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CONFIRMATORY RADIOLOGICAL SURVEY OF THE BORAX-V TURBINE BUILDING IDAHO NATIONAL ENGINEERING LABORATORY IDAHO FALLS, IDAHO

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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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CONTENTS

FIGURES

TABLES

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ABSTRACT

An independent assessment of the remediation of the BORAX-V (Boiling Water Reactor Experiment) turbine building at the Idaho National Engineering Laboratory (INEL), Idaho Falls, Idaho, was accomplished by the Oak Ridge National Laboratory Pollutant Assessments Group (ORNL/PAG). The purpose of the assessment was to confirm the site's compliance with applicable Department of Energy guidelines. The assessment included reviews of both the decontamination and decommissioning Plan and data provided from the pre- and post-remedial action surveys and an independent verification survey of the facility.

The independent verification survey included determination of background exposure rates and soil concentrations, beta-gamma and gamma radiation scans, smears for detection of removable contamination, and direct measurements for alpha and beta-gamma radiation activity on the basement and mezzanine floors and the building's interior and exterior walls. Soil samples were taken, and beta-gamma and gamma radiation exposure rates were measured on areas adjacent to the building.

Results of measurements on building surfaces at this facility were within established contamination guidelines except for elevated beta-gamma radiation levels located on three isolated areas of the basement floor. Following remediation of these areas, ORNL/PAG reviewed the remedial action contractor's report and agreed that remediation was effective in removing the source of the elevated direct radiation.

Results of all independent soil analyses for ^{60}Co were below the detection limit. The highest ^{137}Cs analysis result was 4.6 pCi/g; this value is below the INEL site-specific guideline of 10 pCi/g.

Based on data from the post-remedial action report and the independent verification survey, the radiologic condition of the BORAX-V turbine building conforms to the guidelines outlined by the Formerly Utilized Sites and Surplus Facilities Management Programs for surface and soil contamination.

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1. INTRODUCTION

1.1 TASK DESCRIPTION

The Oak Ridge National Laboratory Pollutant Assessments Group (ORNL/PAG) was selected as the independent verification contractor (IVC) for the Boiling Water Reactor Experiment (BORAX)-V turbine building by the Decontamination and Decommissioning Branch, Division of the Northwestern Area Programs, Office of Environmental Restoration and Waste Management of the Department of Energy (DOE). As a part of its quality assurance program, DOE requires independent (third party) verifications of the effectiveness of remediations conducted within the Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Surplus Facilities Management Program (SFMP) (U.S.DOE 1988).

Independent verification of the remediation of the BORAX-V turbine building addressed the radiological condition of the building foundation and surrounding soils prior to demolition. The primary nuclides of interest at the turbine building were ^{137}Cs and ^{60}Co. Tasks required by FUSRAP protocol for verification and certification included reviews of plans, procedures, and remedial actions. On-site visits and surveys involving direct measurements and sampling were also conducted to determine that all levels are below applicable guidelines. ORNL/PAG is responsible for archiving representative samples of the site, as well as producing this final verification report that becomes part of the final certification docket.

The docket contains documentation verifying that the site is not contaminated with radioactive residues that may present a radiological hazard to the general public (U.S.DOE 1988).

This independent verification is considered a partial verification of the BORAX-V facility since the reactor building is scheduled for decontamination and decommissioning in fiscal year (FY) 1994.

1.2 SITE HISTORY

The BORAX facility, located in the southwestern part of the Idaho National Engineering Laboratory (INEL), was the site for reactor experiments conducted between 1951 and 1964. The experiment series began with BORAX-I, an open-top boiling water reactor. This reactor was buried in place in 1953. Another site northeast of BORAX-I was chosen for subsequent experiments. The BORAX-II, -III, -IV, and -V experiments were conducted on the same site as the existing BORAX-V facility (Fig. 1). On December 20, 1951, EBR-1 was the first nuclear reactor to generate electricity. On July 17, 1955, BORAX-II gained historical significance as the first nuclear reactor to supply electricity to a city: Arco, Idaho (EG&G 1990).

All BORAX experiments, except BORAX-I, were housed in two main buildings: the reactor building (AEF-601) and the turbine building (AEF-602), later designated as buildings 717 and 718 respectively. These buildings were constructed of sheet metal over steel frames. A wooden cooling tower and guard post, designated as buildings 719 and 709 respectively, were also originally part of the facility. The turbine building contained a 1926 Westinghouse turbine-generator and associated process piping, instrumentation, and testing loops.

The BORAX-V facility was designated for decommissioning in FY 1985; decommissioning tasks were performed from FY 1985 through FY 1989 (EG&G 1990). A radiation survey conducted in 1989 on the turbine and associated components showed that the major radionuclides present were ^{137}Cs and ^{60}Co. During FY-1991, the turbine, condenser, and associated piping were removed,

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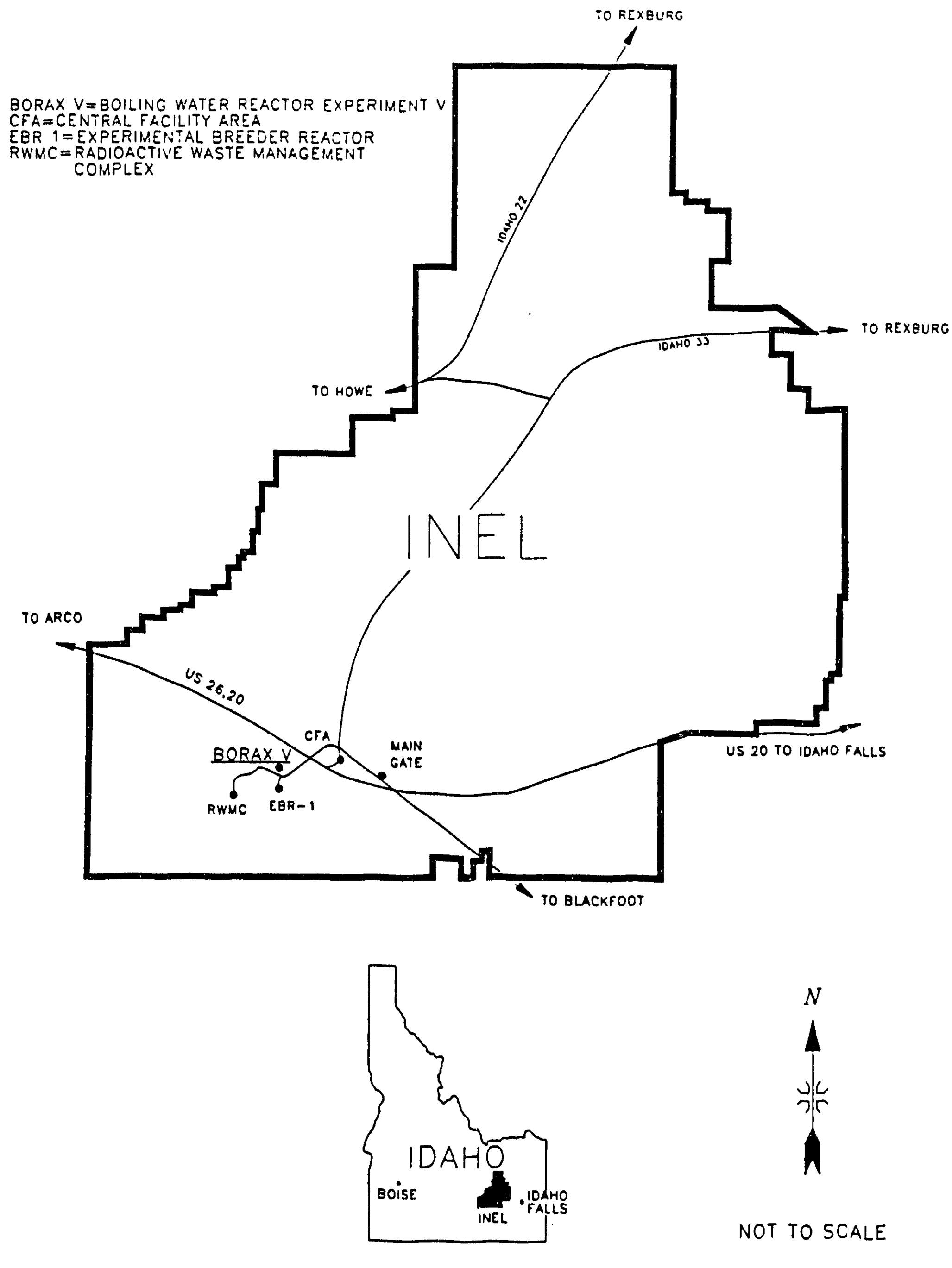

Fig. 1. INEL, showing location of BORAX-V site.

from the turbine building. The walls of the building were also removed, leaving the mezzanine floor concrete pad, concrete walls, and basement walls, on slab and foundation to be demolished in place and backfilled. Early in FY-1992, portions of the concrete were decontaminated by means of concrete chipping in areas of suspected contamination.

Upon completion of remediation, a post-remediation survey was performed by EG&G to demonstrate compliance with the clean-up guidelines. The post-remediation survey report is presented as Appendix A.

2. INDEPENDENT VERIFICATION PROCESS

2.1 DOCUMENT REVIEW

Radiological characterization reports, engineering drawings, and post-remediation survey documents were reviewed for general thoroughness and accuracy. Data were evaluated to ensure that areas exceeding guidelines were identified and remediated.

Information concerning radiologic contamination of the turbine building foundation was taken from an internal EG&G technical report (EG&G 1990) and from surveys conducted during remediation by EG&G.

The general process for independent verification of the BORAX-V facility followed the FUSRAP protocol (U.S.DOE 1988); verification guidelines were based on DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (U.S.DOE 1990). This document lists soil concentration guidelines for thorium and radium, surface contamination guidelines, and methods for determining site-specific authorized limits for radionuclides in air, water, and soil. The primary guidelines used by ORNL for this verification are the surface contamination guidelines for beta-gamma radiation emitters (Table 1).

Table 1. Surface Contamination Guidelines, DOE Order 5400.5

Radionuclides[2/]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1/] Average[3/,4/]	Maximum[4/,5/]	Removable[4/,6/]
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa.	RESERVED	RESERVED	RESERVED
Th-Natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th.	1,000	3,000	200
U-Natural, ^{235}U, ^{238}U, and associated decay product, alpha emitters.	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above.[7/]	5,000	15,000	1,000

1/ 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.

2/ 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.

3/ 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.

4/ 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.

Table 1. (continued)

5/ The maximum contamination level applies to an area of not more than 100 cm^2.

6/ 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.

7/ This category of radionuclides includes mixed fission products, including the ^{90}Sr which is present in them. It does not apply to ^{90}Sr which has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

Analysis results for soil samples were compared to the results for background samples as well as the derived concentration values generated by EG&G and listed in *Development of Criteria for Release of Idaho National Engineering Laboratory Sites Following Decontamination and Decommissioning* (EG&G 1986). This report states that the primary nuclide of interest, ^{137}Cs, shall not exceed 10 pCi/g. Cobalt-60 has a limit of 4 pCi/g, and ^{238}U has a limit of 200 pCi/g. The guidelines for ^{226}Ra are from DOE Order 5400.5: concentrations of ^{226}Ra in soil shall not exceed 5 pCi/g above background in the first 15 cm and 15 pCi/g above background in subsequent 15-cm soil layers when averaged over 100 m^2.

2.2 FIELD SURVEY

A team from ORNL/PAG visited the BORAX-V site and performed a scoping inspection in July 1991. An independent verification survey plan was developed based on both this inspection and the remediation survey data. ORNL/PAG conducted an independent confirmatory survey of the turbine building foundation and adjacent land during November 20 to 27 and December 9 to 15, 1991. The survey team performed visual inspections, determined background radionuclide levels and exposure rates, established survey grids, performed gamma and beta-gamma radiation scans, took smears for detection of removable activity, made direct beta-gamma and alpha radiation measurements, and collected surface samples (0 to 15 cm) on designated background soils and soils surrounding the building foundation. Duplicate readings were taken every tenth reading as a quality control measure. Data were evaluated and compared to guidelines set forth in DOE Order 5400.5 (U.S.DOE 1990).

The survey and measurement procedures used are from the ORNL/PAG procedures manual: TE-021, TE-022, TE-025, TE-026, TE-027, TE-028, TE-034 (ORNL 1990). An inventory of the survey equipment used is listed in Appendix B.

2.2.1 Background Radiation Investigation

Six soil samples were collected from areas 0.5 to 10 km from the site to establish background concentrations of radionuclides for comparison purposes (Fig. 2). Background gamma radiation exposure rate levels were measured at 1 m above the surface at background sampling locations using a pressurized ionization chamber (PIC) (Table 2). A corresponding gamma radiation measurement was taken with a sodium iodide (NaI) gamma radiation detector coupled to a ratemeter reading in thousand counts per minute (kcpm). The same procedure was followed at 10 locations at the turbine building site to determine the site-specific gamma radiation exposure rate (Fig. 3, Table 2). The measurements at the turbine building site were used to convert counts to exposure rates in microroentgens per hour (μR/h) as outlined in Procedure TE-022 (ORNL 1990). The conversion formula was μR/h = kcpm/0.34. This factor was used to convert all gamma radiation measurements taken at the site from counts to μR/h.

2.2.2 Exterior Survey

Land Surrounding Turbine Building

A 5 × 5 m grid was established originating at the northwest corner of the building and extending 10 m away from all sides of the building (Fig. 4). An exterior gamma radiation scan of the ground surrounding the building was performed. Piles of gravel had been dumped adjacent to the west side of the structure, thereby precluding a complete scan in that area. Also, during remediation, the ground to the south of the building had been excavated to remove contaminated piping. The survey team was unable to effectively scan these areas due to unsafe slope conditions.

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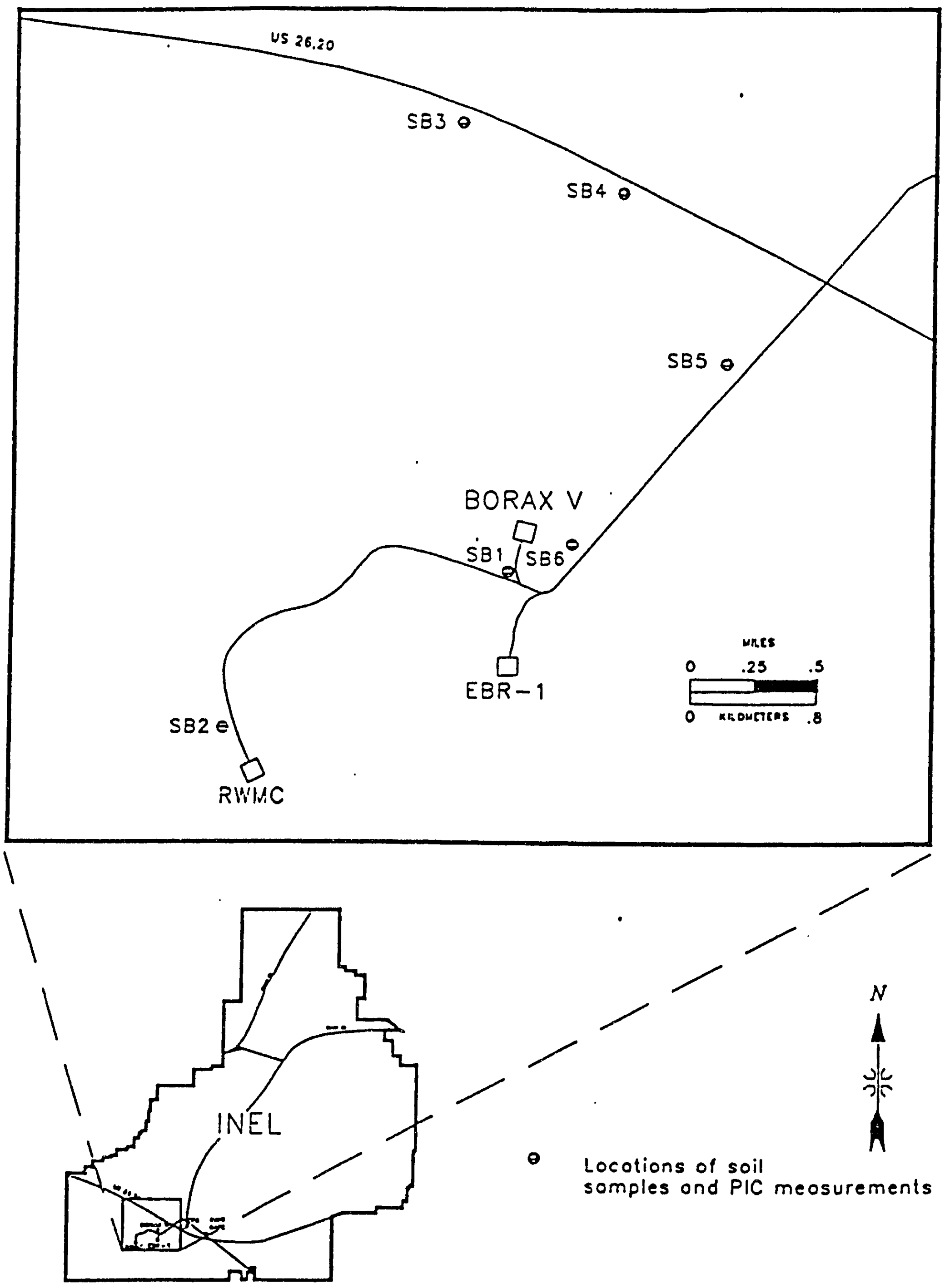

Fig. 2. Sampling locations for background concentrations.

Table 2. Background exposure rates and soil concentrations[a]

PIC Location Number	Exposure Rate, μR/h	^{60}Co,[d] pCi/g	^{137}Cs,[d] pCi/g	^{226}Ra,[d] pCi/g	^{238}U,[d] pCi/g
1[b]	17	No samples taken indoors			
2	17				
3	18				
4	17				
5	15				
6	14				
7	14				
8	14				
9	17				
10	17				
SB1[c]	14	0.01 ±0.04	0.27 ±0.03	1.48 ±0.03	2.43 ± 5.4
SB2	14	-0.02 ±0.04	0.02 ±0.06	1.13 ±0.22	1.89 ± 3.8
SB3	14	0.00 ±0.03	0.15 ±0.02	1.38 ±0.19	2.43 ± 3.8
SB4	14	0.00 ±0.04	0.32 ±0.03	1.32 ±0.22	5.40 ± 3.5
SB5	13	0.00 ±0.05	0.16 ±0.04	1.30 ±0.27	2.43 ± 4.6
SB6	13	-0.02 ±0.03	0.35 ±0.03	1.00 ±0.16	0.54 ± 3.0

[a] Reported at the 95% confidence levels for laboratory equipment.
[b] PIC readings at BORAX-V turbine building interior.
[c] Refer to Fig. 2.
[d] Mean ± 1.96 standard deviations.

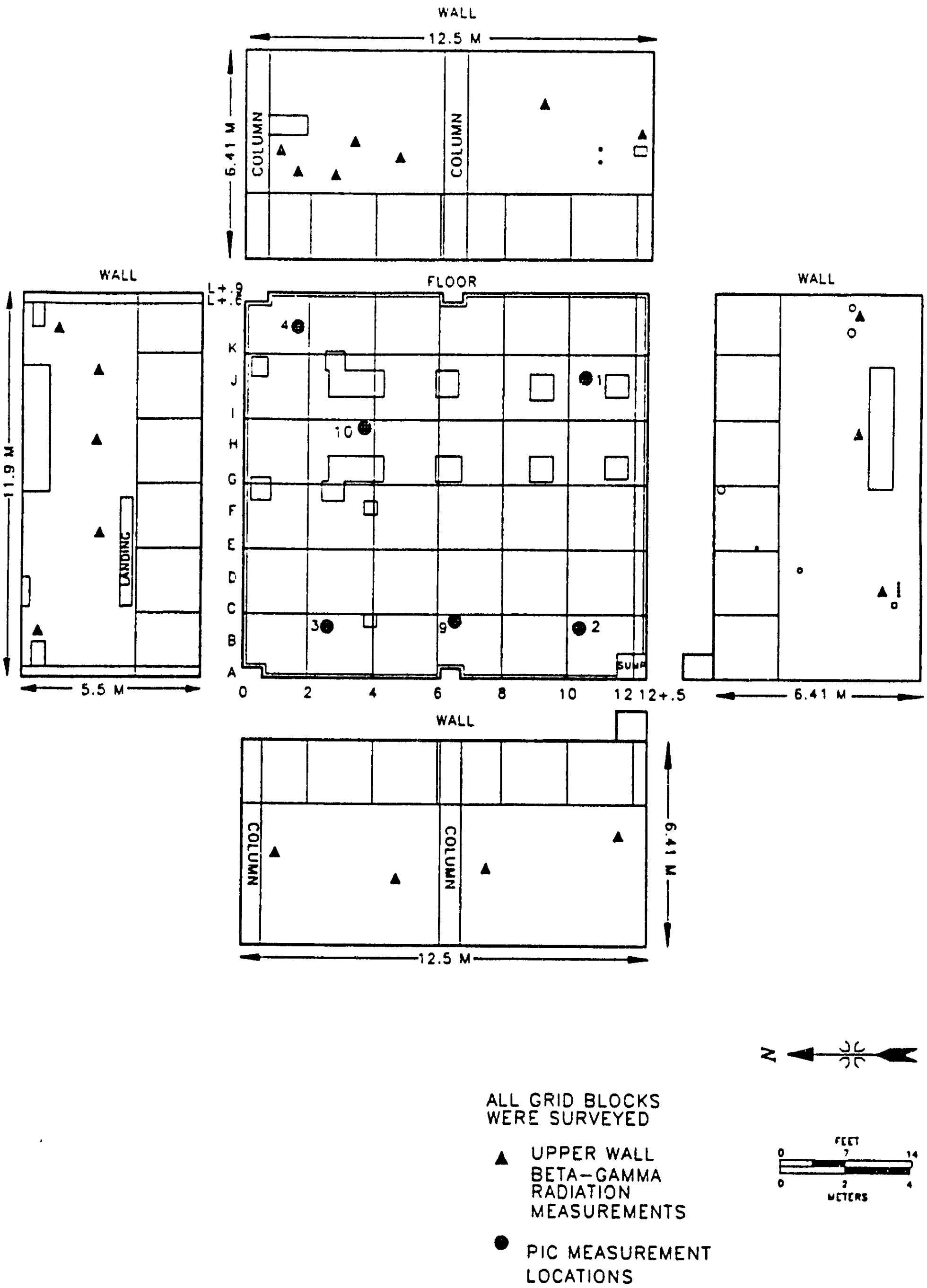

Fig. 3. Turbine building interior walls and floor, showing PIC and additional fixed-point measurement locations.

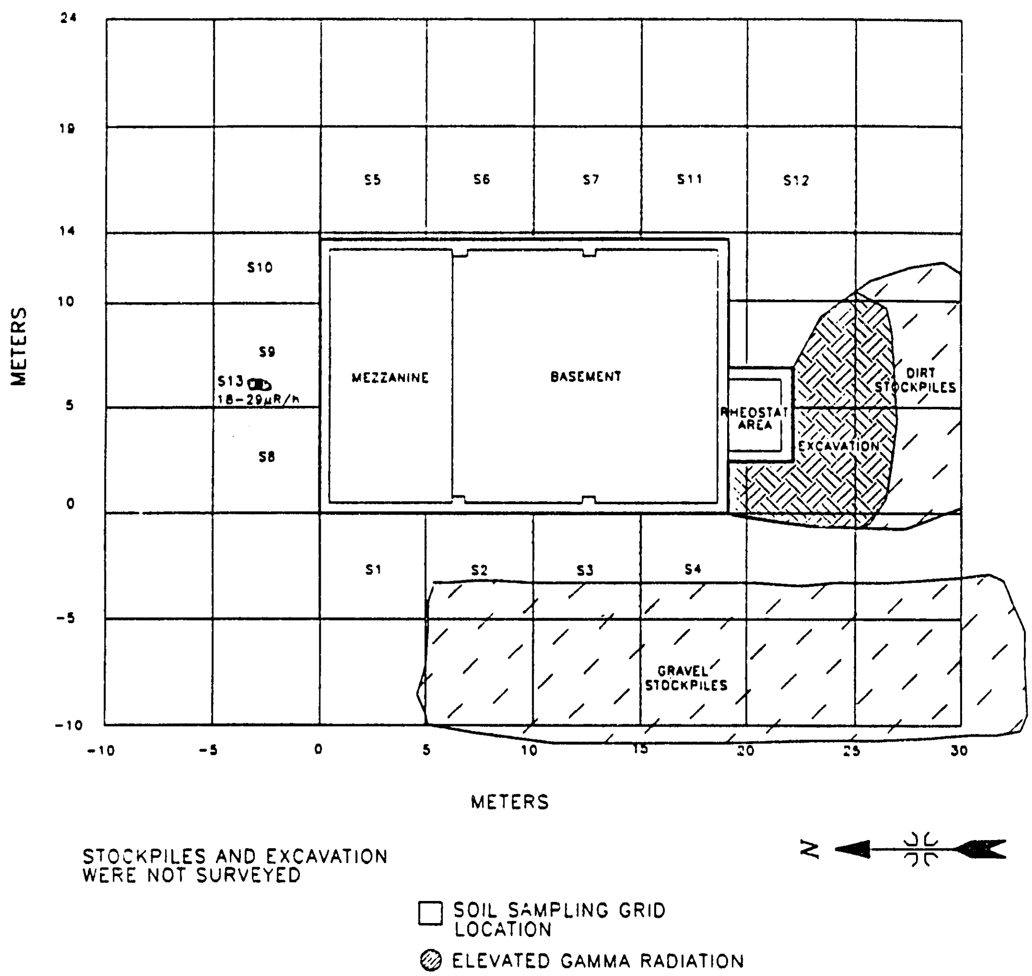

Fig. 4. Exterior grid, showing sampling locations and elevated gamma radiation region.

Fixed-point measurements for beta-gamma and gamma radiation exposure rates were taken at the intersection of all grid points. Gamma radiation exposure rate measurements were also taken at 1 m from the surface at selected grid intersections.

Composite soil samples collected at a depth of 0 to 15 cm were collected in twelve systematically selected grid blocks adjacent to the building (samples S1 to S12, Fig. 4). The samples were composited from plugs taken from the center of each selected grid block and at four points midway between the grid-block center and corners. In addition, one grab sample (S13) was taken at the highest beta-gamma radiation measurement from a region identified during the gamma radiation scan.

Exterior Walls

A 1 × 2 m grid was established originating in the northwest corner of the turbine building (Fig. 5). A beta-gamma radiation scan was performed on all walls except a portion of the south end of the building, where excavation precluded safely surveying the upper walls.

Fixed-point measurements for alpha and beta-gamma radiation were taken at five locations in each accessible grid block at the south end of the building. As a result of these readings and the beta-gamma radiation scan, it was deemed unnecessary to continue extensive fixed measurements on all exterior walls. Single fixed-point measurements were taken for alpha and beta-gamma radiation in each of the remaining grid blocks. The walls and floor inside the rheostat area were also scanned; no beta-gamma radiation contamination was detected (Fig. 4) (Table 3).

2.2.3 Interior Survey

The turbine building interior consisted of a mezzanine level, slab-on-grade, in addition to a basement level. The floor of the basement had numerous protruding concrete supports. A 10-cm-wide trench at the base of the walls discharged to a

ORNL-DWG 93-10782

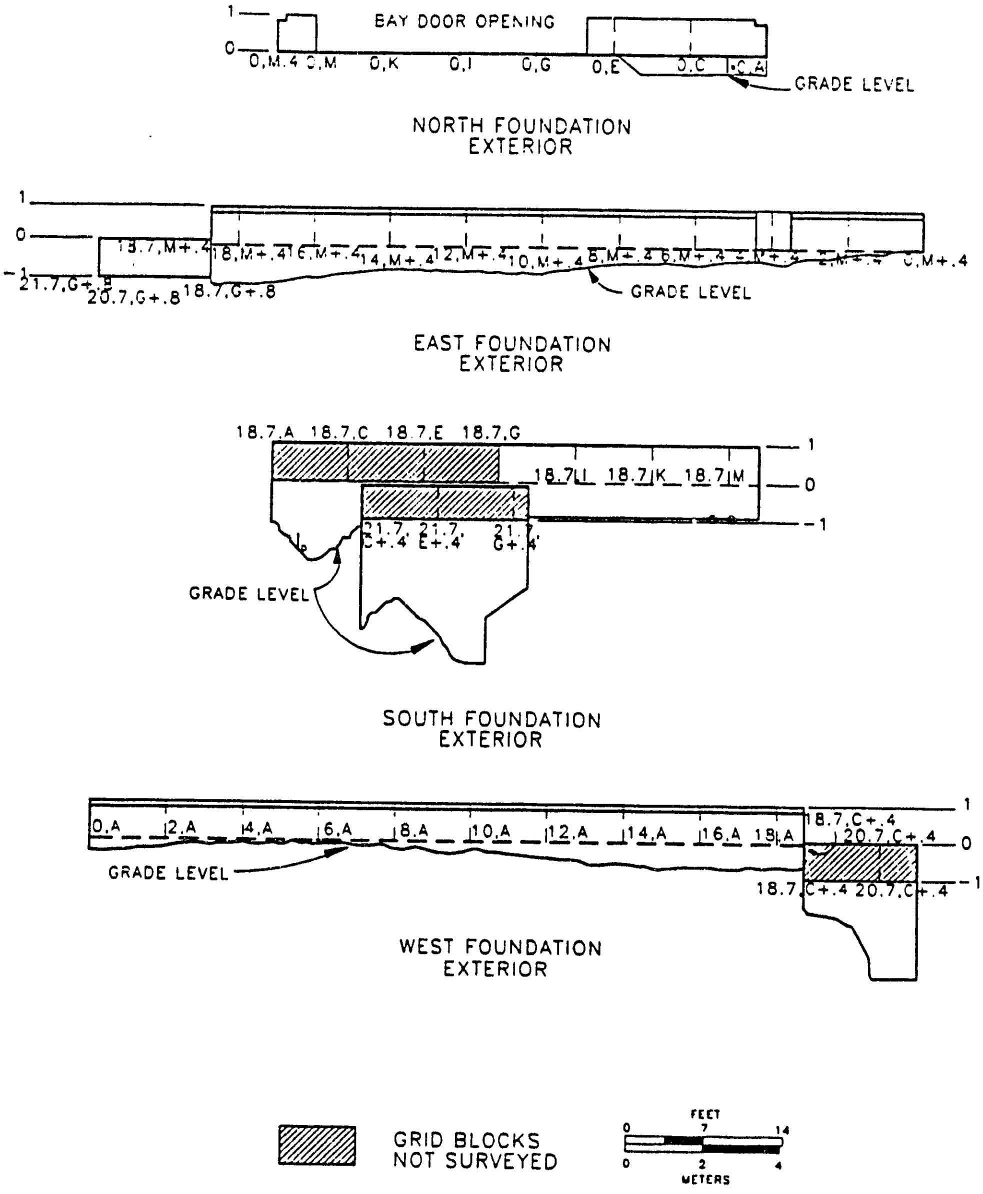

Fig. 5. Exterior wall grids, side view.

Table 3. Summary of BORAX-V turbine building surface-acitivity results

Measurement Location	Number of Grid Blocks or Locations Surveyed	Total Activity, dpm/100 cm^2			
		Alpha radiation		Beta-gamma radiation	
		Highest avg. in any grid block	Range of measurements	Highest avg. in any grid block	Range of measurements
Interior					
North Wall	6	44	<LLD[a] - 44	890	<LLD - 1500
East Wall	7	<LLD	•	890	<LLD - 1500
South Wall	6	48	<LLD - 48	1000	<LLD - 1500
West Wall	7	N/A[b]	N/A	500	<LLD - 1200
Basement Floor	39	76	<LLD - 100	6800	<LLD - 28,000
Basement Trench	14	N/A	N/A	5000	<LLD - 13,000
Mezzanine Floor	18	140	<LLD - 140	1300	<LLD - 4000
Mezzanine Walls	9	60	<LLD - 60	900	•
Exterior					
North Wall	3	58	<LLD - 64	970	•
East Wall	13	140	<LLD - 140	3500	<LLD - 5700
South Wall	17	52	<LLD - 52	1200	<LLD - 1400
West Wall	13	68	<LLD - 68	1700	<LLD - 1700

[a] LLD = Lower limit of detection of instrument. For alpha, the LLD was 37 dpm; for beta-gamma, the LLD was 1200 dpm.
[b] N/A = measurement not taken.
• Range of measurements was less than the lower limit of detection and included some negative numbers.

sump in the southwest corner of the room. At some locations around the walls, exposed pipes and floor supports remained.

A 2 × 2 m alphanumeric grid originating in the northwest corner was established on the floors and up the basement walls (to 2 m) (Fig. 3).

Mezzanine

A 2 × 2 m alphanumeric grid originating in the northwest corner was established for the mezzanine (Fig. 6). A beta-gamma radiation gas proportional counter floor monitor coupled to a scaler/ratemeter with audible indicator was used to scan the accessible area of the mezzanine. Areas inaccessible to the floor monitor were scanned using a Geiger-Mueller (GM) thin-window pancake probe coupled to a scaler/ratemeter. Scans using NaI gamma radiation scintillation detectors coupled to ratemeters were also performed in the pipe chase areas and on the floor.

Fixed-point readings for alpha and beta-gamma radiation were taken at four locations in each grid block (Table 3). These grid blocks included the pipe chase area.

Floor

A beta-gamma radiation gas proportional counter floor monitor was used to scan accessible areas of the floor. The remaining area, which included all concrete supports, the trench, and the sump, were scanned using beta-gamma radiation GM thin window pancake probes attached to scaler/ratemeter. In addition, a gamma radiation scan of the floor was performed using scintillometers.

Direct measurements for alpha and beta-gamma radiation activity levels were systematically made at four equidistant points, midway between the center and corners in each grid block. Smears for detection of removable contamination were taken at the location of the highest direct reading in each grid block. These results are summarized in Table 3.

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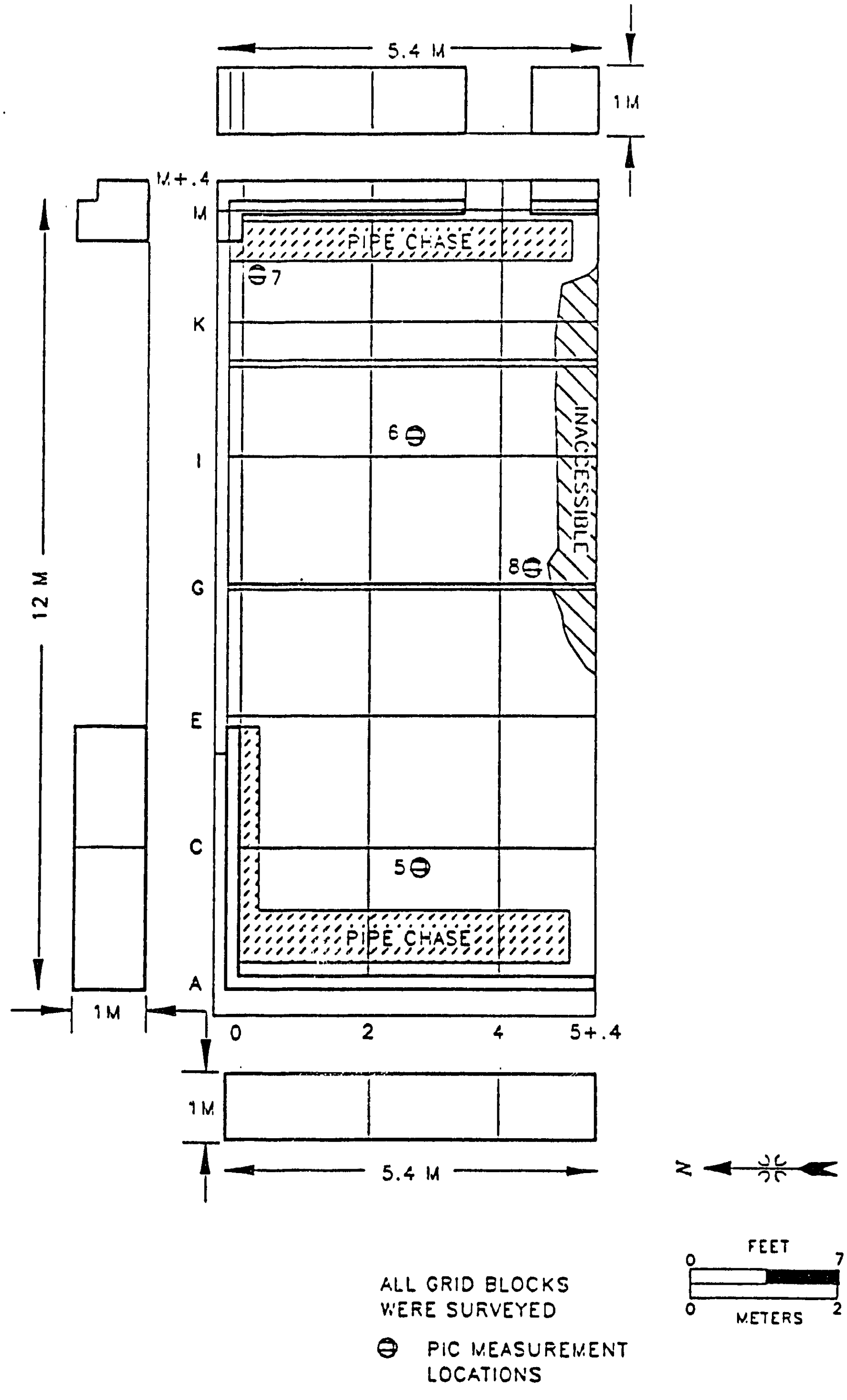


Fig. 6. Turbine building mezzanine grid, showing PIC measurement locations.

Walls

The walls of the basement were scanned to a height of 2 m with beta-gamma radiation pancake probes coupled to scaler/ratemeters. In addition, all areas on the walls with pipes, floor supports, discoloration, or staining were scanned. These additional wall locations are shown in Fig. 3.

Direct measurements for alpha, beta, and gamma radiation activity levels were made in the same manner as were the floor measurements. Fixed-point measurements were taken at four locations per grid block for beta-gamma radiation readings and at one location per grid block for alpha radiation readings. Smears for detection of removable contamination were taken at the location of the highest direct reading in each grid block. These results are summarized in Table 3.

Trench

A trench 10-cm wide and 5-cm deep encompassed the perimeter of the basement floor, ending in a sump located in the southwest corner of the basement. After surveying the floors and walls, a 10-cm-wide region of suspected contamination along the wall and floor was delineated. For each 2-m grid block, three sets of alpha, beta, and gamma radiation measurements were taken: one at 10 cm up from the trench, one at 10 cm out from the trench, and one within the trench itself. This method was repeated for the full length of the trench. The sump was scanned for beta-gamma radiation; no elevated readings were detected (Table 3).

3. FINDINGS AND RESULTS

3.1 DOCUMENT REVIEW

ORNL reviewed the post decontamination and decommissioning survey of the BORAX-V turbine building (EG&G 1990) prepared by EG&G as part of the confirmatory activities. The information provided was not sufficient to determine if contamination still remained at the BORAX-V Turbine Building site. The data was reported in counts per minute (cpm). These units give an indication of relative "cleanness." However, unless they are converted to disintegrations per minute (dpm) per surface area, cpm measurements cannot be used as evidence that the building surfaces meet FUSRAP/SFMP guidelines for unrestricted use. After obtaining the necessary information, ORNL was able to complete the independent verification plan.

ORNL also reviewed the data and survey results of the decontamination of the hot spots identified during the independent verification survey. These results were compared to the established guidelines. This is discussed further in Sect. 3.4. ORNL concurs that the "Final Report of the Decontamination and Decommissioning of the Borax-V Facility Turbine Building" provides an adequate summation of the current radiological status of the site.

3.2 BACKGROUND RADIATION MEASUREMENTS

PIC measurements for gamma radiation exposure rates at the six background locations (SB1 to SB6, Fig. 2) ranged from 13 to 14 μR/h. All soil samples were sent to ORNL in Oak Ridge, Tenn., for ^{137}Cs, ^{60}Co, ^{238}U, and ^{226}Ra radionuclide analyses using gamma spectroscopy. Results of the analyses for the six background locations and the exposure rates are presented in Table 2. PIC readings taken at the turbine building were slightly higher, yielding gamma exposure rates ranging from 14 μR/h in the mezzanine area to 18 μR/h in the basement (Table 2). This was attributed to the emanation of the gamma radiation from several directions since the measurements were performed in a concrete basement.

3.3 EXTERIOR RADIATION MEASUREMENTS

The exterior survey, using gamma radiation scintillation detectors coupled to ratemeters, revealed gamma radiation exposure rates ranging from 12 to 18 μR/h. One area, approximately 1 m^2 and located just north of the mezzanine area, had a gamma radiation exposure rate range of 18 to 29 μR/h (Fig. 4). Soil sample S13 was taken at this location.

Results of radionuclide analyses of soil samples taken in each grid block adjacent to the turbine building and at the slightly elevated location identified by the gamma radiation scan are presented in Table 4. All concentrations were below the guidelines of 4 pCi/g for ^{60}Co, 10 pCi/g for ^{137}Cs, 5 pCi/g for ^{226}Ra, and 200 pCi/g for ^{238}U. ORNL/PAG has archived all soil samples and will maintain custody of these samples for five years after certification of the BORAX-V turbine building has been achieved.

A summary of exposure rate measurements for gamma and beta-gamma radiation taken at the intersections of grid blocks surrounding the turbine building is presented in Table 5. All measurements were below the established guidelines.

3.4 TURBINE BUILDING RADIATION MEASUREMENTS

Gamma radiation exposure rate measurements on the mezzanine and basement floor, using scintillation detectors coupled to ratemeters, yielded exposure rates ranging from 18 to 21 μR/h.

A summary of the results of the fixed-point measurements for alpha and beta-gamma radiation are presented in Table 3. Instrument background measurements of 60 cpm for beta-gamma radiation were noted. Instrument

Table 4. Surface soil concentrations[a]

Sample ID	Grid Block Identifier	Gamma Exposure Rate, μR/h	^{60}Co,[a] pCi/g	^{137}Cs,[b] pCi/g	^{226}Ra,[b] pCi/g	^{238}U, pCi/g
S1	00, -05	15	-0.01 ±0.03	0.20 ±0.02	1.13 ±0.16	1.08 ±3.20
S2	05, -10	16	0.01 ±0.05	0.27 ±0.03	1.13 ±0.22	1.62 ±5.70
S3	10, -05	17	0.02 ±0.03	0.10 ±0.04	1.22 ±0.32	3.78 ±5.40
S4	15, -05	16	0.00 ±0.04	0.14 ±0.03	1.08 ±0.24	0.27 ±5.10
S5	00, 14	14	0.00 ±0.02	0.18 ±0.01	0.86 ±0.14	1.65 ±2.60
S6	05, 14	15	0.00 ±0.09	0.16 ±0.10	0.89 ±0.27	2.43 ±13.00
S7	10, 14	16	-0.02 ±0.12	0.13 ±0.08	0.84 ±0.38	-2.16 ±12.00
S8	-05, 00	16	0.00 ±0.06	0.25 ±0.08	0.86 ±0.38	2.97 ±10.00
S9	-05, 05	15	0.00 ±0.08	0.86 ±0.14	0.94 ±0.32	0.54 ±13.00
S10	-05, 10	15	0.00 ±0.13	0.32 ±0.11	0.84 ±0.32	-0.54 ±16.00
S11	15, 14	16	-0.04 ±0.10	0.13 ±0.07	0.97 ±0.51	-1.62 ±11.00
S12	20, 14	16	-0.04 ±0.11	0.10 ±0.06	0.97 ±0.38	-1.08 ±12.00
S13	-02, 06	29	-0.01 ±0.10	4.59 ±0.27	0.84 ±0.40	-3.51 ±15.00

[a] Reported at the 95% confidence level for laboratory equipment.
[b] Mean ± 1.96 standard deviations.

Table 5. Summary of exterior exposure rates

	n	$\bar{x}$	*s*
Gamma radiation, μR/h at surface	65	16	2
Gamma radiation, μR/h at 1 m	14	15	1
Beta-gamma radiation, dpm/100 cm^2	65	790	320

n = number of measurements
$\bar{x}$ = mean
s = standard deviation.

background measurements for alpha radiation were 5 cpm. Portions of the drainage trench, floor, and walls adjacent to the trench showed elevated beta-gamma radiation count rates. These areas did not exceed DOE guidelines when averaged over 1 m^2. All readings for alpha radiation on the interior and exterior surfaces were below applicable guidelines.

Smear locations were selected as discussed in Sect. 2 to detect removable alpha and beta-gamma radiation activity. Results of these measurements are presented in Table 6. All smear readings were below established guidelines, and in many instances, the measurements were below the lower limit of detection (LLD) of the instrument. It should be noted that measurements below the LLD are very uncertain and probably invalid for verification purposes.

Beta-gamma radiation scans were performed with the knowledge that the guidelines were exceeded at 5,000 dpm or 215 cpm. Therefore, all readings above 150 cpm were carefully investigated for possible contamination. Three small regions on the basement floor exceeding the guidelines were identified. The locations of these regions are presented in Fig. 7; the readings are summarized in Table 7. Further remediation of these "hot spots" was performed by the remedial action contractor, and after review of the clean-up report of decontamination of the hot spots (Appendix C), the turbine building was recommended for certification. A statement of verification has been issued by ORNL/PAG for the BORAX-V turbine building (Appendix D).

4. SUMMARY

In order to document the adequacy of remedial actions, ORNL/PAG performed independent verification on the BORAX-V turbine building at INEL. Verification activities included document reviews, independent measurements, sampling, and confirmatory laboratory analyses. Field activities were performed during November and December 1991. Three small areas on the turbine building

Table 6. Summary of interior removable contamination

Measurement Location	Alpha Radiation: Number of Grid Blocks or Locations Surveyed	Alpha Radiation: Activity, dpm/100 cm^2 Maximum Reading	Alpha Radiation: Activity, dpm/100 cm^2 LLD	Beta-gamma Radiation: Number of Grid Blocks or Locations Surveyed	Beta-gamma Radiation: Activity, dpm/100 cm^2 Maximum Reading	Beta-gamma Radiation: Activity, dpm/100 cm^2 LLD
West wall	16	< LLD	22	16	< LLD	118
North wall	15	< LLD	22	15	< LLD	118
East wall	14	< LLD	22	14	< LLD	118
South wall	12	< LLD	22	12	< LLD	118
Floor	40	< LLD	22	40	160	118

LLD = lower limit of detection of instrument.

ORNL-DWG 93-10784

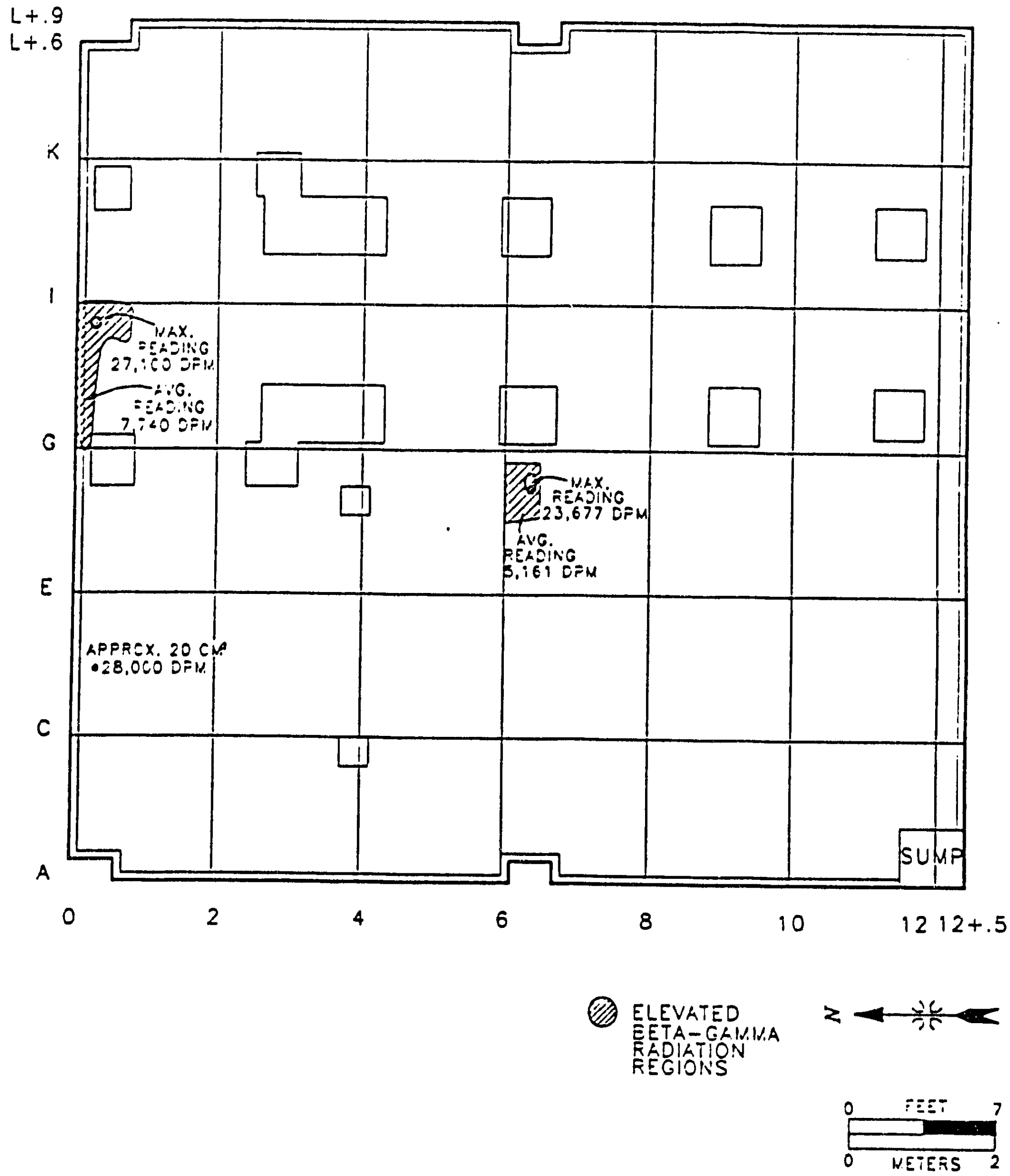


Fig. 7. Turbine building floor, showing elevated beta-gamma radiation regions.

Table 7. Location of elevated direct radiation identified by scans of the BORAX-V turbine building basement floor and trench

Grid block identifier	Area, cm^2	Total Activity, $dpm/100cm^2$		Guidelines Exceeded?		Resolution
		Alpha Radiation	Beta Radiation	Hot Spot	Average	
6, E	450	51	23,700	yes	yes	remediated
0, C	20	N/A	28,000	yes	no	remediated
0, G	3280	N/A	27,100	yes	yes	remediated

N/A = not available

basement floor and trench that required further cleanup were identified. The three areas were remediated by EG&G, and a post-decontamination survey was sent to ORNL/PAG (Appendix C). The independent verification survey confirmed that remedial action reduced contaminant levels below applicable guidelines prior to demolition and burial so that the public and environment are thereby protected. A statement of verification has been issued by ORNL/PAG for the BORAX-V turbine building (Appendix D).

REFERENCES

EG&G. 1986. *Development of Criteria for Release of Idaho National Engineering Laboratory Sites Following Decontamination and Decommissioning.* EGG-2400. EG&G Idaho, Inc., Idaho Falls, Idaho.

EG&G. 1990. *Decontamination and Decommissioning Plan for the BORAX-V Facility.* PR-W-79-017, Revision 3. EG&G Idaho, Inc., Idaho Falls, Idaho.

ORNL. 1990. *Pollutant Assessments Group Procedures Manual.* ORNL-6645. Health and Safety Research Division. Oak Ridge National Laboratory, Grand Junction, Colo.

U.S.DOE. 1988. *Verification and Certification Protocol for the Formerly Utilized Sites and Surplus Facilities Management Programs.* Office of Environmental Restoration, U. S. Department of Energy, Washington D.C.

U.S.DOE. 1990. *Radiation Protection of the Public and the Environment.* DOE Order 5400.5. U. S. Department of Energy, Washington, D.C.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

BORAX	Boiling Water Reactor Experiment
cpm	counts per minute
DOE	Department of Energy
dpm	disintegrations per minute
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
GM	Geiger Mueller
INEL	Idaho National Engineering Laboratory
IVC	independent verification contractor
kcpm	thousand counts per minute
μR/h	microroentgens per hour
LLD	lower limit of detection
ORNL/PAG	Oak Ridge National Laboratory/Pollutant Assessments Group
PIC	pressurized ionization chamber
SFMP	Surplus Facilities Management Program

APPENDIX A

POST-REMEDIATION SURVEY BY EG&G

Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

October 15, 1991

Ms. Gloria H. Stevens
Oak Ridge National Lab
P. O. Box 2567
Grand Junction, CO 81502-2567

SUBJECT: Post Decontamination and Decommissioning of the BORAX-V Turbine Building - ERD-439-91

Dear Ms. Stevens:

Please find enclosed a copy of the Post Decontamination and Decommissioning (D&D) Survey of the BORAX-V Turbine Building. This survey is provided to assist the Independent Verification Contractor (IVC) with the preparation of a workplan that will outline the methodology for the verification and certification of D&D activities at the BORAX-V Turbine Building site located at the Idaho National Engineering Laboratory.

Should you have any questions, please contact me at (FTS) 583-0193, commercial (208) 526-0193, or A. W. Mikkola at (FTS) 583-0725, commercial (208) 526-0725.

Sincerely,

W. N. Sato, Acting Director
Environmental Restoration Division

Enclosure

cc w/o enc: S. G. Stiger, EG&G
R. H. Meservey, EG&G
G. R. Rodman, EG&G

October 7, 1991

BORAX-V TURBINE BUILDING FOUNDATION
POST DECONTAMINATION RADIOLOGICAL
SURVEY RESULTS

BORAX-V TURBINE BUILDING FOUNDATION

POST DECONTAMINATION RADIOLOGICAL

SURVEY RESULTS

Date of survey : 10/07/91

Instruments used in survey:

Contamination level: Ludlum 2A Serial No. 111055

Radiation level: Bicron 2000 Serial No. 130970

Smears counted on Tennelec 5100 Alpha-Beta Scaler Serial No. 65307

Smear Results: No smearable contamination detected on any of the 100 cm^2 smears.

No Alpha contamination detected on any of the smears.

General Notes:

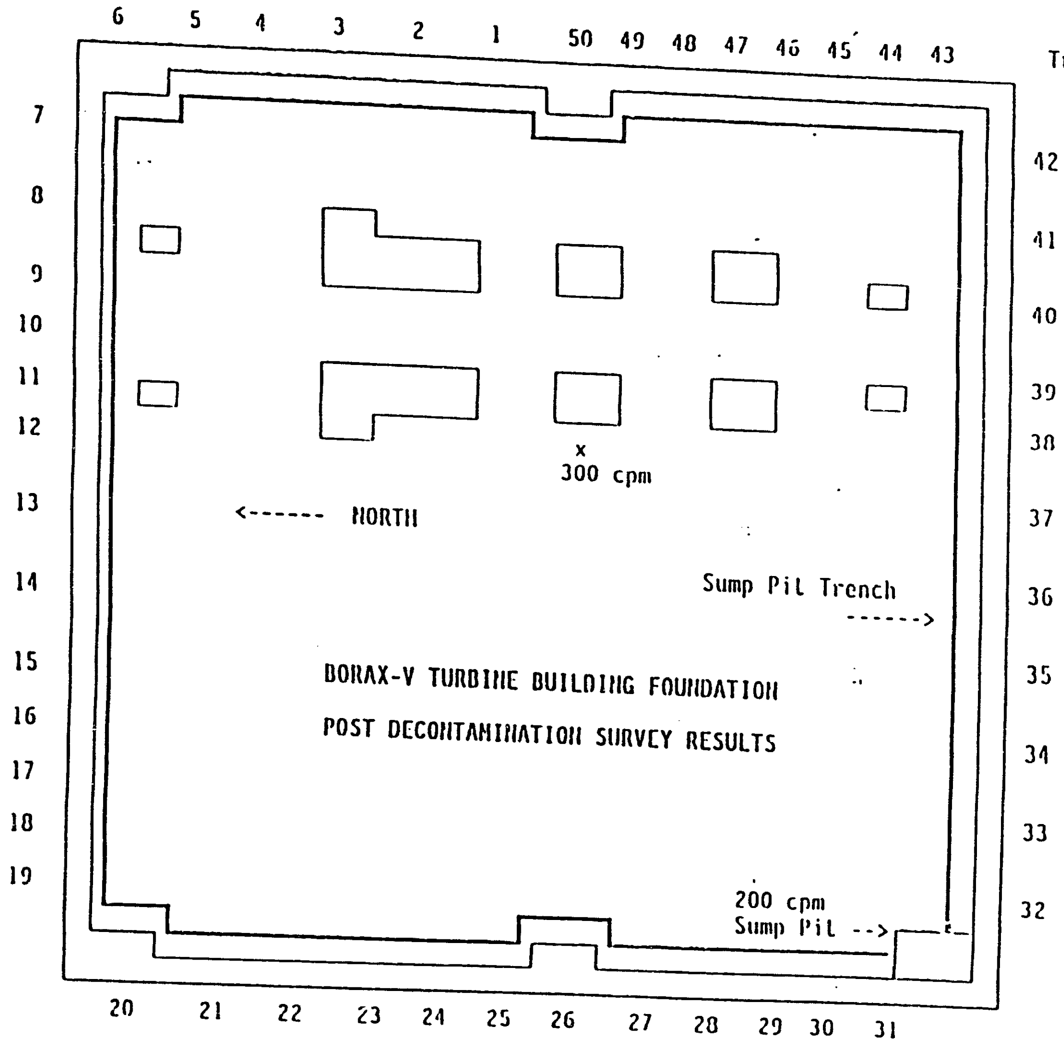
All contamination levels reported in counts per minute (cpm) above background (bkgd.).

Background level used at BORAX-V is 100 cpm.

All exterior and interior foundation walls and the main floor are radiologically clean.

Basement floor, excluding the sump pit trench and sump pit, has only one area of approximately 1 ft^2 with fixed contamination of maximum 300 cpm above background (area marked with "x").

Sump pit contamination levels average 200 cpm above background.



Trench Location No.	Contamination Level Above Bkgd.
1	Bkgd.
2	Bkgd.
3	100 cpm
4	100 cpm
5	200 cpm
6	100 cpm
7	100 cpm
8	200 cpm
9	100 cpm
10	200 cpm
11	200 cpm
12	100 cpm
13	100 cpm
14	100 cpm
15	100 cpm
16	200 cpm
17	100 cpm
18	100 cpm
19	200 cpm
20	200 cpm
21	200 cpm
22	200 cpm
23	200 cpm
24	300 cpm
25	200 cpm
26	200 cpm
27 - 50	Bkgd.

Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

November 1, 1991

Mr. D. K. Halford
Oak Ridge National Laboratory
Grand Junction Project Office
P. O. Box 2567
Grand Junction, CO 81502

SUBJECT: BORAX-V D&D Radiological Survey - ERD-474-91

Dear Mr. Halford:

As per your request, please find enclosed the latest BORAX-V Turbine Building Radioactive Survey. The values have been converted from counts per minute (cpm) to disintegrations per minute per 100 cm^2, (dpm/100 cm^2) using CS-137 as the primary isotope.

We look forward to your field survey trip the first week in November.

Please call A. W. Mikkola at (FTS) 583-0725 if you have any questions.

Sincerely,

W. N. Sato, Acting Director
Environmental Restoration Division

Enclosure

cc: G. Stevens, ORNL/GJPO, w/enc.
R. H. Meservey, EG&G, w/o enc.
G. R. Rodman, EG&G, w/o enc.

October 7, 1991

BORAX-V TURBINE BUILDING FOUNDATION

POST DECONTAMINATION RADIOLOGICAL

SURVEY RESULTS

BORAX-V TURBINE BUILDING FOUNDATION

POST DECONTAMINATION RADIOLOGICAL

SURVEY RESULTS

Date of survey : 10/07/91

Instruments used in survey:

Direct Scan: Ludlum 2A, Serial No. 111056

Radiation level: Bicron 2000, Serial No. 130870

Smears counted on Tennelec 5100 Alpha/Beta-Gamma Scaler Serial No. 65307

Smear Results: All smearable contamination is < 200 dpm/100 cm^2 Beta-Gamma and < detectable Alpha.

General Notes:

Background level used at BORAX-V is 100 cpm as measured with the Ludlum 2A. This instrument has a calibration expiration date of 12/27/91 and an efficiency of 20%.

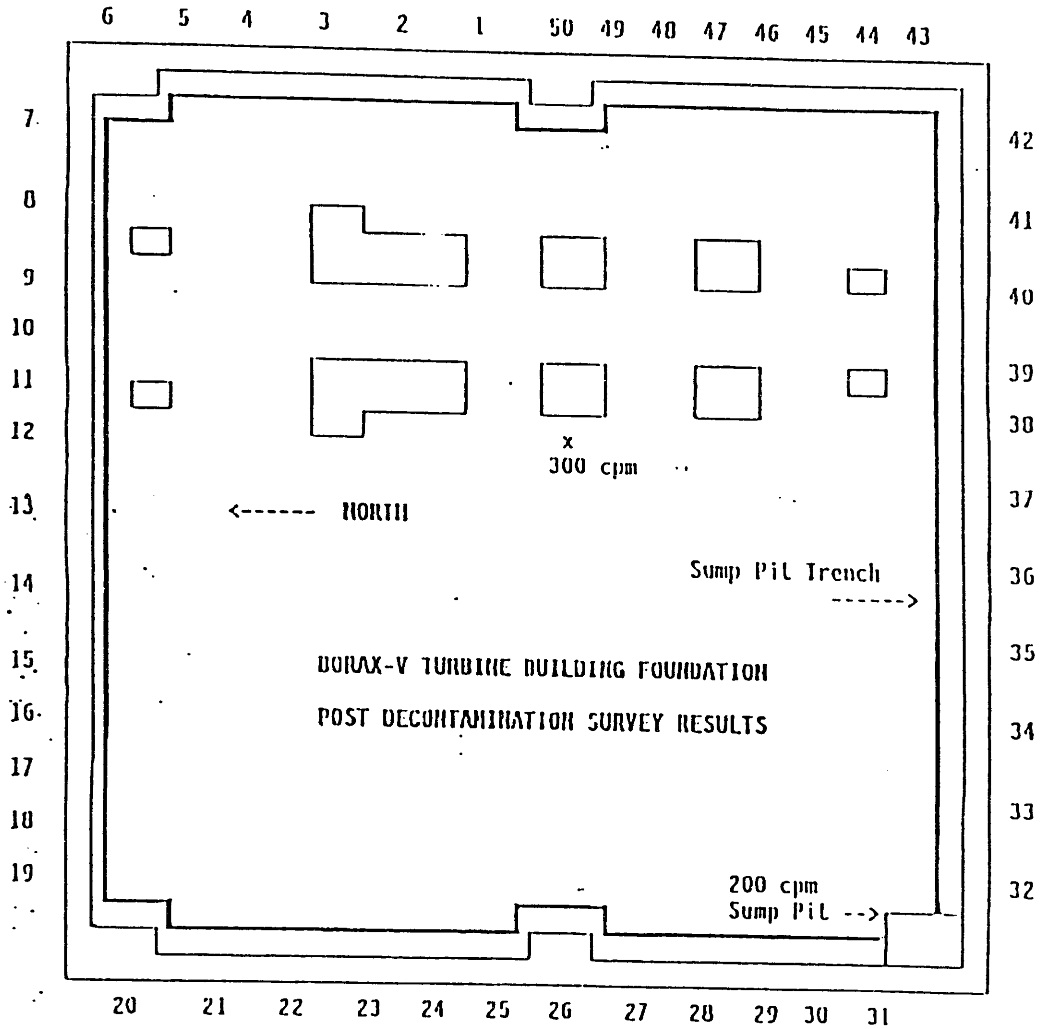
All direct scan measurements are given in counts per minute (cpm) but are converted to dpm/100 cm^2 by using the methodology on page 4. Therefore, the background level at the BORAX-V Turbine Building basement may also be reported as 538 dpm/100 cm^2.

All exterior and interior foundation walls have been surveyed and found to be free of fixed and loose contamination.

The basement floor, excluding the sump pit trench and sump pit, has only one area of approximately 1 ft^2 with a maximum fixed contamination value of 300 cpm above background (area marked with "x"). A value of 896 dpm/100 cm^2 above background averaged over 1 m^2 may be computed using the methodology on page 4.

The fixed contamination levels in the sump pit average 1075 dpm/100 cm^2 above background.

All fixed contamination levels are reported on page 4 in dpm/100 cm^2 above background (averaged over 1 m^2).


6 5 4 3 2 1 50 49 48 47 46 45 44 43
7 8 9 10 11 12 13 14 15 16 17 18 19
42 41 40 39 38 37 36 35 34 33 32
20 21 22 23 24 25 26 27 28 29 30 31
x
300 cpm
<------- NORTH
Sump Pit Trench
------>
BORAX-V TURBINE BUILDING FOUNDATION
POST DECONTAMINATION SURVEY RESULTS
200 cpm
Sump Pit -->

Sump Pit Trench Location Number	Contamination Level Above Background As Averaged Over 1 m^2,[1] (dpm/100 cm^2)
1	Bkgd.
2	Bkgd.
3	538
4	538
5	1075
6	538
7	538
8	1075
9	538
10	1075
11	1075
12	538
13	538
14	538
15	538
16	1075
17	538
18	538
19	1075
20	1075
21	1075
22	1075
23	1075
24	1613
25	1075
26	1075
27-50	Bkgd.

1. These values were originally reported in cpm using the Ludlum 2A direct scan field instrument. This instrument has an efficiency of 20% and a counting surface area of 15.5 cm^2. Therefore, assuming CS-137 to be the major isotope it is possible to convert the data set from cpm to dpm/100 cm^2 by using the following relation:

$$\frac{cpm}{15.5\ cm^2} \times 5 \times 6.45 = \frac{dpm}{100\ cm^2}$$

Further, the tabulated values have been averaged over a 1 m^2 surface area. This is possible by saying that a 1 meter segment of the trench 6 inches wide represents approximately 1/6th of the 1 m^2 area. Thus, the converted values are divided by 6 and are tabulated above.

APPENDIX B

SURVEY AND ANALYTICAL EQUIPMENT

APPENDIX B

SURVEY AND ANALYTICAL EQUIPMENT

The display or description of a specific product is not to be construed as an endorsement for that product or its manufacturer by the authors or their employer.

1. DIRECT RADIATION MEASUREMENTS

Victoreen portable ratemeter
Model 490 THYAC III
Victoreen, Cleveland, Ohio

Victoreen NaI scintillation detector
Model 489-55
Victoreen, Cleveland, Ohio

Eberline beta-gamma radiation "pancake" detector
Model HP-260
Eberline, Santa Fe, N.M.

Ludlum ratemeter-scaler
Model 2221
Ludlum, Sweetwater, Tex.

Reuter-Stokes pressurized ionization chamber
Model RSS-111
Reuter-Stokes, Twinsburg, Ohio

Eberline alpha radiation scintillation detector
Model AC-3-7
Eberline, Santa Fe, N.M.

Bicron® Analyst ratemeter-scaler
Bicron, Newbury, Ohio

Ludlum gas proportional counter floor monitor
Model 239-1F
Ludlum, Sweetwater, Tex.

2. LABORATORY ANALYSES

Ludlum dual alpha, beta-gamma radiation smear counter
Model 2929
Ludlum, Sweetwater, Tex.

Gamma spectroscopy
ND® multichannel analyzer
Model 9900
Nuclear Data Systems®
Canberra Industries,
Itasca, Ill.

High purity germanium lithium detectors
ORTEC®, Tennelec,
ND® Corp,
601 Oak Ridge Turnpike
Oak Ridge, Tenn.

APPENDIX C

DECONTAMINATION OF HOT SPOTS IDENTIFIED AT BORAX-V

Department of Energy
Field Office, Idaho
785 DOE Place
Idaho Falls, Idaho 83401-1562

February 5, 1992

Ms. G. H. Stevens
Oak Ridge National Laboratory
P.O. Box 2567
Grand Junction, Colorado 81502-2567

SUBJECT: Survey of the BORAX-V Turbine Building Post Decontamination
RPO-21-92

Dear Ms. Stevens:

This letter formally transmits the results of efforts to remove fixed contamination from three small areas on the Turbine Building floor. These three small areas were identified by your staff during the Independent Verification Contractor (IVC) effort in November and December of 1991. The final readings meet the requirements of DOE Order 5400.5.

If you have any questions regarding these results, please contact A. W. Mikkola at (FTS) 583-0725.

Sincerely,

Alice C. Williams, Director
Environmental Restoration Division

Enclosure

Enclosure

Concerning 5400 15Kdpm
See page 1 of 4 of
Attachment 2.

BLDG BORAX	LOCATION · BORAX	DATE 01/05/92	TIME 13:00
PURPOSE PRE-DECON & POST-DECON			

SURFACE CONTAMINATION SURVEY

INSTRUMENT	TYPE	ID NUMBER
	2A	131707

SMEARS	
WIPES	
SCAN	X

		YES	NO	NA
ALL SMEARS	< 200 DPM/100 CM² BETA/GAMMA			X
	< 20 DPM/100 CM² ALPHA			X
ALL WIPES	< 100 CPM ABOVE BACKGROUND BETA/GAMMA			X
	< DETECTABLE ALPHA			X
DIRECT SCAN	< 100 CPM ABOVE BACKGROUND BETA/GAMMA		X	
	< DETECTABLE ALPHA			X

IF NO; LIST THOSE GREATER THAN THE VALUES INDICATED

#	LOCATION	DPM/100 CM²		#	LOCATION	DPM/100 CM²	
		BETA/GAMMA	ALPHA			BETA/GAMMA	ALPHA

RADIATION SURVEY

ALL RADIATION READINGS < 5 MREM/HR — YES X NO ___ NA ___

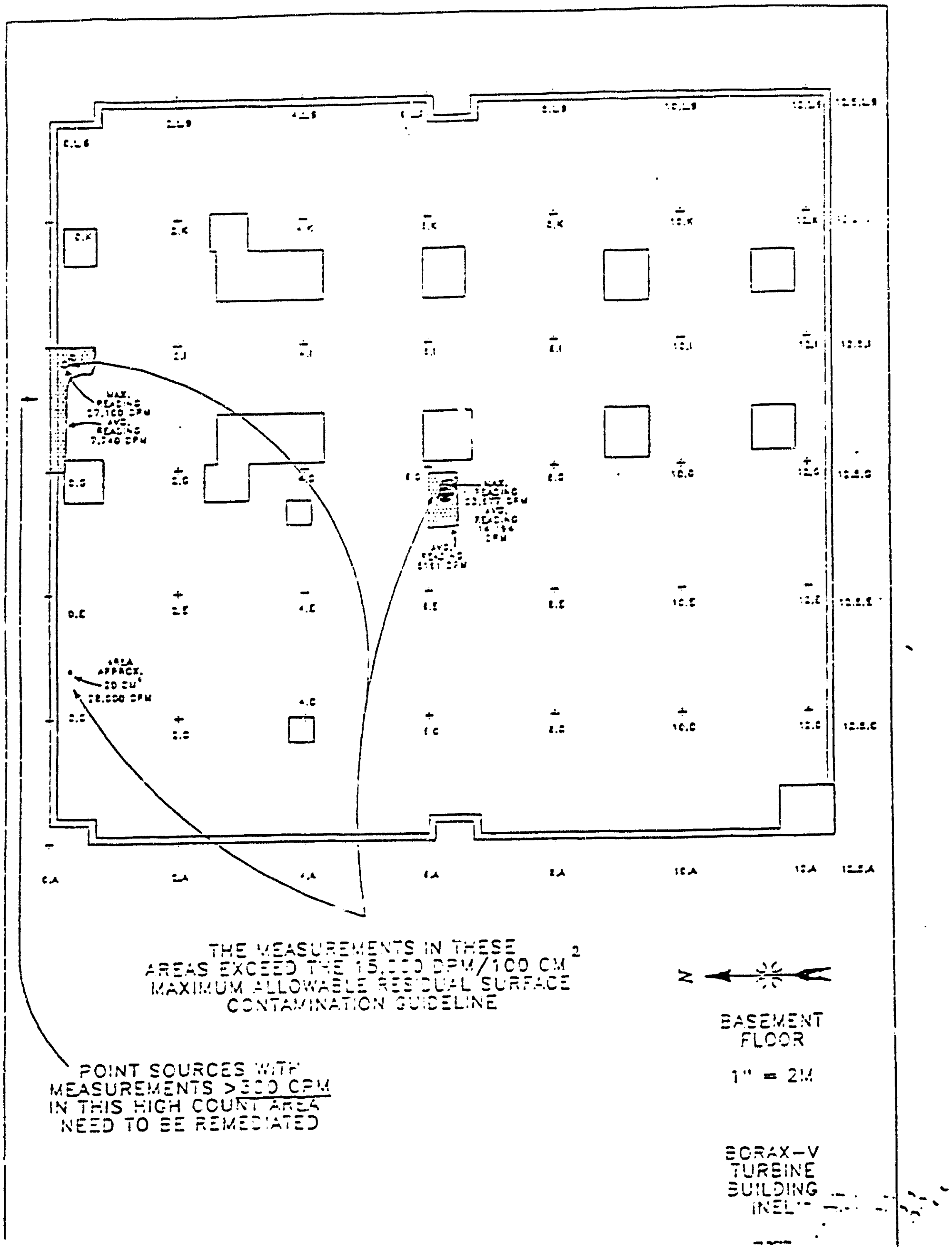
SEE #1 & #2 ATTACHMENTS

H.P. TECH SIGNATURE Hilton D. L. Barker — DOSE REC. MREM 0

H.P. SUPERVISOR REVIEW [signature] 1-7-92

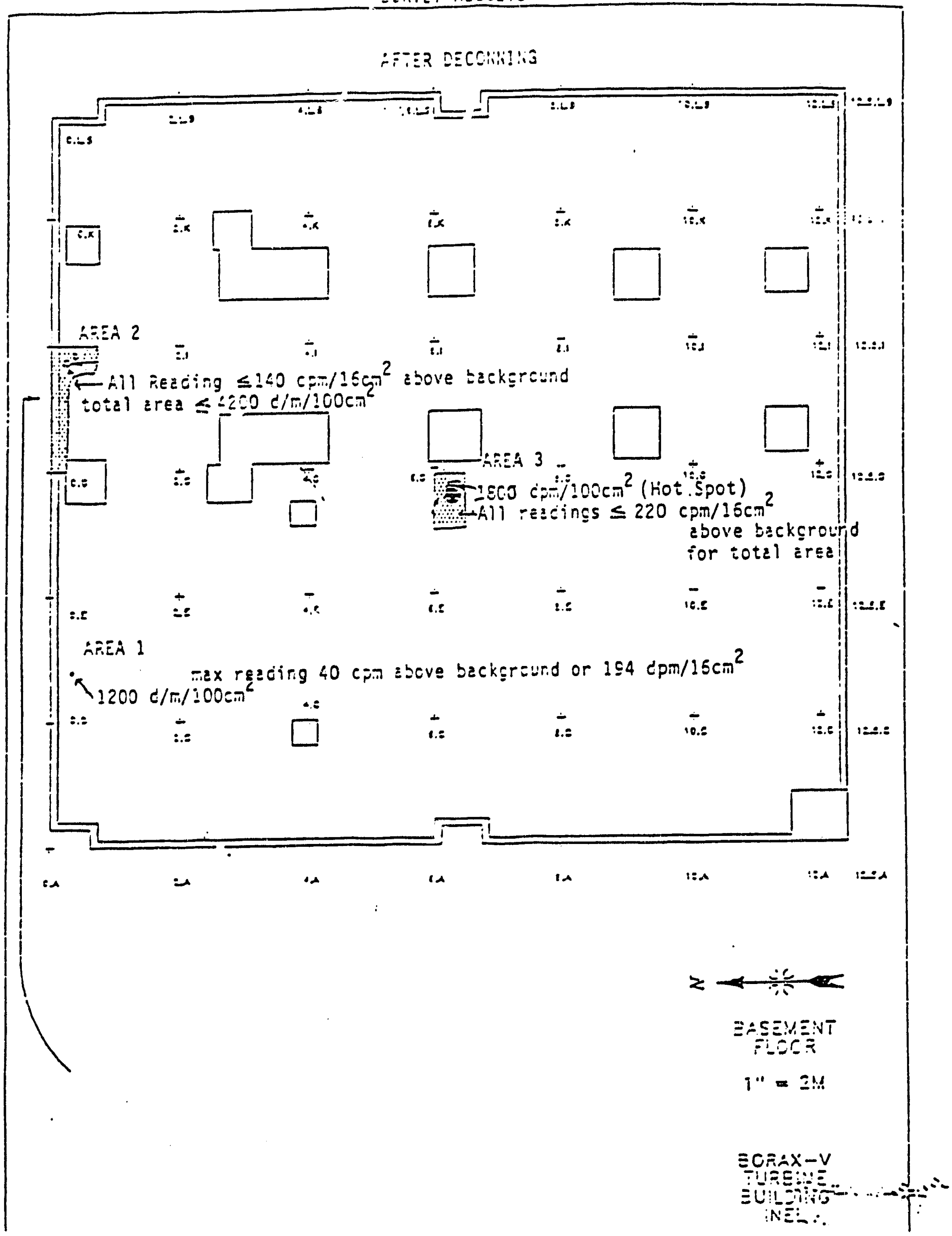
Attachment 1
Page 1 of 3

Pre Decon Map



Attachment 1
Page 2 of 3

SURVEY RESULTS



Attachment 1
Page 3 of 3

Calculation Information

A. To figure dpm

1. $\frac{\text{cpm - bkgd}}{\text{eff of instrument}}$ = dpm

b. To convert d/m/16cm² to d/m/100cm²
d/m/16cm² X 6 = d/m/100cm²

c. Instrument # 131707 calibration information

eff.	Cs 137	20.6%
	Sr 90	25%
	Co 60	3.2%
	Tc 99	12.8%

NOTE: The instrument used has a 16cm² detection area

SURVEY RESULTS
for AREA 1

0,E

2,E

DOE Surface Contamination Limits
Beta-gamma emitus
Removable - 1,000 dpm-/100cm^2
Fixed and removable - 5,000 dpm -/100 cm^2

Hot spots - up to 15,000 dpm
as long as the average for
1 sqmeter does not exceed
5,000 dpm -/100cm^2

Rad Con Manual
Chaper 4.0
Table 4-1

○ ← 1200 d/m/100cm^2

TRENCH

0,C

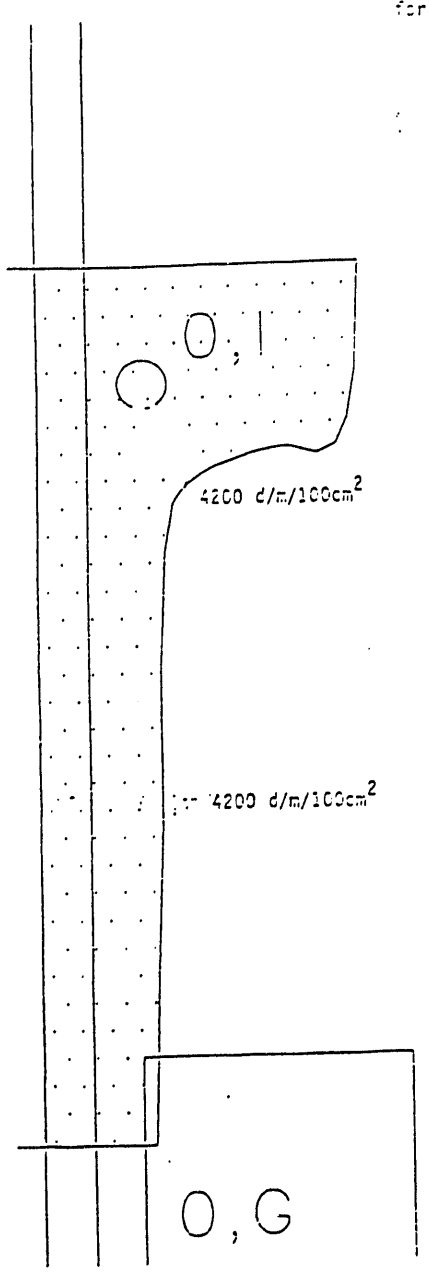
2,C

After deconning
cpm:100
bkgd:60 Net cpm = 40
eff:20% (instrument calibrated by Cs^{137} source)

$$dpm = \frac{cpm}{eff} = \frac{40}{.20} = 200 \ d/m/16cm^2$$

$$200 \ d/m/16cm^2 \times 6 = 1200 \ d/m/100cm^2$$

SURVEY RESULTS
for AREA 2



After Deconning-- all readings are less than 200 cpm including bkgd.

cpm:200
bkgd:60
net cpm = 140 cpm
eff:20% (instrument efficiency to Cs^{137})

$$dpm = \frac{cpm}{eff} = \frac{140}{.20} = 700\ dm/16cm^2$$

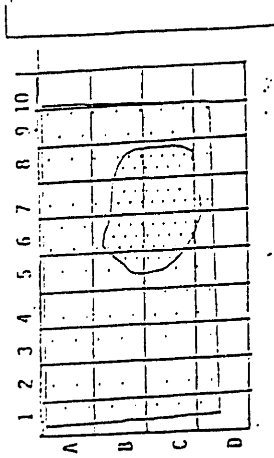
$$700\ d/m/16cm^2 \times 6 = 4200\ d/m/100cm^2\ \text{maximum}$$

12/19/91 14:42 ☎3166227 ORNL GRAND JCT. 003

Attachment 2
Page 3 of 4

SURVEY RESULTS
for AREA 3

6,G



8,G

6,E

8,E

AREA 3 SURVEY RESULTS

Pre-Decon Averages

A-1	140	B-1	150	C-1	100	D-1	50
A-2	140	B-2	220	C-2	170	D-2	70
A-3	200	B-3	220	C-3	320	D-3	220
A-4	140	B-4	380	C-4	220	D-4	280
A-5	100	B-5	340	C-5	590	D-5	230
A-6	260	B-6	280	C-6	500	D-6	240
A-7	90	B-7	200	C-7	290	D-7	90
A-8	40	B-8	60	C-8	160	D-8	90
A-9	30	B-9	40	C-9	40	D-9	50
A-10	40	B-10	40	C-10	40	D-10	60

These readings are in cpm/16cm² above background.

POST-DECON SURVEY RESULTS

Post-Decon on A, B, C, & D #'s 3-7

All averages 40 - 60 cpm above background

The maximum count rate in the hot spot within the area identified is 60 cpm

$$dpm = \frac{cpm}{eff} \qquad dpm = \frac{60\ cpm}{.20} = 300\ dpm/16cm^2$$

300 dpm X 6 = 1800 dpm/100cm² maximum within the area identified

APPENDIX D

APPENDIX D

STATEMENT OF VERIFICATION FOR BORAX-V TURBINE BUILDING AT IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO FALLS, IDAHO

An independent assessment of remedial action activities at the Borax-V turbine building at Idaho National Engineering Laboratory, Idaho Fall, Idaho, has been accomplished by the Oak Ridge National Laboratory (ORNL) Pollutant Assessments Group. The purpose of the assessment was to confirm the site's compliance with applicable Department of Energy (DOE) guidelines. The assessment included reviews of the Decontamination and Decommissioning Plan and data provided in the pre- and post-remedial action surveys. In addition, an independent verification survey of the facility was conducted November 20-27 and December 9-15, 1991.

The independent verification survey included alpha, beta-gamma, and gamma radiation scans, smears for removable contamination, and direct measurements for alpha and beta-gamma radiation activity on the basement and mezzanine floors and the building's interior and exterior walls. In addition, soil samples were taken, and alpha, beta-gamma, and gamma radiation exposure rate measurements were performed adjacent to the building.

Based on the findings of this survey, the measurements on the building surfaces at this facility were within the established contamination guidelines except for elevated beta-gamma radiation levels on three floor surface areas. These areas were subsequently remediated by the remedial action contractor (RAC). ORNL reviewed the RAC's report following this remediation and agrees that the remediation was effective in removing the source of the elevated direct radiation. The independent soil analyses indicated no ^{60}Co above detection limits. The highest ^{137}Cs analysis result was 4.6 pCi/g; this value is below the site-specific guideline of 10 pCi/g for ^{137}Cs.

Based on the data in the post-remedial action report and the independent verification survey results, the radiologic condition of the Borax-V turbine building conforms to the guidelines outlined in the *Verification and Certification Protocol for the Formerly Utilized Sites and the Surplus Facilities Management Programs,* Office of Environmental Restoration, U.S. Department of Energy, Washington, D.C.

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END

DATE FILMED

9 / 10 / 93