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OAK RIDGE NATIONAL LABORATORY

LOCKHEED MARTIN

CONFIRMATORY RADIOLOGICAL SURVEY FOR THE 190-C MAIN PUMPHOUSE FACILITY DECOMMISSIONING AT THE HANFORD SITE, RICHLAND, WASHINGTON

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Confirmatory Radiological Survey for the 190-C Main Pumphouse Facility Decommissioning at the Hanford Site, Richland, Washington

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TABLE OF CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

BHI	Bechtel Hanford, Inc.
cpm	counts per minute
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOE/RL	Department of Energy/Richland
dpm	disintegrations per minute
DQO	data quality objective
EM	Environmental Restoration and Waste Management
ETS	Environmental Technology Section
GM	Geiger-Mueller
IVC	independent verification contractor
MDA	minimum detectable activity
NaI	sodium iodide
ORNL/GJ	Oak Ridge National Laboratory/Grand Junction, Colorado
QA	quality assurance
RAC	remedial action contractor
ZnS(Ag)	zinc sulfide (silver)

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ABSTRACT

An independent assessment of remedial action activities at the 190-C Main Pumphouse Facility at the Hanford Site, Richland, Washington has been accomplished by the Oak Ridge National Laboratory Environmental Assessments Group. The purpose of the assessment was to confirm the site's compliance with DOE applicable guidelines and provide independent measurements of the activity levels in the 190-C trenches and 105-C process water tunnels. The assessment included reviews of the Decontamination and Decommissioning Plan and data provided in the pre- and post-remedial action surveys. An on-site independent verification survey of the facility was conducted during the period of November 19-21, 1996.

The independent verification survey included beta and gamma scans, smears for removable contamination, and direct measurements for beta-gamma activity in the trenches and tunnels. The same measurements and scans, with the addition of alpha measurements, were performed on the floor in the filter repair confinement area. The facility was also spot-checked for direct alpha and beta-gamma activity.

Based on findings from this survey, together with data provided by the remedial action contractor, the building surfaces in the 190-C Main Pumphouse Facility, with the exception of the trenches and tunnels, conform to the applicable guidelines for surface contamination at this site (Source: *Radiation Protection of the Public and the Environment,* DOE Order 5400.5, U. S. Department of Energy, 1990). Although the contamination levels in the tunnels and trenches exceeded the established DOE release limits, the average radiation levels in these areas were found to be less than those reported by the remedial action contractor.

Confirmatory Radiological Survey for the 190-C Main Pumphouse Facility Decommissioning at the Hanford Site, Richland, Washington

1. INTRODUCTION

The Department of Energy Richland Operations Office has assigned Bechtel Hanford, Inc. (BHI) the responsibility of implementing the Decontamination and Decommissioning (D&D) Program at the Hanford Site at Hanford, Washington. Included for decontamination and demolition is the 190-C Main Pumphouse Facility located in the 100-B and C areas of the site (Fig. 1).

The decommissioning objective for this facility is to remove all radioactively contaminated material (except that in the trenches and tunnels) such that the remaining amounts are consistent with the limits for release published in DOE Order 5400.5 (U.S. DOE 1990). The U. S. DOE Richland Operations Office has the authority to approve supplemental limits specific to D&D projects at the Hanford Site. Supplemental limits on concentrations of residual radioactive material are derived using the ALARA process when circumstances exist in which otherwise applicable authorized limits are inappropriate or impracticable to apply. The radiological conditions of the trenches and tunnels have been previously evaluated and, based on the evaluations, a request will be made for approval of supplemental authorized limits of residual radioactive contamination levels associated with this facility. At a later date, the facility will be demolished to a level about 1 m (3 ft) below grade. The basement structure, located deeper than 1 m (3 ft) below grade, will remain and be filled with demolition debris. All below-grade areas will be filled to eliminate future subsidence (Kennedy and Moeller 1996).

1.1 Purpose

It is the policy of DOE to perform independent (third party) verifications of the effectiveness of remedial actions conducted within the various remedial action programs (U.S. DOE 1988). The Oak Ridge National Laboratory/Grand Junction, Colorado (ORNL/GJ) Environmental Technology Section (ETS) has been assigned by the D&D Branch Division of the Northwestern Area Programs Office of Environmental Restoration and Waste Management (EM) as the independent verification contractor (IVC) for this decommissioning project at Hanford. The scope includes independent verification of the filter repair confinement area and independent measurements of the activity levels in the 105-C water tunnels and 190-C trenches.

The radiological contaminants of interest for the 190-C trenches and the 105-C tunnels are ^{90}Sr > ^{137}Cs > ^{60}Co > ^{152}Eu > ^{239}Pu > ^{241}Am. The activity percentage of strontium is 53% and of cesium is 46% (Kennedy and Moeller 1996). Based on information obtained from technical smears, the radionuclides identified in the 190-C Main Pumphouse Facility in sequence of the most abundant are ^{154}Eu > ^{155}Eu > ^{60}Co > ^{90}Sr. There is approximately 1.5 times more ^{60}Co than ^{90}Sr and

ORNL-DWG 97-74401

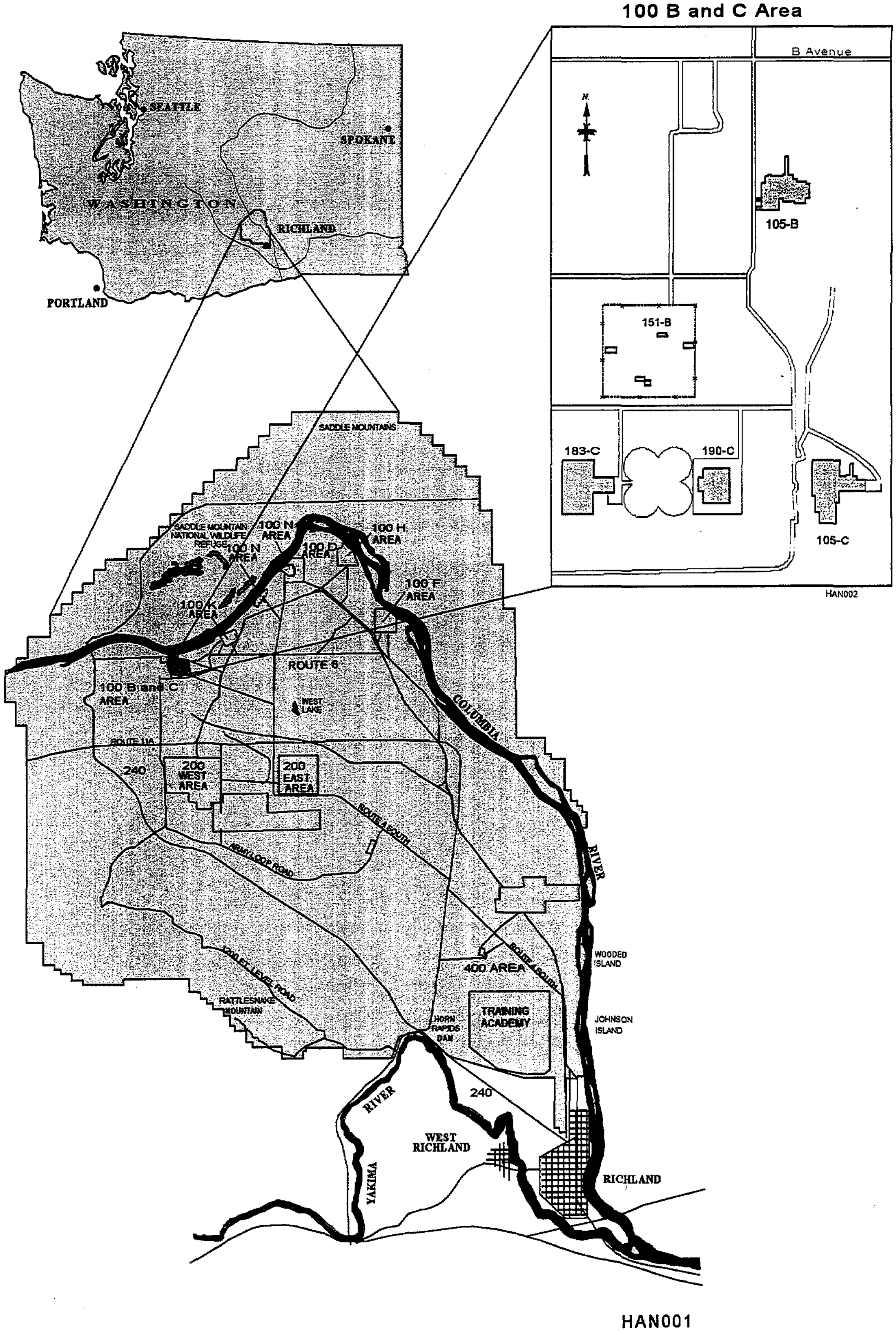

Fig. 1. Location of 190-C Main Pumphouse Facility at Hanford Site.

approximately 23 times more cobalt and europium combined than strontium (Harris and Winslow 1996). The surface contamination guidelines for the radionuclides of interest are shown in Table 1 (U.S. DOE 1990). Note that the release limit for ^{90}Sr for this case is 5000 dpm/100 cm^2 averaged over 1 m^2 because the strontium has never been chemically separated. This is the release limit for all radionuclides of real concern in the 190-C building.

1.2 Site Background

The 190-C Main Pumphouse Facility was used in support of the reactor cooling water treatment process for the 105-C Reactor. The facility is constructed of reinforced concrete, structural steel framework, transite siding, and a transite roof. The building is 60 m (196 ft) long by 49 m (160 ft) wide and contains a full-sized basement. Located on the main floor are ten pumping stations with a 10,000-gpm capacity each. The building accommodates the pump room, solids mix room, electrical cubicle room, offices, control room, instrument shop, air compressor station, valve pits and the entrances to the water tunnels in support of pumping the reactor cooling process water for the 105-C Reactor. The basement contains the cooling water/piping system, compressed air and steam piping, fluid coupling heat exchanger, and the solids injection system. Located at the northeast and southeast corners of the basement are the entrances to the 105-C water tunnels leading to the reactor. Each of these tunnels is approximately 3.3 m (10 ft) wide by 4 m (12 ft) high by 152 m (500 ft) and contain process water and steam piping (Marske 1996).

Water from the Columbia River passed through filter beds located in 183-C and was then pumped through 190-C on its way to the reactor coolant system. The water did not return through 190-C and 183-C. *Characterization Report on the 190-C Main Pumphouse Facility*, BHI-00523, confirms that the interior of piping and equipment is not radiologically contaminated.

Both the 190-C Pumphouse and the 105-C process water tunnels were considered to be radiologically uncontaminated facilities for most of their operation because they were on the intake (not discharge) side of the water coolant system. However, during the operation of the C Reactor, reactor coolant water occasionally entered the tunnels from the 105-C facility and deposited radioactive contamination on the floors of the tunnels and trenches of the 190-C basement. These trenches were about 0.7 m (2.5 ft) wide by 0.6 m (2 ft) deep, and were used to channel water away from the pump station foundations and other floor areas (Kennedy and Moeller 1996). There is no indication that the coolant ever escaped the collection trench and sump collection areas of the basement.

The facility was also used as a storage location for 105-N Reactor miscellaneous material. A confinement for repair of filters from the 117-N filter building was constructed in the north end of the main bay area on the main floor of building 190-C in 1970. This repair facility was in use until 1987 in support of 105-N activities. During filter changing operations, containment was lost and contamination was spread in the air of the 190-C facility (Harris and Winslow 1996).

Table 1. Surface contamination guidelines

Radionuclides[b]	Allowable total residual surface contamination (dpm/100 cm^2)[a]		
	Averaged[c]	Maximum[d, e]	Removable[d, f]
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	RESERVED (100)	RESERVED (300)	RESERVED (20)
Th-natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-natural, U-235, U-238, and associated decay products, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[g]	5,000	15,000	1,000

[a]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[e]The maximum contamination level applies to an area of not more than 100 cm^2.

[f]The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[g]This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

Source: Radiation Protection of the Public and the Environment, DOE Order 5400.5, U. S. Department of Energy, 1990.

To evaluate if contamination from the filters could have significantly modified the source term for the 190-C trenches, additional smear samples have been taken from the HEPA filter area and analyzed by IT Hanford Co. The results of these analyses indicated that the radionuclide distribution for the HEPA filter contamination was a different mixture of radionuclides, not consistent with the radionuclide mixture found for the 190-C trenches or the 105-C tunnel. The HEPA filter contamination was mostly ^{60}Co, ^{154}Eu and ^{152}Eu, with some ^{90}Sr, while the contamination on the samples from the 190-C trenches contained a significant amount of ^{90}Sr (Kennedy and Moeller 1996).

Most of the work scope for 190-C Main Pumphouse Facility, which is to radiologically decontaminate the facility and properly dispose of all radiological materials, has been performed. The scope was to remove the hazardous oils and greases from the pumps and valves along with the asbestos containing material steam piping/lagging/transite and associated components of the pump stations. The various hazardous materials (such as mercury switches, light bulbs, light ballasts, and polychlorinated biphenyl-contaminated oils) was also to be removed and properly disposed before completely dismantling the facility in a safe, efficient manner within state and federal regulations. Prior to demolition the site will be verified as free of radiological and hazardous contamination (Marske 1996). The exception is that the remaining radiological contamination in the 190-C trenches and the 105-C water tunnels will not be removed. Evaluations performed by others (Kennedy and Moeller 1996) have determined that authorized limits for the trenches and tunnels will represent a safe and cost-effective approach to their final disposition. A significant part of this survey was to provide independent measurements of the activity levels in these areas, which can be used to assess the accuracy of the data used when performing the dose modeling associated with these evaluations.

2. METHODS

A team from ORNL visited the 190-C Pumphouse Facility site and performed a scoping inspection in September 1996. An independent verification survey plan was developed based on both this inspection and the remediation survey data. ORNL conducted an independent confirmatory survey of the 190-C Main Pumphouse Facility and 105-C Water Process Tunnels on November 19-21, 1996. The survey team performed visual inspections, determined detector background responses for the building material, established survey grids, performed beta and gamma radiation scans, took smears for detection of removable activity, and collected direct beta, gamma and alpha radiation measurements. Data were evaluated and compared to guidelines set forth in DOE Order 5400.5 (U.S. DOE 1990). Information in addition to what is found here concerning survey protocols can be found in these procedural documents: *Environmental Technology Section Procedures Manual* (ORNL 1993) and *Measurement Applications and Development Group Guidelines* (ORNL 1995).

2.1 Health and Safety

IVC work activities followed BHI health and safety procedures that comply with requirements for protection from hazards identified in the *Activity Hazard Analysis for 190-C, 100-C Area* (BHI 1996), applicable radiation work permits for D&D of Hanford facilities and the ORNL health and safety procedures and guidelines (Fasso 1996). The RAC provided a secure staging area for the IVC. When the IVC entered the contamination control zone, protective clothing was provided and disposed of by the RAC. The RAC also monitored access control and work site activities in the contamination control zone.

2.2 Document Review

Radiological characterization reports, engineering drawings, and post-remedial action survey documents were reviewed. Data were evaluated to assure that areas exceeding guidelines were identified and underwent remedial action. These reports were also reviewed for general thoroughness and accuracy.

2.3 Equipment

All equipment listed here had been calibrated in accordance with guidelines published in the report ORNL-6782 (ORNL 1995) prior to performing any measurements.

Direct Measurement Equipment: Direct surface contamination measurements for beta-emitting radionuclides were performed using Geiger-Mueller pancake type detectors. Two separate configurations were used: 1) Eberline HP-260 single detector models connected to Bicron Analyst™ and Surveyor-M™ scaler/ratemeters; and 2) Ludlum model 44-89 quad-detector models connected to Bicron Analyst™ and Surveyor-M™ scaler/ratemeters. The single detector probes are similar to common pancake detectors used at all DOE facilities, while the quad-detector form is essentially just four of these same detectors encased within a single probe housing and electronically coupled to one output. It is important to note that all of these detectors are calibrated such that each detector responds to within 10% of one another. Using this acceptance protocol during calibration allows for the use of the same conversion factor for all detectors and requires that only one each of the detectors be used when collecting background measurements.

Direct gamma scans were performed using Victoreen 489-55 NaI(Tl) detectors connected to Victoreen Thyac-III ratemeters. These instruments are not used to measure exposure rate directly, but instead are simply used to locate anomalous areas of elevated gamma fluence from surfaces of interest. Similar to the portable beta instrumentation, each NaI detector used during this survey had been calibrated to respond within 10% of one another.

Direct surface contamination measurements for alpha-emitting radionuclides were performed using ORNL model Q-2101 ZnS(Ag) type probes connected to Bicron Analyst scaler ratemeters.

Sample Analysis Equipment: Swipe (or smear) analyses for gross transferrable contamination were performed using a combination of a stationary Geiger-Mueller beta counter and a ZnS(Ag) alpha counter. In addition, gamma spectrometry measurements of collected media were performed using a stationary shielded hyper-pure germanium spectrometer.

2.4 Areas Surveyed

All direct surface contamination measurements collected during the course of this project were taken at contact with the material being measured. All beta scans were conducted such that the face of the probe remained within approximately ¼ to ½ inch of the surface and all gamma scans were performed with the detector held to within 6 inches of the surface being evaluated. The following sections detail the measurement locations and the specific approach used for collecting survey data in that area.

It should be noted that there is no history of alpha-emitting radionuclides at this facility. Although low levels of alpha emitters had been previously detected during characterization and remediation exercises, the quantity present was always found to be much less than the beta-gamma-emitting radionuclides and are therefore not considered to be of concern. The alpha measurements collected during this survey were performed for completeness of confirming the lack of significant alpha emitters. As a point, if any significant alpha emissions were found on the aged concrete of this facility the first path of evaluation should be to determine whether the emissions were due to radon daughters which had plated out onto the surface.

2.4.1 Basement Trenches

Figure 2 shows a drawing of the 190-C basement area and displays the reference grid used for each of the trench segments. A grid referencing the lineal distance along the trench from a zero starting point was used for each trench. The perimeter trench encircles the entire basement area and is immediately adjacent to the outside basement wall. There are two trenches which cut across the entire span of the basement in a west-to-east direction with one additional trench that spans only the western half of the basement. These trenches were labeled trenches A, B and C, respectively, for the purpose of reference during this survey. All of this is shown graphically in Fig. 2 with the reference grid used for collecting data superimposed.

The entire trench area, which included the bottoms and sides of the trenches, had been painted prior to this survey. Based on conversations with site personnel associated with painting activities, it was determined that approximately three coats of paint had been used to prevent the transfer of any existing contamination by workers. In addition, many sections of the trench lengths were obstructed from easy access by piping.

The entire length of each trench was scanned with pancake type detectors for the purpose of locating localized areas of elevated beta-emitting radionuclides, with the exception of Trench C. Randomly selected sections of the trench were also scanned with NaI detection equipment with

ORNL-DWG 97-74402

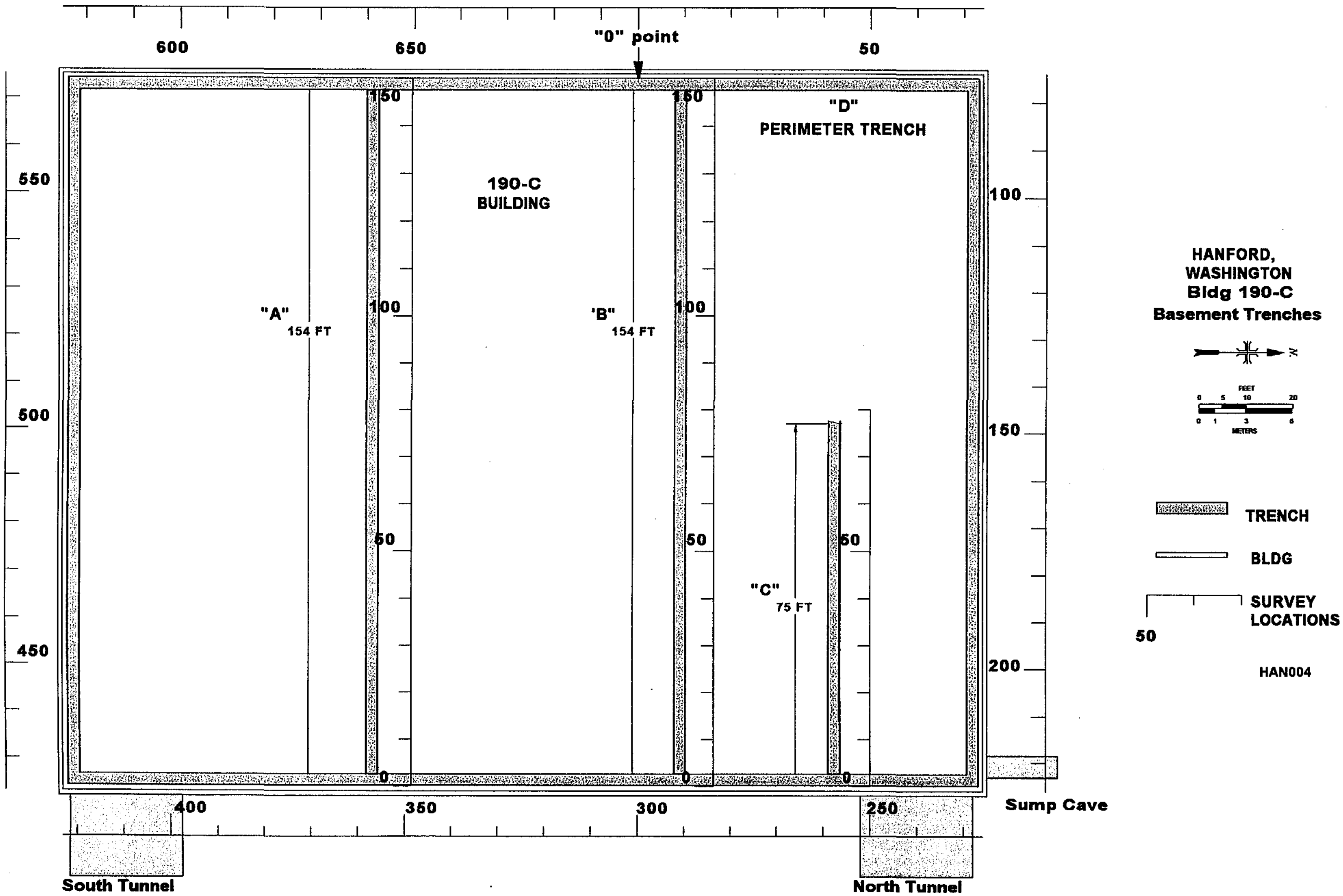

Fig. 2. 190-C basement trenches showing trench layout and reference grid.

the purpose of locating significant amounts of gamma-emitting radionuclides which may have soaked into cracks or expansion joints. In addition to the scans, one-minute integrated measurements were collected at each 30-foot interval of the floor of each trench using the quad-pancake probes. These measurements were collected to provide an estimate of the average amount of contamination that exists on the trench surfaces but that would not necessarily be detected during the scans. Trench C could not be completely surveyed. The trench was cluttered with excessive debris which prevented complete coverage during the survey; however, a "best effort" was made to spot-check the trench for any anomalous contamination areas.

2.4.2 Tunnels

Two tunnels are associated with the 190-C facility. For the purpose of reference, these will be labeled as *North Tunnel* and *South Tunnel*. These tunnels enter the basement of 190-C at the north and south corners of the east wall as shown in Fig. 2. The entire length and shape of each tunnel is shown in Fig. 3.

At the time of the site survey the tunnel areas were zoned as radiological contamination areas. Considering this, the quad-pancake detectors used for measuring the gross direct beta contamination in the tunnels were placed in quart-sized plastic bags with a nominal thickness of ~1.5 mil (density thickness of ~3.5 mg/cm^2). This was done to prevent contamination of the probe surfaces. Appropriate consideration was given to the presence of this cover when selecting a detection efficiency to convert data for final reporting.

Three static 0.1-min integrated counts were collected at each 10-foot interval along the length of each tunnel. The measurement positions are indicated on Fig. 3. For reference, a lineal grid was used along the length of each tunnel. The zero point was set at the SW corner of each tunnel with the x axis running South to North and the y axis running West to East. In addition to the static measurements, sparse scanning was performed between measurement points with the intent of checking for relative uniformity of the surface contamination. The contamination level between successive measurement points was found to be generally uniform and, as such, the static measurements are assumed to be representative of the contamination surrounding them.

2.4.3 Main Floor Bay Area

The main floor bay area is a relatively large expanse of interior space and, at the time of this survey, was still occupied by what appeared to be large hydraulic pump units. The ceiling is very high with spanned girder beams and truss support. As diagrammed in Fig. 4, this area occupies approximately the western two-thirds of the building. Also shown in the diagram is a separate cluster of rooms occupying approximately the eastern one-third of the building on the main level. Not shown in the figure is a mezzanine area directly above this cluster of rooms. References to a mezzanine area in the building apply to this area above the rooms.

ORNL-DWG 97-74403

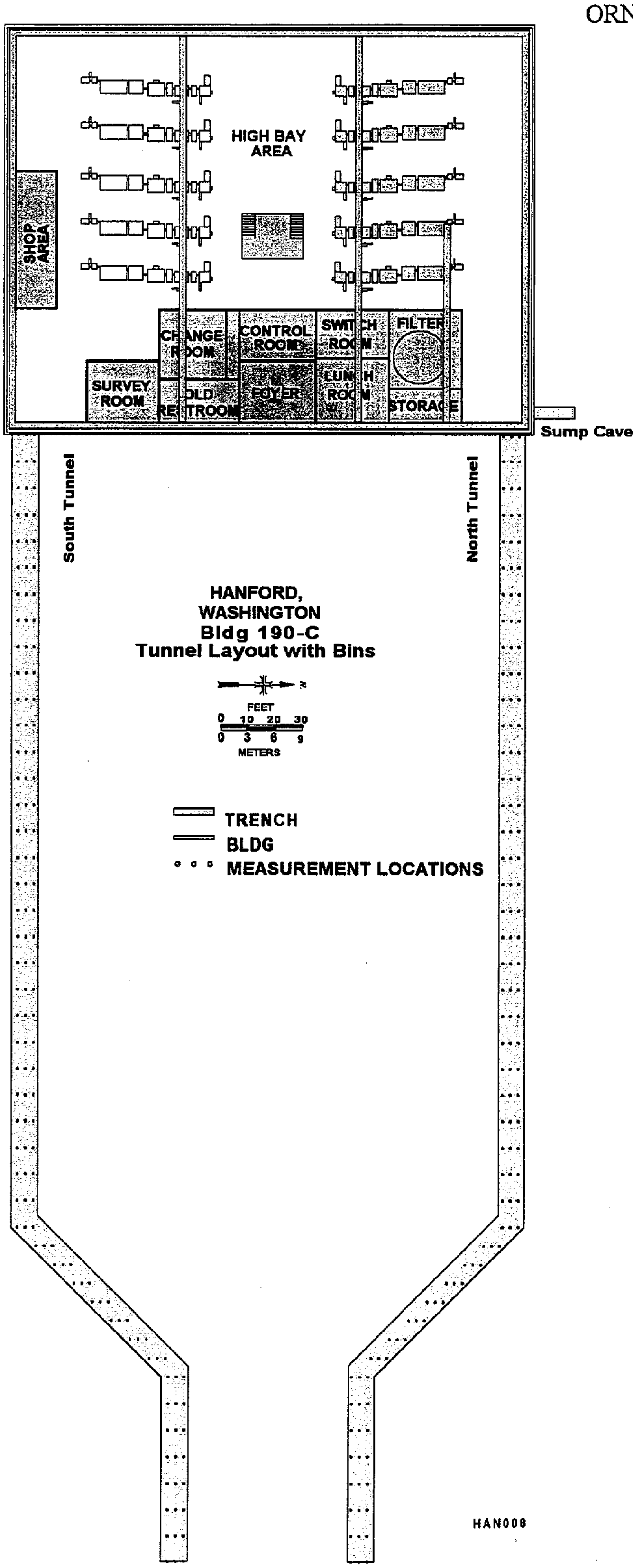

Fig. 3. 105-C water process tunnels showing fixed-point measurement locations.

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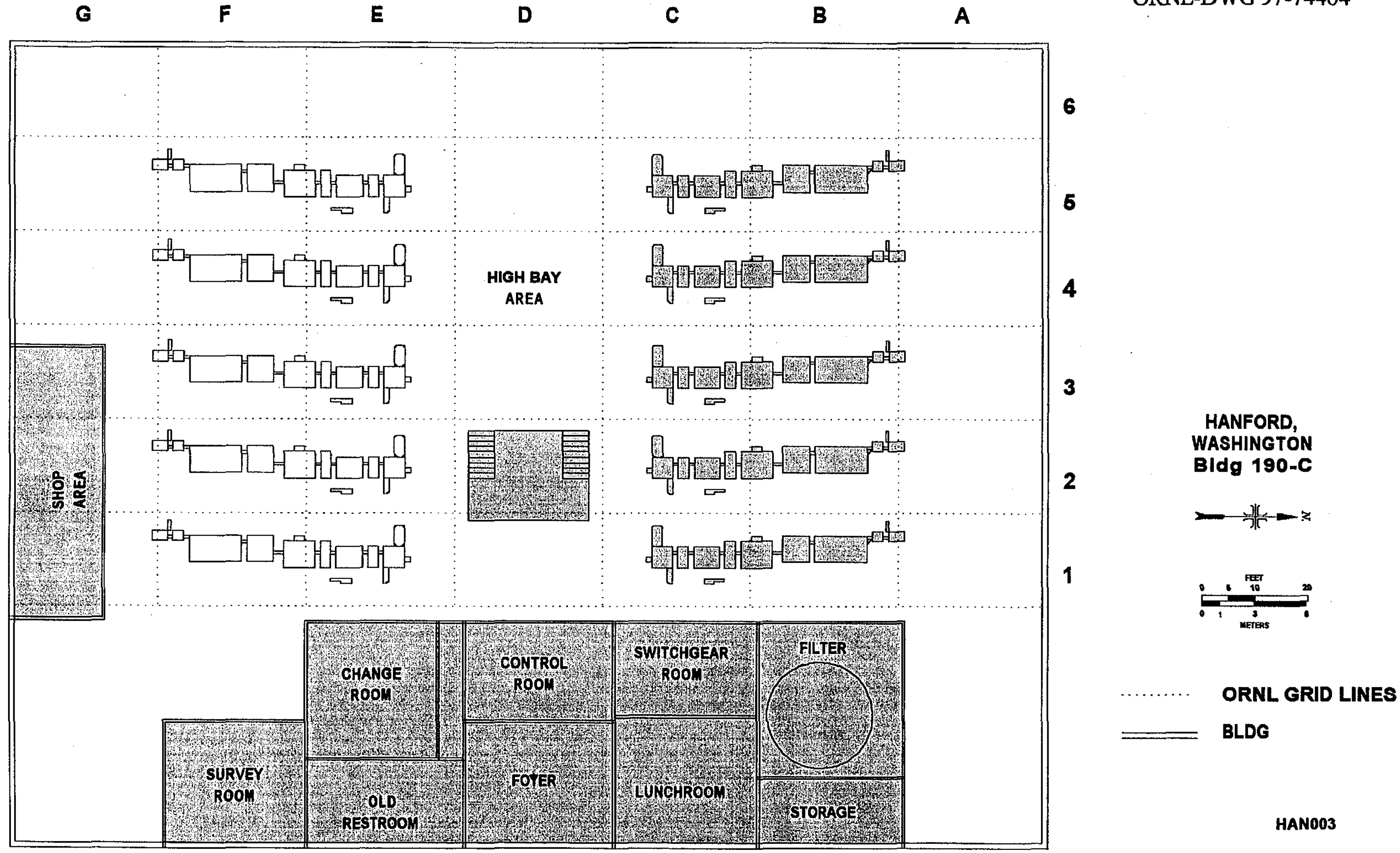

Fig. 4. 190-C building high bay area with grid layout positions and area of scan.

To facilitate referencing measurements, a grid was established across the bay area as shown in Fig. 4. Based on conversations with site personnel and previous document reviews, it was determined that the temporary filter maintenance area had been assembled in the NW region of the building, which correlates to an approximate grid range of A3 through A6.

A thorough beta surface contamination scan was performed in the region which had been used for filter maintenance, i.e., the region bounded by the grid range A3 through A6. In addition to this comprehensive scan, dispersed scans were performed throughout the remainder of the bay area with special emphasis placed on cracks, seams, pitted concrete and any other areas that would appear to easily retain loose dust. Integrated 1-minute count measurements were collected with both beta and alpha measurement equipment at each grid intersection shown by the dashed lines on Fig. 4. The purpose of these measurements was to identify and quantify any potential large-area, low-level dispersed contamination that would not be easily detected during the scan surveys and spot checks.

Limited spot checks were performed on beams above the area where the filter maintenance had occurred, at random points on the hydraulic pump units, hand rails, steel grates and other nonconcrete surfaces and items. This task included direct measurements primarily for beta-emitting radionuclides, although direct alpha measurements were also made at random points across the bay area.

3. RESULTS

The following sections describe the data collected from each of the surveyed areas listed in Section 2, in addition to conversion factors used and any other notable observations.

3.1 Background Measurements

The majority of the measurements collected during this survey were collected from concrete surfaces. After discussions with site personnel and checking various parts of the building, it was decided that the floor area in the basement would provide a good background measurement location for the building concrete. The primary basement floor elevation does not appear to have ever been contaminated. Ten representative background measurements for the detection equipment were collected from this area for one detector each of the quad-detector and the NaI scintillator. Note that the background response of the quad-detector is exactly 4 times that of the single pancake detector. The results for these measurements are listed in Table 2. Based on these measurements, the background values used for each type of detector were as follows: single detector pancake = 50 cpm, quad-detector pancake = 210 cpm and NaI scintillator = 3000 cpm.

Table 2. Detector background measurements

GM Pancake Quad-Detector (cpm)	NaI Scintillator (x 1000 cpm)
225	2.6
209	3.3
206	2.9
199	2.6
220	2.5
230	3.3
232	3.1
183	3.0
203	3.0
202	3.5
Average 211	**3.0**

3.2 Radionuclides and Detection Efficiencies

Swipes collected from the tunnel areas were analyzed by gamma spectrometry and gross beta counting to determine whether or not the gamma-emitting radionuclide to total beta emission rate was consistent with what had been previously reported. The previously reported concentrations, as discussed in Section 1, were reported to be as follows: ^{137}Cs 46% (by activity), ^{90}Sr (53% by activity) and all other (1%). For purposes of comparison, it was assumed that the only radionuclides existing in the tunnel and trench areas at significant levels were ^{137}Cs and ^{90}Sr. Using this assumption and the results from the gamma spectrometry analysis and gross beta analysis of the swipes, the relative concentrations of the radionuclides were determined to be: ^{137}Cs (~80% by activity) and ^{90}Sr (~20% by activity).

The original radionuclide data was compiled from analysis of samples collected from within the tunnel areas. The data compiled during this survey is based on analysis of swipes collected from within the same area. Since it is not possible to know which of these analyses is more accurate, it was decided to use the originally reported ratios when determining detection efficiencies in these areas.

3.3 Trench Data

The amount of activity in the basement trenches could not be truly determined since the entire trench surface had been painted with about three coats of paint. A correction for the presence of the paint was estimated based on calibrated measurements through a similar amount of absorbing material, but it is not possible to know the true thickness of the paint at any given point. For this reason, it is advisable to consider the results from the trench areas as "best" estimates.

The results of the systematic direct beta measurements collected from the trench areas are presented in Table 3. The data has been grouped into four categories; each category describes the area or reference grid from which the data was collected, as shown on Fig. 2. The detection efficiency was corrected to account for the layers of paint on the trench surfaces, assuming the radionuclide mixture presented in Section 3.2. The resulting detection efficiency for the beta detectors in this area for the radionuclide mix and covering material was calculated to be ~0.19 cpm per total (gross) beta dpm.

A localized region of higher contamination was identified during radiation scans of the trench area in the NE corner of the basement perimeter trench as detailed in Fig. 5. Additional measurements were collected in this region with the purpose of evaluating the magnitude of above-average contamination in the area. Points A and B on Fig. 5 indicate specific locations where atypically high radiation levels were observed. Location A was an approximately 1-m^2 area on the wall of the trench with a total direct beta measurement of ~34,000 dpm/100 cm^2, and location B indicates an expansion crack in the concrete with a direct gamma reading of approximately 0.2 mR/h at contact with the seam. Based on a combination of independent gamma and beta measurements, it was determined that the contamination in the crack was at least deeper than what could be penetrated by the beta emissions.

3.4 Tunnel Data

The results of the systematic direct beta measurements collected from the floor of each tunnel are presented in Table 4. The gross alpha and beta analysis results for transferrable swipes collected from within the tunnels are presented in Table 5. Generally, the tunnels are contaminated along the entire length to varying levels as indicated by the data. It appears that the area running along the center of the tunnel floors where personnel can easily walk has the least amount of contamination, with significantly higher levels to the sides underneath the transfer piping.

The average contamination levels in the north and south tunnels were found to be ~17,000 and ~19,000 dpm/100 cm^2, respectively, with a wide variation in the amount from area to area. As mentioned in Sect. 2.4.2, the detectors were placed in plastic bags to prevent contamination of the probes. The detection efficiency was corrected to account for this, assuming the radionuclide mixture presented in Section 3.2. The resulting detection efficiency for the beta detectors in this area for the radionuclide mix and covering material was calculated to be ~0.21 cpm per total (gross) beta dpm.

Each data point collected is believed to reasonably estimate the average amount of contamination within that specific area of the tunnel, so a direct average of the data is an acceptable method for determining the overall mean. The contamination in the tunnels is loose but only slightly

Table 3. Surface contamination measurements from the 190-C basement trenches

Grid location (ft)	Total direct β^- (dpm/100 cm^2)*	Grid location (ft)	Total direct β^- (dpm/100 cm^2)*
Perimeter of basement		**NE corner of perimeter trench**	
0	760	215	2200
30	760	220	520
60	720	225	2000
90	1500	230	7700
120	480	235	800
150	1800		
180	2300	Average	**2700**
210	1100		
240	610		
270	1000		
300	900		
330	240		
360	690		
390	860		
420	1500		
450	440		
480	110		
510	200		
540	400		
570	240		
600	200		
630	180		
660	270		
Average	**800**		
Trench A (South)		**Trench B (Middle)**	
30	[-50]	30	[-40]
60	[-440]	60	[30]
90	220	90	690
120	[-60]	120	[-120]
150	430	150	200
Average	**20**	Average	**200**

*All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector. The critical detection level for direct beta (β^-) measurements was ~280 dpm/100 cm^2. The MDC for direct beta measurements was ~600 dpm/100 cm^2.

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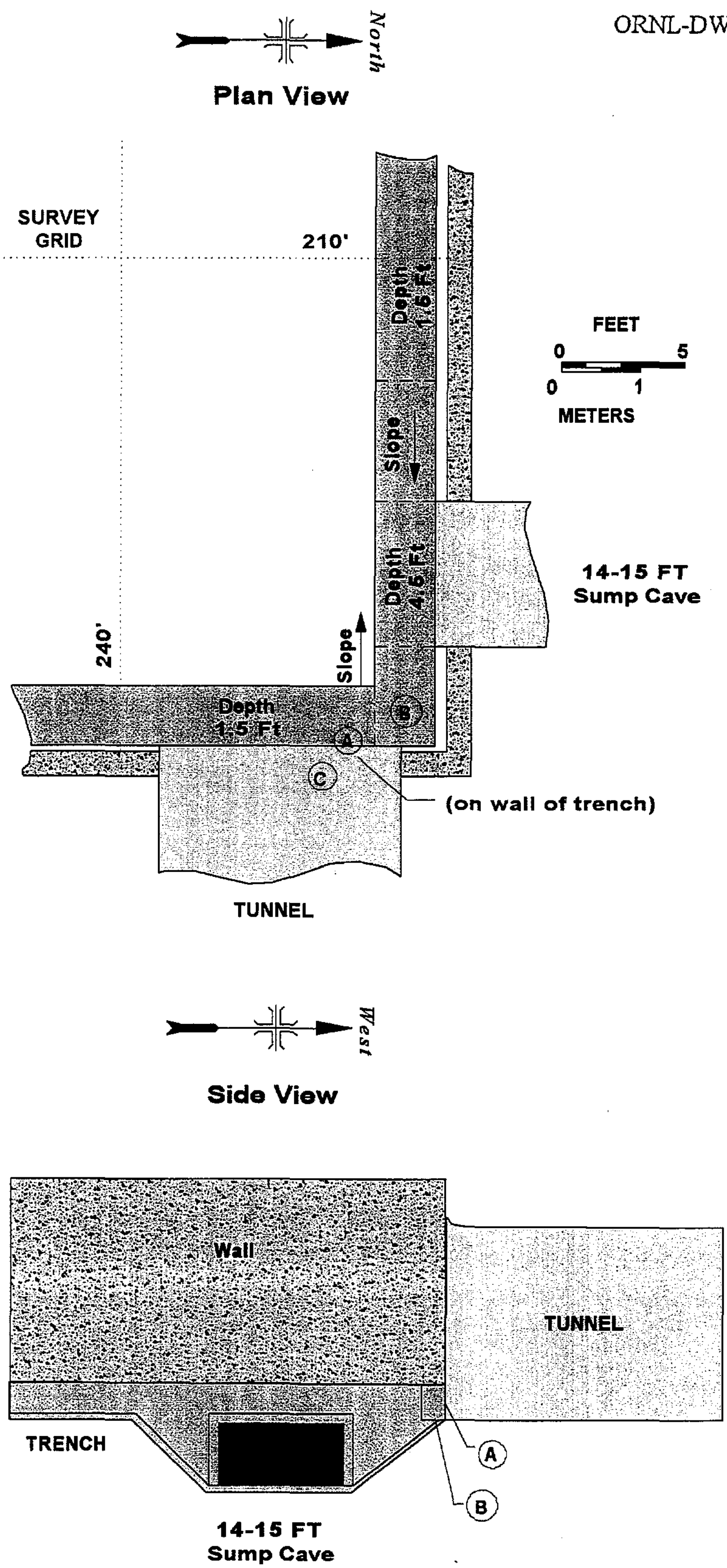

Fig. 5. 190-C basement trench detail showing region of interest near the north tunnel entrance.

Table 4. Surface contamination measurements from the 190-C water process tunnels (beta measurements collected on the floor surface)

X Location (ft)	North Tunnel Total direct β^- (dpm/100 cm^2)* Y Location (ft) -3	-6	-9	South Tunnel Total direct β^- (dpm/100 cm^2)* Y Location (ft) -3	-6	-9
0	14000	8000	[-310]	[0]	[460]	1500
10	28000	[230]	[-230]	920	[310]	29000
20	30000	[310]	[-150]	[380]	[310]	31000
30	24000	[0]	[0]	[-384]	[0]	38000
40	5200	[460]	[-150]	[150]	[310]	12000
50	1600	[-690]	[230]	[80]	770	8800
60	2800	[-380]	[-460]	[-154]	[-77]	5300
70	11000	[-150]	850	[-77]	17000	25000
80	24000	[80]	610	1100	19000	26000
90	41000	[0]	[0]	36000	29000	33000
100	44000	[-230]	[-690]	32000	35000	35000
110	32000	[-150]	[-770]	32000	36000	36000
120	38000	[-80]	920	24000	25000	2100
130	45000	[460]	1100	35000	40000	[80]
140	56000	[-150]	[-80]	33000	37000	32000
150	53000	610	[-540]	31000	30000	37000
160	51000	850	[-80]	31000	34000	35000
170	57000	[-310]	[-380]	31000	38000	48000
180	48000	770	[-380]	1400	41000	28000
190	55000	[-150]	[-310]	690	35000	29000
200	50000	11000	610	[380]	40000	34000
210	51000	[460]	[-150]	[80]	1200	30000
220	47000	[540]	[-80]	[-154]	1100	37000
230	53000	850	690	[-154]	610	39000
240	52000	12000	[150]	[-307]	1500	40000
250	54000	[310]	[-380]	610	1200	35000
260	78000	1400	[380]	[-154]	690	42000
270	66000	920	[380]	[230]	1600	32000
280	48000	1600	1200	[0]	[150]	36000
290	32000	[540]	920	1300	37000	34000
300	48000	1200	[-610]	[80]	41000	43000

Table 4 (continued)

X Location (ft)	North Tunnel Total direct β⁻ (dpm/100 cm²)* Y Location (ft) -3	-6	-9	South Tunnel Total direct β⁻ (dpm/100 cm²)* Y Location (ft) -3	-6	-9
310	43000	770	610	[460]	2200	32000
320	49000	610	540	[80]	610	29000
330	48000	1200	[80]	[80]	690	30000
340	49000	2000	770	610	[230]	33000
350	51000	1400	[80]	[-230]	1100	29000
360	50000	4200	540	770	61000	30000
370	39000	52000	2200	47000	50000	30000
380	41000	12000	1100	[80]	1200	22000
390	50000	690	690	[380]	2000	36000
400	65000	[-310]	460	[-154]	1200	47000
410	59000	[230]	850	1200	72000	32000
420	54000	[230]	540	690	31000	39000
430	52000	2000	770	[460]	43000	19000
440	49000	54000	16000	2200	40000	18000
450	19000	52000	63000	32000	33000	25000

*All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector. The critical detection level for direct beta (β^-) measurements was ~810 dpm/100 cm^2. The MDC for direct beta measurements was ~1900 dpm/100 cm^2.

Table 5. Swipe analysis results

Sample ID	Location	Gross β^- (dpm/100 cm^2)*	Gross α (dpm/100 cm^2)*
V1T	North tunnel: 130', -3'	710	[0]
V2T	North tunnel: 140', -3'	1000	[3]
V3T	North tunnel: 150', -3'	100	nc**
V4T	North tunnel: 160', -3'	220	[0]
V5T	North tunnel: 250', -3'	300	[3]
V6T	North tunnel: 450', -9'	210	[0]
V7T	Bay Area, overhead beam	70	[0]
V8T	South tunnel: 0', -9'	[-62]	nc
V9T	South tunnel: 100', -9'	[9]	nc
V10T	South tunnel: 200', -6'	320	[3]
V11T	South tunnel: 300', -9'	[38]	nc
V12T	South tunnel: 400', -9'	[29]	nc
V13T	South tunnel: 450', -6'	62	nc
V14T	Bay Area, overhead beam	[0]	[0]
V15T	Bay Area, overhead beam	[15]	[0]

*All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector. The critical detection level for the beta (β^-) counter was ~60 dpm. The MDC for the beta counter was ~170 dpm/100 cm^2. The critical detection level for alpha (α) counter was ~5 dpm. The MDC for the alpha counter was ~20 dpm.

**nc These swipes were not counted for alpha contamination.

transferrable. Swipes collected from areas with direct measurements of ~60,000 dpm/100 cm^2 showed transferrable quantities of ~1,000 dpm/100 cm^2, or approximately 2% by activity.

3.5 Bay Area Data

The results of the systematic direct alpha and beta measurements collected from the bay floor area are presented in Table 6. The gross alpha and beta analysis results for transferrable swipes collected from the beams over the bay area are presented in Table 5. Although the direct alpha measurements show some slightly positive results, this is most likely due to radon daughters that have plated onto the concrete surface. In either case, the values are less than applicable release limits. No elevated regions of radioactive contamination were identified within the bay area.

4. CONCLUSIONS

Based on findings from this survey, together with data provided by the remedial action contractor, the building surfaces in the 190-C Main Pumphouse Facility, with the exception of the trenches and tunnels, conform to the surface contamination applicable guidelines for contamination at this site (U. S. DOE 1990). Although the contamination levels in the tunnels and trenches exceeded the established DOE release limits, the average radiation levels in these areas were found to be less than those reported by the remedial action contractor.

Table 6. Surface contamination measurements from the 190-C main floor bay area

Grid location	Total direct β^- (dpm/100 cm^2)*	Total direct α (dpm/100 cm^2)*
A1	[160]	60
A2	[230]	[0]
A3	[160]	[0]
A4	[-590]	30
A5	[90]	[9]
A6	[130]	[0]
B1	560	40
B2	[-630]	30
B3	[-410]	[20]
B4	[-50]	[0]
B5	[90]	[0]
B6	[-130]	[0]
C1	[-520]	[-9]
C2	450	[0]
C3	[-520]	[0]
C4	[-340]	50
C5	[50]	50
C6	[-450]	[9]
D1	[-50]	[20]
D2	[-380]	[9]
D3	[-270]	[0]
D4	[-90]	[9]
D5	700	30
D6	[-230]	40
E1	[130]	[-9]
E2	[-270]	[9]
E3	[20]	30
E4	[50]	[-20]
E5	[200]	[-9]
E6	[130]	[-9]

Table 6 (continued)

Grid location	Total direct β^- (dpm/100 cm^2)*	Total direct α (dpm/100 cm^2)*
F1	520	[-20]
F2	[-130]	[0]
F3	[130]	[9]
F4	[20]	[9]
F5	[160]	[-9]
F6	[160]	[-9]
G1	[50]	[20]
G2	[160]	[-9]
G3	[-270]	[-9]
G4	[340]	[-20]
G5	[-410]	[-9]
G6	[-20]	[0]

*All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector. The critical detection level for direct beta measurements was ~600 dpm/100 cm^2. The MDC for direct beta (β^-) measurements was ~1300 dpm/100 cm^2. The critical detection level for direct alpha (α) measurements was ~30 dpm/100 cm^2. The MDC for direct alpha measurements was ~90 dpm/100 cm^2. As with all surface alpha measurements, these estimates of detection ability assume only a small amount of absorption in the surface material. For aged concrete, the absorption can be as high as 100% because the material may have eroded into the pores or may have been covered by other coating materials. For this worse case, alpha emissions cannot penetrate through to be measured and will result in false negative values.

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APPENDIX A

STATEMENT OF VERIFICATION

APPENDIX A

VERIFICATION STATEMENT FOR 190-C MAIN PUMPHOUSE FACILITY AT THE HANFORD SITE, RICHLAND, WASHINGTON

An independent assessment of remedial action activities at the 190-C Main Pumphouse Facility at the Hanford Site, Richland, Washington has been accomplished by the Oak Ridge National Laboratory Environmental Assessments Group. The purpose of the assessment was to confirm the site's compliance with DOE applicable guidelines and provide independent measurements of the activity levels in the 190-C trenches and 105-C process water tunnels. The assessment included reviews of the Decontamination and Decommissioning Plan and data provided in the pre- and post-remedial action surveys. An independent verification survey of the facility was also conducted on November 19-21, 1996.

The independent verification survey included beta and gamma scans, smears for removable contamination, and direct measurements for beta-and-gamma-emitting radionuclides in the trenches and tunnels. Similar measurements and scans, with the addition of alpha measurements, were performed in the bay area of the main floor. The facility was also spot-checked for direct beta-, gamma- and alpha-emitting radionuclides.

Based on findings from this survey, together with data provided by the remedial action contractor, the building surfaces in the 190-C Main Pumphouse Facility, with the exception of the trenches and tunnels, conform to the applicable guidelines for surface contamination at this site (Source: *Radiation Protection of the Public and the Environment,* DOE Order 5400.5, U. S. Department of Energy, 1990). Although the contamination levels in the tunnels and trenches exceeded the established DOE release limits, the average radiation levels in these areas were found to be less than those reported by the remedial action contractor.

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