	*Microsoft Excel 2000* function "*AVERAGE"*
Maximum value of Data Set	The highest value in a set of numbers.	*Microsoft Excel 2000* function "*MAX*"
Calculated 95 percent Confidence of Data Set	$\mu_\alpha = \bar{x} + t_{1-\alpha,df}\frac{S_x}{\sqrt{n}}$ Where: df (degrees of freedom) is n-1. α is the false positive. $\bar{x}$ is the calculated mean of the data set. s_x is the standard deviation of the data set. n is the number of individual data points used to determine $\bar{x}$ and s_x	NUREG/CR-5849 Appendix B, Table B-1 with interpolation as necessary for values not included in the table.
Guideline Level	Comparison number.	Residual contamination level described in Table 1 of this report.
Calculated $c_g - \bar{x}/s_x$ Value	$\frac{c_g - \bar{x}}{s_x}$ Where: c_g is the guideline value. $\bar{x}$ is the calculated mean of the data set. s_x is the standard deviation of the data set.	NUREG/CR-5849 Appendix B, Table-2 with interpolation as necessary for values not included in the table.
Total measurements Collected	Total number of measurements collected in that specific category.	*Microsoft Excel 2000* function "*COUNT*"
Total measurements needed	Lookup of $\frac{c_g - \bar{x}}{s_x}$ result on NUREG/CR—5849 Appendix B, Table B-2	NUREG/CR-5849 Appendix B, Table B-2 with interpolation as necessary for values not included in the table.
Measurements needed	The difference of the collected measurements and the total measurements needed.	A value less than 0 is reported as 0.
Current survey density meets 5849	"Yes" or "No"	Is the value reported in "Measurements needed" less than or equal to 0?

Item	Formula / Comments	Reference
Meets quality criteria?	"Yes" or "No"	Is the value of "Calculated 95 percent confidence of Data Set" less than the guideline value?
Meets CR-5849 guideline Value	"Yes" or "No"	Is the maximum value of the data set less than the guideline value?
Meets CR-5849 maximum value limit	"Yes" or "No"	Is the maximum value of the data set less than the "hot spot" criteria of three times the guideline value?

During evaluation, actual values returned during the survey process were utilized even if they were less than or equal to the calculated MDA values for the instrumentation selected. Use of the MDA values would have skewed the data results too high and the standard deviation too low, to provide a true representation of the acquired data because an overwhelming majority of the results would have been calculated using the MDA values.

5.4 Building Survey Results

A summary of the final survey results for each building zone is provided below by survey section and unit. Data summary tables (including statistical evaluations) are presented in Appendix C. Decommissioning Survey Data Sheets are presented in Appendix D. Removable alpha and beta/gamma smear sample characterization reports and removable Tritium and Carbon-14 smear sample characterization reports are contained in Appendices E and F respectively. Appendix G presents a summary of the gamma spectroscopy analysis of smear samples collected during the final surveys. This analysis was performed to ensure contamination of gamma emitting mixed fission products did not exceed acceptable removable surface radiological levels for unrestricted use. Facility building zone maps (including room designations) are provided as Figures 3, 4, and 5.

5.4.1 Building Zone 1

Building Zone 1 consists of 30 rooms encompassing approximately 760 square meters of floor space within the southwestern most portion of the building (Figure 2). This building zone housed administrative and managerial offices, restrooms, a break room, a TLD badge service area, an alpha and beta activity counting laboratory, and a TLD instrument demonstration laboratory (Figure 3). This

building zone was divided into three units for surveying purposes: Unit Z1U, an unaffected area; and Units Z1A-W and Z1A-E, both affected areas with a low risk level classification.

5.4.1.1 Unaffected Survey Unit Z1U

Unaffected Survey Unit Z1U is comprised of the following 21 subunits: Rooms 100, 101, 103, 105, 107, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 123, 125, and 127. This unit encompasses approximately 500 square meters of floor space. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpeting and Tile
- Walls: Drywall, Tile, Concrete Block, and Wood
- Ceiling: Drywall and Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-1.

5.4.1.2 Affected Survey Unit Z1A-W

Affected Unit Z1A-W is comprised of the following seven subunits: Rooms 102, 102A, 102B, 102C, 102D, 108, and 108A. This unit encompasses approximately 185 square meters of floor space. Room 102C housed the TLD instrument demonstration laboratory and Room 108 housed the TLD badge service area. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpet
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-2.

5.4.1.3 Affected Survey Unit Z1A-E

Affected Survey Unit Z1A-E is comprised of the following two subunits: Rooms 124 and 124A. This unit encompasses approximately 80 square meters of floor space. Room 124A housed the alpha and beta activity counting laboratory. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpet and Tile
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-3.

5.4.2 Building Zone 2

Building Zone 2 consists of 20 rooms encompassing approximately 770 square meters of floor space within the northwestern most portion of the building (Figure 2). This building zone primarily housed laboratory areas for sample receipt, storage, preparation, and analysis and to a lesser extent administrative and managerial offices (Figure 3). This building zone was divided into four units for surveying purposes: Unit Z2U, an unaffected area; and Units Z2A-W, Z2A-EN, and Z2A-ES, all affected areas with low risk level classifications.

5.4.2.1 Unaffected Survey Unit Z2U

Unaffected Survey Unit Z2U is comprised of the following four subunits: Rooms 200, 206, 206A, and 212. This unit encompasses approximately 140 square meters of floor space. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile and Concrete
- Walls: Drywall and Concrete Block
- Ceiling: Tile and Metal

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological

levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-4.

5.4.2.2 Affected Survey Unit Z2A-W

Affected Survey Unit Z2A-W is comprised of the following nine subunits: Rooms 202, 202A, 202B, 202C, 202D, 204, 204A, 204B, and 204C. This unit encompasses approximately 340 square meters of floor space. Operations in Rooms 202A and 202C were primarily associated with sample preparation and analysis for Tritium. Rooms 202, 202B, 204B, and 204C were primarily associated with Alpha Spectroscopy operations. Operations in Rooms 204 and 204A primarily supported the gas analysis conducted in Room 203 and Teletrace Sample Counting respectively. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile and Carpet
- Walls: Drywall and Wood
- Ceiling: Tile

Results of characterization surveys performed for this unit showed that a wooden countertop located along the west wall of Room 202 and wooden laboratory drawer located in Room 202A were radiologically contaminated. Each of these areas was remediated (countertop and drawer removed) and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-5.

5.4.2.3 Affected Survey Unit Z2A-EN

Affected Survey Unit Z2A-EN is comprised of the following three subunits: Rooms 208, 210, and 210A. This unit encompasses approximately 140 square meters of floor space. Operations in these rooms were primarily associated with sample receipt (Room 208), alpha and beta sample preparation (Room 210A) and Strontium and Radium – 228 analysis (Room 210). The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile and Concrete
- Walls: Drywall and Concrete Block

- Ceiling: Tile

Results of characterization surveys performed for this unit showed that a small area of tile floor in Room 208 was radiologically contaminated. This area was remediated (floor tile removed) and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). It should be noted that the more restrictive total beta/gamma and removable surface beta/gamma release criteria for Strontium-90 were used to evaluate the final clearance surveys for Room 210 (1,000 and 200 dpm/100 cm^2 respectively). The survey data summary tables for this unit is contained in Appendix C-6.

5.4.2.4 Affected Survey Unit Z2A-ES

Affected Survey Unit Z2A-ES is comprised of the following four subunits: Rooms 203, 207, 209, and 209A. This unit encompasses approximately 150 square meters of floor space. Operations in these rooms were primarily associated with gas analysis (Room 203), iodine analysis (Room 207), sample preparation (sample weighing and sample mount storage) for environmental chemistry (Room 209) and environmental uranium analysis (Room 209A). The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall and Concrete Block
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). It should be noted that the more restrictive total and removable beta/gamma acceptance criteria for Iodine-131 were used to evaluate the final clearance surveys for Room 207 (1,000 and 200 dpm/100 cm^2 respectively). The survey data summary tables for this unit is contained in Appendix C-7.

5.4.3 Building Zone 3

Building Zone 3 consists of 24 rooms encompassing approximately 610 square meters of floor space within the south central portion of the building (Figure 2). This building zone housed the main building

entrance, reception area, a TLD baking and spare parts storage areas, accounting offices, a conference room, a restroom, and other administrative and managerial type offices (Figure 4). This building zone was classified as one unit for surveying purposes, Unit Z3U, an unaffected area.

5.4.3.1 Unaffected Survey Unit Z3U

Unaffected Survey Unit Z3U is comprised of the following 24 subunits: Rooms 300, 301, 302, 302A, 302B, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 316, 316A, 317, 317A, 318, 319, and 321. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpet and Tile
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-8.

5.4.4 Building Zone 4

Building Zone 4 consists of 23 rooms encompassing approximately 650 square meters of floor space within the north central portion of the building (Figure 2). This building zone housed laboratories, a sample storage room, a maintenance shop, TLD reader assembly areas, NaI crystal assembly areas, shipping and receiving, and administrative and managerial type offices (Figure 4). This building zone was divided into two units for surveying purposes: Unit Z4U, an unaffected area; and Unit Z4A, an affected area with a low risk level classification.

5.4.4.1 Unaffected Survey Unit Z4U

Unaffected Survey Unit Z4U is comprised of the following 21 subunits: Rooms 400, 402, 404, 405, 405A, 406, 406A, 407, 408, 408A, 409, 410, 410A, 411, 412, 412A, 413, 414, 415, 417, and 417A. This unit encompasses approximately 575 square meters of floor space. Two lofts were also included in this unit (a hallway loft and a receiving area loft). The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile, Concrete, and Wood (Loft)

- Walls: Drywall, Wood, and Concrete Block
- Ceiling: Tile, Drywall, and Metal

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-9.

5.4.4.2 Affected Survey Unit Z4A

Affected Survey Unit Z4A is comprised of the following two subunits: Rooms 401 and 403. This unit encompasses approximately 75 square meters of floor space. Operations in Room 401 were primarily associated with sample preparation for Carbon-14 and Tritium analysis. Room 403 was used for environmental sample storage. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall and Cinderblock
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-10.

5.4.5 Building Zone 5

Building Zone 5 consists of 23 rooms encompassing approximately 570 square meters of floor space within the southeastern portion of the building (Figure 2). This building zone housed health physics laboratories and offices, alpha and gamma spectroscopy counting laboratories, an environmental TLD laboratory, administrative and managerial offices, restrooms, and a break room (Figure 5). This building zone was divided into three units for surveying purposes: Unit Z5U, an unaffected area; and Units Z5A-W and Z5A-E, both affected areas with low risk level classifications.

5.4.5.1 Unaffected Survey Unit Z5U

Unaffected Survey Unit Z5U is comprised of the following 16 subunits: Rooms 500, 501, 503, 505, 506, 506A, 507, 508, 509, 509A, 511, 511A, 511B, 511C, 513, and 513A. This unit encompasses approximately 460 square meters of floor space. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile and Carpet
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-11.

5.4.5.2 Affected Survey Unit Z5A-W

Affected Survey Unit Z5A-W is comprised of the following three subunits: Rooms 502, 504, and 504A. This unit encompasses approximately 60 square meters of floor space. Operations in these rooms were primarily associated with alpha and gamma spectroscopy. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpet, Tile, and Concrete
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-12.

5.4.5.3 Affected Survey Unit Z5A-E

Affected Survey Unit Z5A-E is comprised of the following five subunits: Rooms 510, 512, 512A (Hallway), 514, and 516. This unit encompasses approximately 60 square meters of floor space. Operations in these rooms were primarily associated with sample storage/analysis (Room 510) and health

physics counting (Rooms 512 and 516). It should be noted that Room 514 was an employee break area that falls within this contiguous final survey unit. The primary building materials associated with the construction of this unit were as follows:

- Floor: Carpet, Tile, and Concrete
- Walls: Drywall and Wood
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-13.

5.4.6 Building Zone 6

Building Zone 6 consists of 25 rooms encompassing approximately 770 square meters of floor space within the northeastern portion of the building (Figure 2). This building zone primarily housed sample preparatory, counting, clean, and mass spectroscopy laboratories and to a lesser extent administrative and managerial offices, including two restrooms (Figure 5). This building zone was divided into seven units for surveying purposes: Units Z6U-W and Z6U-E, both unaffected areas; and Units Z6A-NW, Z6A-SW, Z6A-CS, Z6A-C, and Z6A-E, affected areas with low- to medium-risk level classifications.

5.4.6.1 Unaffected Survey Unit Z6U-W

Unaffected Survey Unit Z6U-W is comprised of the following seven subunits: Rooms 600, 601, 603, 609, 610, 611, and 612. This unit encompasses approximately 220 square meters of floor space. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall and Tile
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-14.

5.4.6.2 Unaffected Survey Unit Z6U-E

Unaffected Survey Unit Z6U-E is comprised of the following three subunits: Rooms 620, 620A, and 620C. This unit encompasses approximately 50 square meters of floor space. The primary building materials associated with the construction of this unit were as follows:

- Floor: Concrete, Tile, and Carpet
- Walls: Drywall, Wood, and Tile
- Ceiling: Tile

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-15.

5.4.6.3 Affected Survey Unit Z6A-NW

Affected Survey Unit Z6A-NW is comprised of the following three subunits: Rooms 602, 606, and 606A. This unit encompasses approximately 130 square meters of floor space. Operations in these rooms were primarily associated with radiochemistry and gamma spectroscopy. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall
- Ceiling: Drywall

Results of characterization surveys performed for this unit showed that several small areas on the north and west walls of Room 606 were radiologically contaminated. In addition, characterization surveys showed that several small areas of the tile floor and portions of the east and south walls in Room 602 were radiologically contaminated. Each of these areas was remediated (floor tile/drywall removed) and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2).

One lower surface survey location in Room 602 exceeded the more restrictive removable alpha activity guideline value of 20 dpm/100 cm^2 with a result of 39 dpm/100 cm^2. However, based on process knowledge for Room 602, this result does meet the alpha release limit of 1,000 dpm/100 cm^2 for Uranium-235 and mixed fission products, which is the appropriate guideline value for this room. It also should be noted that the more restrictive total and removable surface beta/gamma acceptance criteria for Strontium-90 were used to evaluate the final clearance surveys for Room 602 (1,000 and 200 dpm/ 100 cm^2 respectively). The survey data summary tables for this unit is contained in Appendix C-16.

5.4.6.4 Affected Survey Unit Z6A-SW

Affected Survey Unit Z6A-SW is comprised of the following two subunits: Rooms 605 and 607. This unit encompasses approximately 40 square meters of floor space. Operations in these rooms were primarily associated with gamma spectroscopy and radon analysis laboratories. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall
- Ceiling: Drywall

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-17.

5.4.6.5 Affected Survey Unit Z6A-CS

Affected Survey Unit Z6A-CS is comprised of the following two subunits: Rooms 613 and 615. This unit encompasses approximately 25 square meters of floor space. Operations in these rooms were primarily associated with geochemistry clean laboratories. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall and Wood
- Ceiling: Tile and Drywall

Final clearance surveys were performed for this unit. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha

activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-18.

5.4.6.6 Affected Survey Unit Z6A-C

Affected Survey Unit Z6A-C is comprised of the following six subunits: Rooms 614, 614A, 614B, 614C, 617, and 619. This unit encompasses approximately 250 square meters of floor space. Operations in these rooms were primarily associated with low enriched uranium, mass spectroscopy, and geochronometry laboratories. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile and Concrete
- Walls: Drywall
- Ceiling: Tile

Results of characterization surveys performed for this unit showed that several small areas of tile floor, concrete floor surface, and drywall wall surfaces in Rooms 614A, 614B, and 614C were radiologically contaminated. Each of these areas was remediated (floor tile removed, concrete scabbled, and drywall removed) and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-19.

One lower surface survey location in Room 617 exceeded the more restrictive removable alpha activity guideline value for transuranics of 20 dpm/100 cm^2 with a result of 27 dpm/100 cm^2. However, based on process knowledge for Room 617, this result does meet the alpha release limit of 1,000 dpm/100 cm^2 for Uranium-235, which is the appropriate guideline value for this room.

5.4.6.7 Affected Survey Unit Z6A-E

Affected Survey Unit Z6A-E is comprised of one subunit, Room 620B. This unit encompasses approximately 40 square meters of floor space. Operations in these rooms were primarily associated with instrument calibration and the storage of radioactive materials and sources. The primary building materials associated with the construction of this unit were as follows:

- Floor: Tile
- Walls: Drywall
- Ceiling: Tile

Results of characterization surveys performed for Room 620B showed that the interior of a safe box used to store source materials was radiologically contaminated. The interior surface of the safe box was decontaminated and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-20.

5.4.7 Building Zone 7

Building Zone 7 consists of eight rooms and a loft area encompassing approximately 380 square meters of floor space within the southeastern most portion of the building (Figure 2). This building zone primarily housed a Precious Metals Decontamination facility and a High Enriched Uranium Laboratory (Figure 5). These facilities were used for the decontamination of precious metals and the preparation of high enriched uranium samples for mass spectroscopy analysis. This building zone was divided into two units for surveying purposes: Units Z7 and Z7A both affected areas with high risk level classifications.

5.4.7.1 Affected Survey Unit Z7

Affected Survey Unit Z7 is the 190 square meter loft located above the entire Zone 7 area. This loft housed the HEPA filter units and an air scrubber for the operations conducted in Zone 7. The primary building materials associated with the construction of this unit were as follows:

- Floor: Wood
- Walls: Drywall, Concrete Block, and Wood
- Ceiling: Wood

Results of the characterization surveys performed on this subunit showed that large areas of the loft's wooden floor structure were radiologically contaminated. As a result, approximately 25 percent of the loft structure was removed. Final clearance surveys were conduced on the remaining surfaces of the unit that included floor joists, walls, and the ceiling.

Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000

dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-21.

5.4.7.2 Affected Survey Unit Z7A

Affected Survey Unit Z7A is comprised of the following eight subunits: Rooms 700, 701, 702, 702A, 703, 704, 705, and 705A. This unit encompasses approximately 190 square meters of floor space. Operations in these rooms were primarily associated with precious metals decontamination and high enriched uranium sample preparation. The primary building materials associated with the construction of this unit were as follows:

- Floor: Resin, Tile, and Concrete
- Walls: Drywall
- Ceiling: Drywall

Results of characterization surveys performed in the majority of these subunits showed that areas of the resin-covered concrete floor surfaces, drywall wall surfaces, and miscellaneous laboratory surfaces (countertops, hood, etc.) were radiologically contaminated. Each of these areas was remediated and resurveyed for residual radioactive material. Results of the final clearance surveys have been compared to, and were determined to meet, the release criteria for total surface radiological levels (alpha activity – 100 dpm/100 cm^2 and beta/gamma – 5,000 dpm/100 cm^2) and removable surface radiological levels (alpha – 20 dpm/100 cm^2 and beta/gamma 1,000 dpm/100 cm^2). The survey data summary tables for this unit is contained in Appendix C-22.

One lower surface survey location in Room 702A exceeded the more restrictive removable alpha activity guideline value for transuranics of 20 dpm/100 cm^2 with a result of 33 dpm/100 cm^2. However, based on process knowledge for Room 702A, this result does meet the alpha release limit of 1,000 dpm/100 cm^2 for Uranium-235, which is the appropriate guideline value for this room.

6.0 Decommissioning Summary

This chapter provides a summary of the decommissioning activities completed for the termination of the NRC licenses and release of the Westwood, New Jersey facility for unrestricted use. Decommissioning activities completed and discussed in this report include decontamination efforts, facility scoping and characterization surveys of buildings and drain lines, remediation efforts, final surveys, data evaluation, and radiological material management.

6.1 Building Surveys

The results of the buildings scoping and characterization survey activities showed that several building structures and surfaces were radiologically contaminated. Each of these areas was remediated and resurveyed for residual radioactive material and have been determined to meet the unrestricted release criteria. These survey results are presented as Final Survey findings in Section 5.4 of this decommissioning report.

6.2 Wastewater Collection System Assessment

The results of the wastewater collection system assessment activities showed piping for several of the subsurface drain lines were radiologically contaminated. Each of these drain lines were removed and disposed. Surveys and sample results demonstrate the areas now meet release criteria. These are as follow:

- Room 614A
- Main Drain Line Trunk for Building Zone 6
- Subsurface Neutralization Vault

No above-background radioactivity readings were identified with field survey instruments for the other facility floor drains, sink drains, or drain line cleanouts.

6.3 Radiological Material Management

Areas of the facility were cleared of radiological materials (samples, sources, etc.) and furnishings and equipment prior to commencing radiological survey activities. Select laboratory hood units and associated ventilation ductwork as well as select laboratory countertops, sinks, and drains were also removed (for proper disposal) prior to conducting radiological survey activities. In addition, radiologically contaminated areas of the facility identified during the radiological survey process were remediated to levels that met release criteria for unrestricted use. Remedial activities conducted included

the removal of the following types of contaminated building components and ancillary facilities: tile and wooden flooring, carpeting, drain line piping; and isolated areas of concrete flooring and wall structures. Wastes and sealed sources collected during the facility decommissioning activities performed by the RSD of Teledyne were packaged in appropriate steel drums or B-25 boxes and transferred to the departments' radioactive warehouse. These materials are being stored under the NRC License No. 29-00055-14 and New Jersey License No. NJSL-10123. Disposal of these materials is being performed in accordance with the requirements of the above-referenced licenses via licensed waste processors.

Teledyne intends to continue operation of its' radioactive waste brokerage services at another location. Therefore, the above-referenced radioactive material licenses are not part of the decontamination and decommissioning plans for the 50 Van Buren Avenue facility.

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