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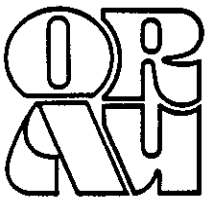

Prepared by
Oak Ridge Associated Universities

Prepared for
U.S. Nuclear Regulatory Commission's Region I Office

Supported by
Safeguards and Materials Program Branch;
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CONFIRMATORY RADIOLOGICAL SURVEY

OF THE

PLUTONIUM FUELS DEVELOPMENT LABORATORY

WESTINGHOUSE NUCLEAR FUEL DIVISION

CHESWICK, PENNSYLVANIA

M. W. STAFFORD

Radiological Site Assessment Program
Manpower Education, Research, and Training Division

FINAL REPORT

May 1984

CONFIRMATORY RADIOLOGICAL SURVEY OF THE PLUTONIUM FUELS DEVELOPMENT LABORATORY WESTINGHOUSE NUCLEAR FUEL DIVISION CHESWICK, PENNSYLVANIA

Prepared for

Safeguards and Materials Program Branch
Division of Quality Assurance, Safeguards, and Inspection Programs
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FINAL REPORT

May 1984

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INTRODUCTION

From 1969 through 1979, the Nuclear Fuel Division of the Westinghouse Electric Corporation performed process development and pilot fabrication of reactor fuels at the Cheswick, Pennsylvania, site. Operations in the Plutonium Fuels Development Laboratory, Building 8, were terminated in 1979 and decontamination and decommissioning efforts were initiated. Upon completion of the final radiological survey of the facility, the licensee presented results in an October 1983 report submitted to the Nuclear Regulatory Commission (NRC). The licensee's survey findings indicated the radiological conditions satisfied the criteria for release for unrestricted use. At the request of the Nuclear Regulatory Commission, the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU) conducted a confirmatory survey of the Plutonium Oxide Laboratory site during December 1983. This report presents the procedures and results of that survey.

SITE DESCRIPTION

The Cheswick Operations facility of Westinghouse Electric Corporation is located on Low Grade Road, approximately 0.5 km northwest of Cheswick, Pennsylvania (see Figure 1). Buildings on this site, in which radioactive materials were handled, included: Building 6, the Astronuclear Laboratory; Building 7, housing the Uranium Oxide Laboratory and the Plutonium Development Laboratory; Building 8, the Plutonium Fuels Development Laboratory; and Building 9, the Naval Pump Repair Facility. Building 6 was previously decommissioned and has been demolished; Building 7 has also been decommisioned and Building 8, having been decontaminated, is in the process of being decommissioned. The Naval Pump Repair Facility adjacent to Building 7 continues in operation. Building 10 served as a security and receiving area for Building 8 and was more recently used for storage and to house a laboratory in support of decommissioning activities.

The Westinghouse Nuclear Fuel Division's Plutonium Fuels Development Laboratory (see Figure 2) was used for development of fabrication processes of mixed oxide fuels for recycle in light water reactors. The fabrication process required handling of enriched, natural, or depleted uranium dioxide and carbide mixed with plutonium and carbide dioxide powder. Processes using solids and liquids were performed primarily in negative pressure glove boxes.

The ARD Laboratory, south of the main fuel processing areas, was previously decontaminated and determined to be clean by a Westinghouse survey and confirmatory survey by Argonne National Laboratory. Decontamination of the facility required the removal of glove boxes and associated ventilation ducts and filters. Non-load bearing walls were removed and paint was stripped to expose original surfaces. Trenches were excavated to expose the "monitor-waste" piping system; all pipes and surrounding soil were removed. Soil samples were obtained and the trenches left open for confirmatory surveys.

The facility can be subdivided into four main areas (see Figure 3): 1) the main laboratory area on the ground floor, approximately 1,300 m^2; 2) the second floor penthouse, approximately 600 m^2 of floor area for facility ventilation and cooling water recirculation systems; 3) the receiving and shipping storage addition; and 4) office areas, general utility support equipment, locker rooms, and a health physics office. The heating, ventilating, and air conditioning (HVAC) equipment consisted of gas fired heaters, blowers, and distribution ducts.

SURVEY PROCEDURES

During the period of December 5 - 16, 1983, ORAU personnel conducted a confirmatory radiological survey of the facility. The purpose of this survey was to verify the adequacy and accuracy of the licensee's final survey and confirm the radiological condition of the facility relative to decommissioning criteria.

Objectives

The objectives of this survey were to:

1. Measure direct radiation levels in the facility,

2. Measure total and removable surface contamination on floors, ceiling areas, walls, miscellaneous fixtures, sumps, drains, etc., and

3. Determine radionuclide concentrations in soil and residues from excavated areas and trenches.

Procedures

Gridding

The grid system established by the licensee, i.e. 1 m x 1 m, on floors and walls and approximately 0.6 m x 1.5 m (2 ft x 5 ft) on the ceiling were used to reference measurements whenever possible. In areas where decontamination activities had removed the original grid system, ORAU reestablished the grid.

Surface Scanning

All floor grid blocks were surface scanned using an alpha floor monitor and hand-held alpha detectors. Walls and overhead surfaces were alpha scanned at approximately 1 m intervals. Particular attention was given to scanning cracks, joints, and horizontal overhead surfaces such as ledges, beams, and pipes. Locations of elevated alpha levels were noted.

Exposure Rate Measurements

Gamma exposure rates at 1 m above the floor were measured throughout the facility using a pressurized ionization chamber.

Surface Contamination Measurements

Approximately 20% of the blocks originally surveyed by the licensee were selected for survey for total and transferable alpha contamination. Additional blocks were chosen randomly to cover a total of 10% of the floor and walls of the controlled access area, penthouse, and shipping and receiving area, in addition to blocks identified by scanning. At least 3% of the ceiling was surveyed in the three areas, including 20% of the blocks surveyed by the licensee. Office areas and the support facility annex were surveyed by performing direct and smear measurements (at least 30 in each room) in addition to any locations of contamination disclosed by scanning.

In each grid block surveyed, total alpha measurements were systematically performed at the center and four equidistant points, midway between the center and block corners. The five measurements were averaged and compared to the release criteria. Smears for transferable alpha contamination were performed at the location in each grid block, where the highest total measurement was obtained. Grid blocks, selected for measurements, were scanned and total and transferable contamination were also determined at locations of elevated levels. Total and transferable contamination measurements were performed on ledges, piping, and ungridded horizontal and vertical surfaces.

Soil Sampling in Excavated Areas

Trenches and open pits were sampled systematically to provide representative coverage of the excavated areas. Samples were collected at locations where joints and turns of the pipes were evident and at 1 meter intervals along a trench where an expansion joint was removed. Sampling was also performed in the pit where liquid waste holding tanks were previously buried outside of the building. Locations of soil sampling are shown on Figure 4.

Additional Sampling

Floor corings were performed at five locations suspected of soil contamination below the concrete floor. Soil was collected for analysis. Locations of floor corings are shown on Figures 5 and 6.

Sample Analysis and Interpretation of Data

Smears were counted to determine gross alpha activity. Soil samples were analyzed by gamma spectrometry for U-238, U-235, Am-241, and any other identifiable photopeaks. Major analytical equipment used for this survey is listed in Appendix A. Appendix B contains a description of the analytical procedures applicable to this survey.

Results were compared with guidelines for release of facilities for unrestricted use. Surface contamination guidelines, established by the Nuclear Regulatory Commission are presented in Appendix C. The contamination guidelines for total plutonium alpha contamination are 100 dpm/100 cm^2 averaged over an area of 1 m^2 and 300 dpm/100 cm^2 maximum. The guideline for transferable plutonium alpha contamination is 20 dpm/100 cm^2. The recommended guideline for plutonium and americium in soil is 30 pCi/g.

RESULTS

Exposure Rates

Exposure rate measurements at 1 m above the floor throughout the building ranged from 7.0 to 10.5 μR/h. These exposure rates are consistent with normal background levels.

Surface Contamination Levels

The results of surface contamination measurements are summarized in Tables 1 and 2. Table 3 presents a list of areas identified as exceeding release guidelines. Two small areas of alpha contamination in excess of the maximum guideline were identified in the portion of the building not

previously designated as a restricted area. Contamination levels of 336 and 6,920 dpm/100 cm^2 were measured in the hallway across from the conference room and utility room, respectively.

In the restricted area several discrete areas of contamination were identified on the floor and lower walls of the penthouse, with levels ranging from 928 to 3,500 dpm/100 cm^2. The maximum was also exceeded at one location along the horizontal surface of ventilation duct work with 353 dpm/100 cm^2 detectable. No areas of transferable contamination above the alpha guideline of 20 dpm/100 cm^2 were identified in the penthouse.

An extensive area of surface contamination was located in the northwest corner of the floor of the Shipping and Receiving area. Eleven grid blocks in this area exceeded release criteria with maximum total alpha measurements ranging from 371 to 1,650 dpm/100 cm^2 and average alpha levels in excess of 100 dpm cm^2. Other discrete areas of surface alpha contamination in excess of the release criteria were identified (see Figure 7), including a spot on the east wall with 1,130 dpm/100 cm^2.

Two larger areas of contamination exceeding the release criteria were identified, on the floor of the main laboratory area. The two areas correspond to the entry of the analytical laboratory and the major portion of the chemical processing laboratory, where plutonium nitrate solution was converted to plutonium dioxide powder and various recovery operations were performed. Glove box decontamination and cut-up facilities were also located in these areas during the facility decommissioning phase. The contamination limits were exceeded on the east wall of the main laboratory area. Total alpha contamination ranging from 3,730 to 6,790 dpm/100 cm^2 was measured on the east and south walls of the Decon Room. Maximum removable alpha contamination was 249 dpm/100 cm^2.

Figure 8 summarizes the levels of the large contaminated areas identified on the floor of the main laboratory area. Total alpha contamination levels were as high as 23,400 dpm/100 cm^2 with removable alpha contamination of 136 dpm/100 cm^2 at one location (J-27). The majority of the grid blocks were near the maximum limit and average limits were exceeded in

most cases. Other discrete spots of contamination in excess of the limits were identified in addition to the two large areas. A total of 81 of the 228 grid blocks surveyed on the floor of the main laboratory area exceeded the release criteria.

The contaminated areas were identified and the licensee performed decontamination of several of these locations during the course of the survey. Areas requiring further decontamination were confined to the two large areas identified in the main laboratory area. On January 16 and 17, 1984, ORAU personnel returned to the site to conduct follow up measurements. Figure 9 illustrates the pattern of grid blocks measured in the previously contaminated areas. Table 4 presents the results of the follow up measurements. These results indicated that all areas were decontaminated to levels below the release guidelines.

Radionuclide Concentrations in Soil

The excavated areas were sampled by ORAU personnel on November 8, 1983, during the final survey of Building 7. A total of 53 locations were selected for sampling (see Figure 4). Plutonium radioisotope concentrations, summarized in Table 5, were generally less than 0.3 pCi/g; however, one sample was determined to have an Am-241 concentration as high as 1.3 pCi/g.

Radionuclide Concentrations in Floor Corings

Locations selected for subfloor sampling (coring), three in the Shipping and Receiving Area and one in the main laboratory area, did not demonstrate significant contamination levels. Table 5 summarizes the results.

SUMMARY

At the request of the Nuclear Regulatory Commission, ORAU conducted a radiological survey of the former Plutonium Fuels Development Laboratory at the Westinghouse Nuclear Fuel Division in Cheswick, Pennsylvania. The purpose of the survey was to verify the adequacy and accuracy of the licensee's survey and to evaluate whether the facility satisfies NRC guidelines for release from licensing.

Contamination levels in several small isolated spots and two large areas were determined to be in excess of the established limits. These findings indicated that additional cleanup was required in two large areas of the main laboratory.

Following decontamination, floor surfaces were resurveyed. All areas of contamination, identified by the initial ORAU survey, had been removed or adequately cleaned. Soil in excavated areas was within the release criteria of 30 pCi/g. Therefore, all results indicate that the radiological status of the facility complies with the NRC guidelines for release for unrestricted use by the general public.

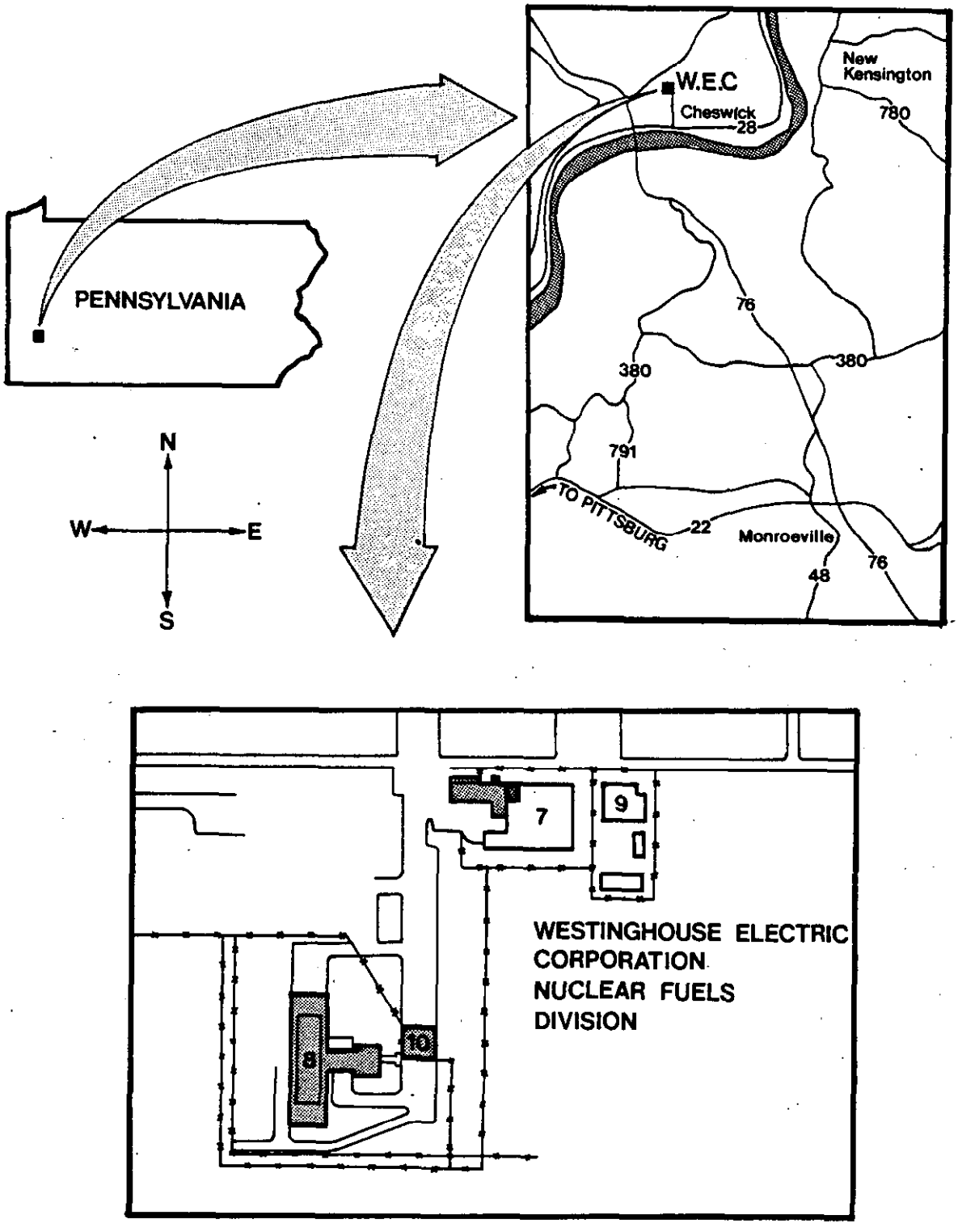

FIGURE 1: Maps Indicating the Location and General Layout of the Westinghouse Electric Corporation's Cheswick Site.

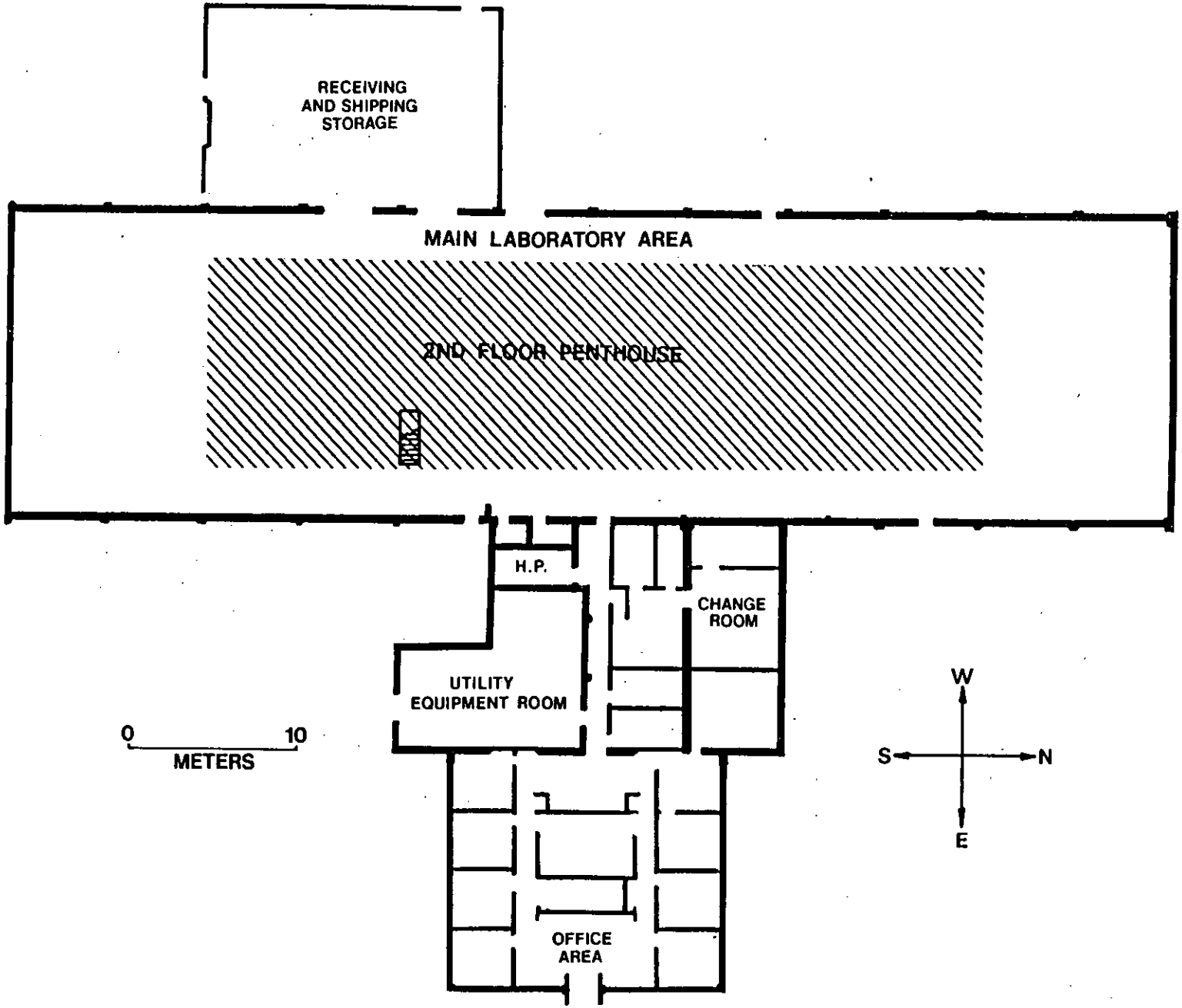

FIGURE 2: Floor Plan of Building 8.

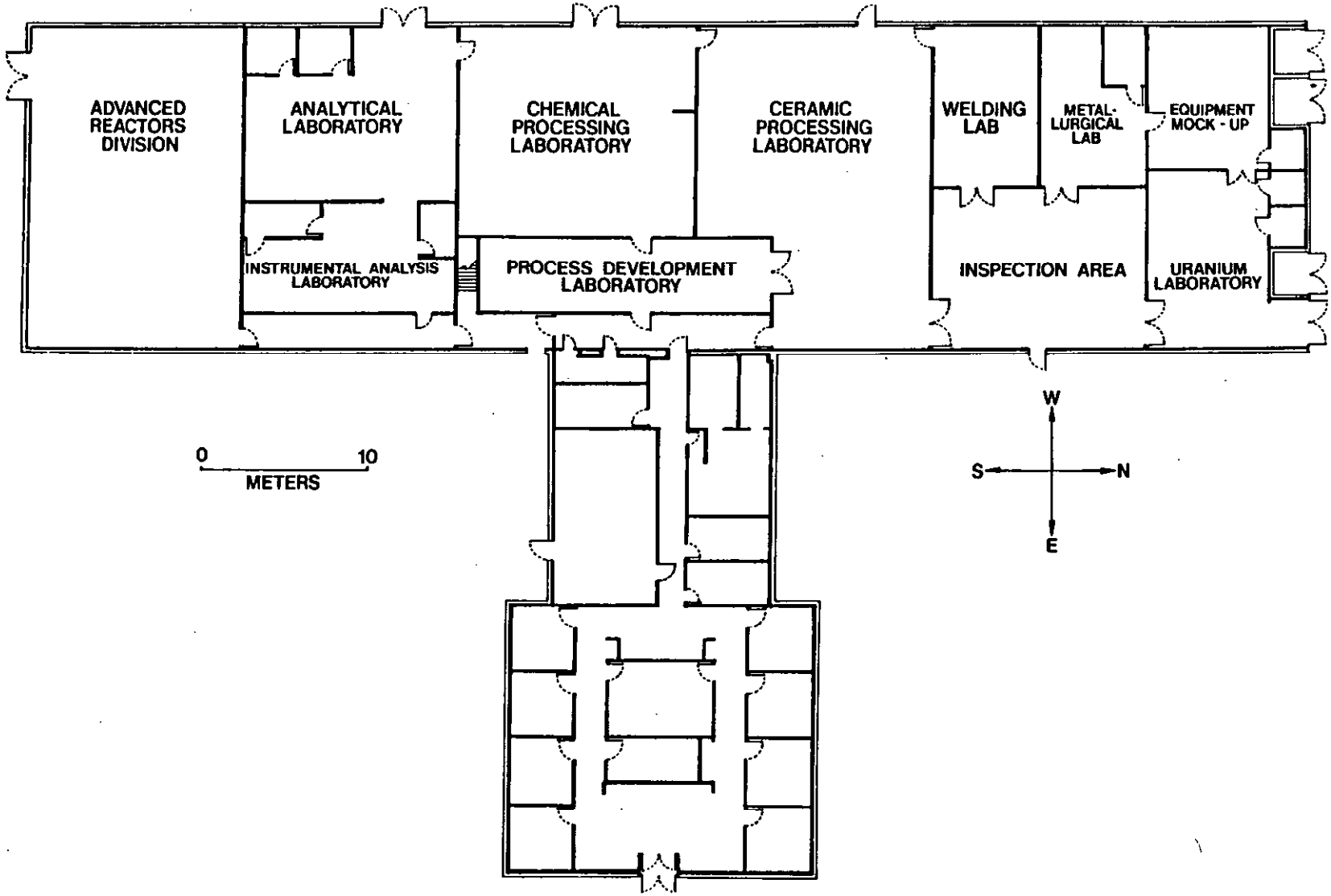

FIGURE 3: Floor Plan of the Main Laboratory Area of Building 8 Showing Original Room Layout.

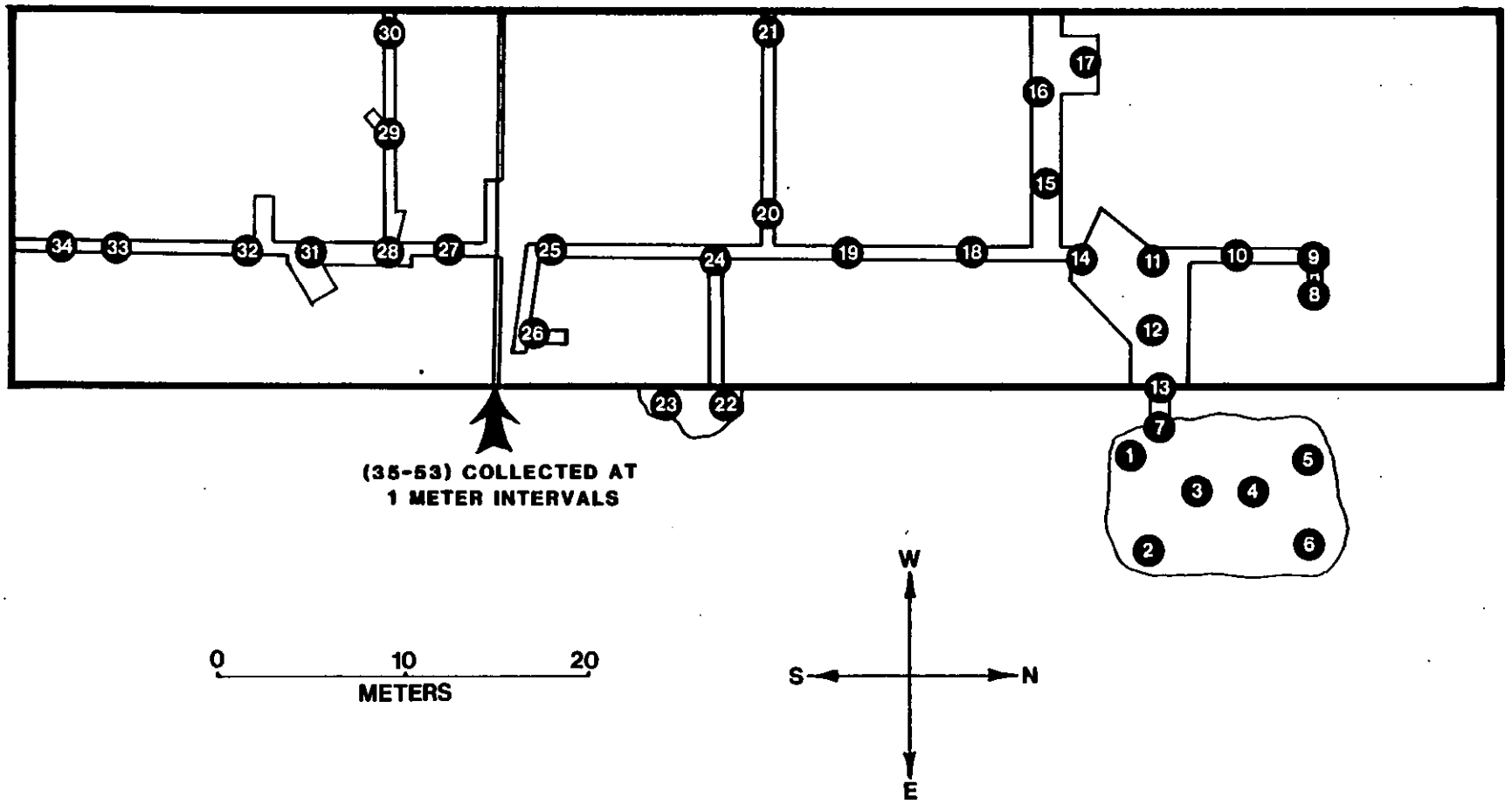

FIGURE 4: Locations of Soil Samples Collected to Provide Representative Coverage of Excavated Areas.

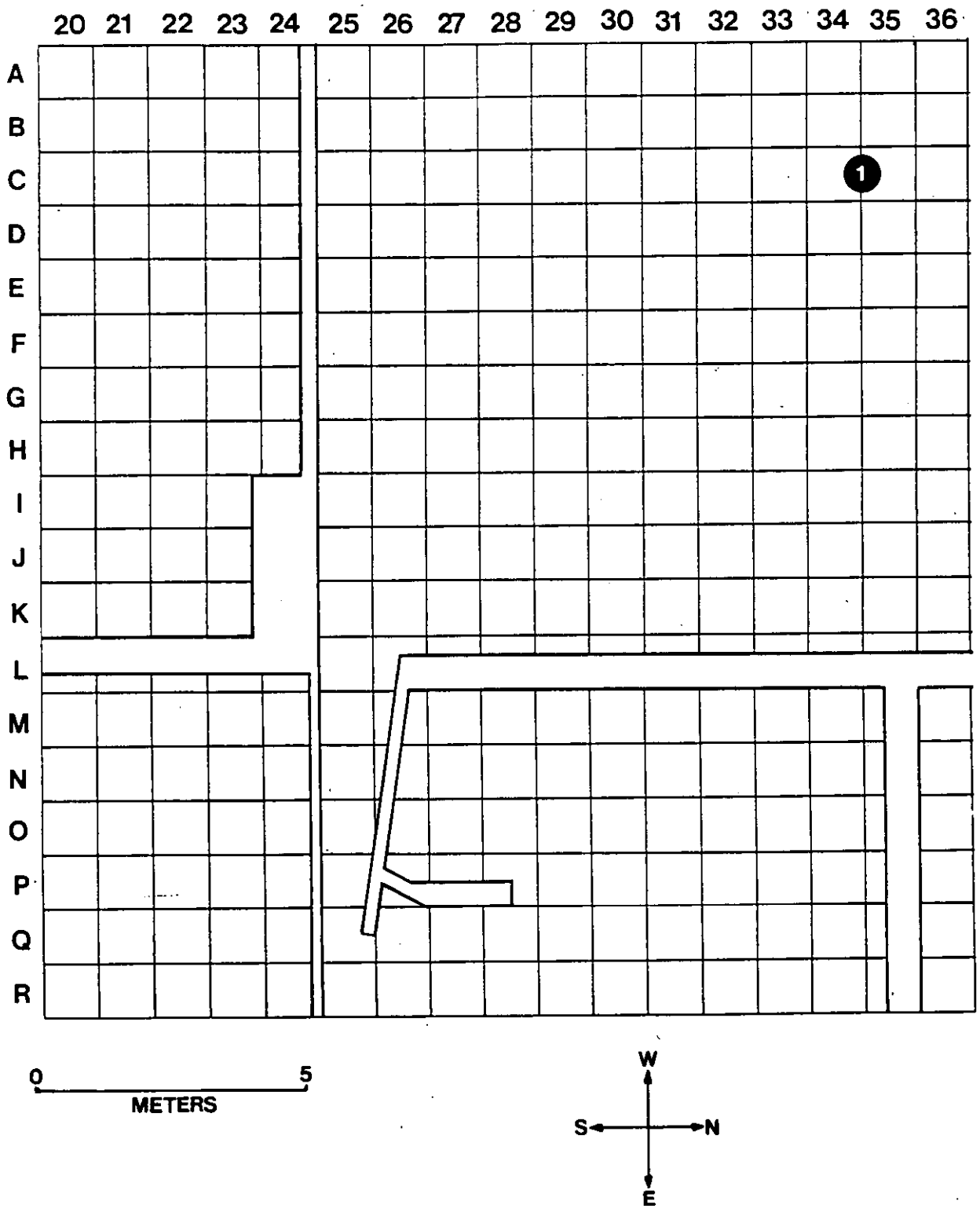

FIGURE 5: Location of Floor Coring in the Main Laboratory Area.

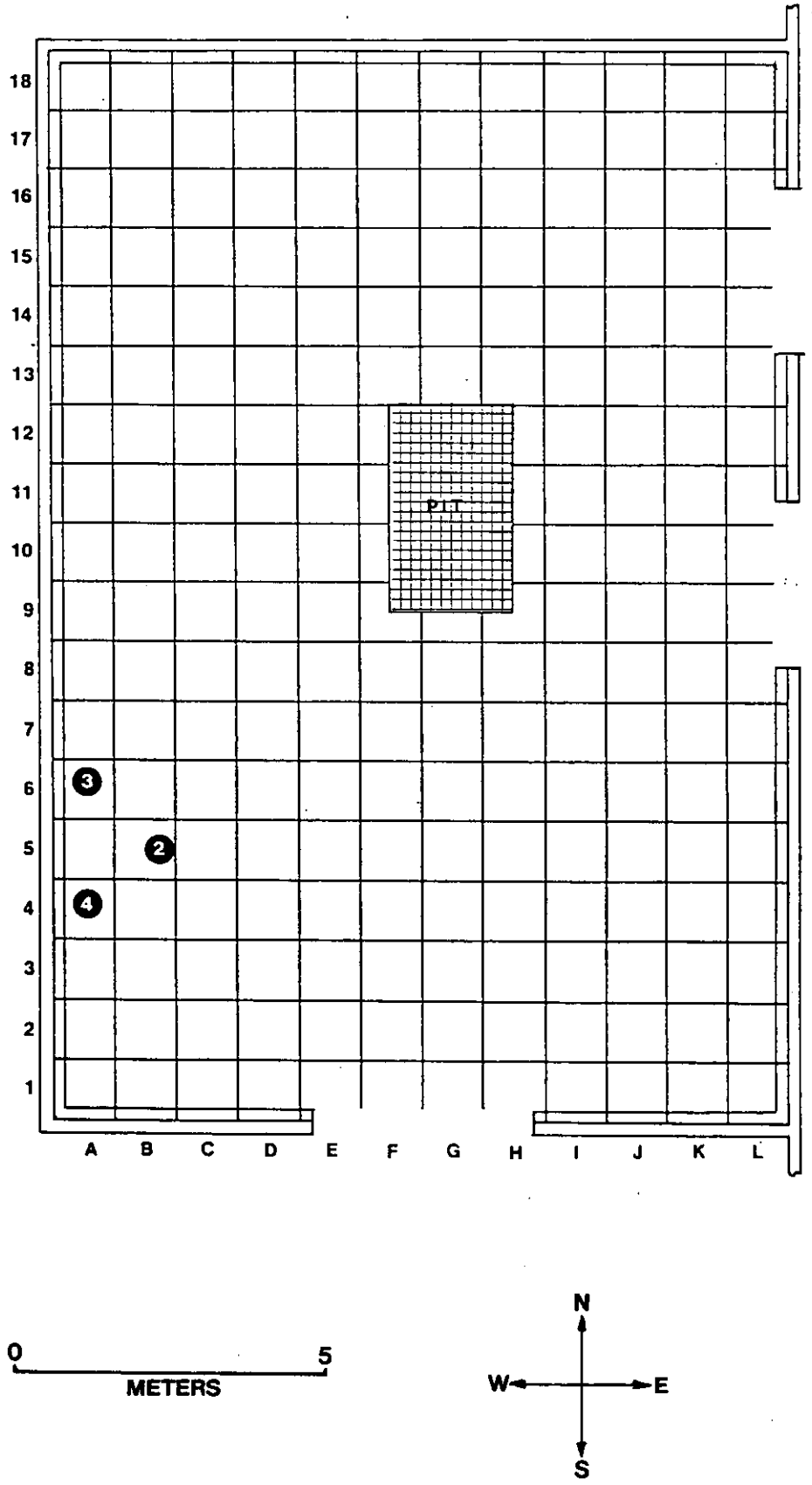

FIGURE 6: Location of Floor Corings in the Shipping and Receiving Area.

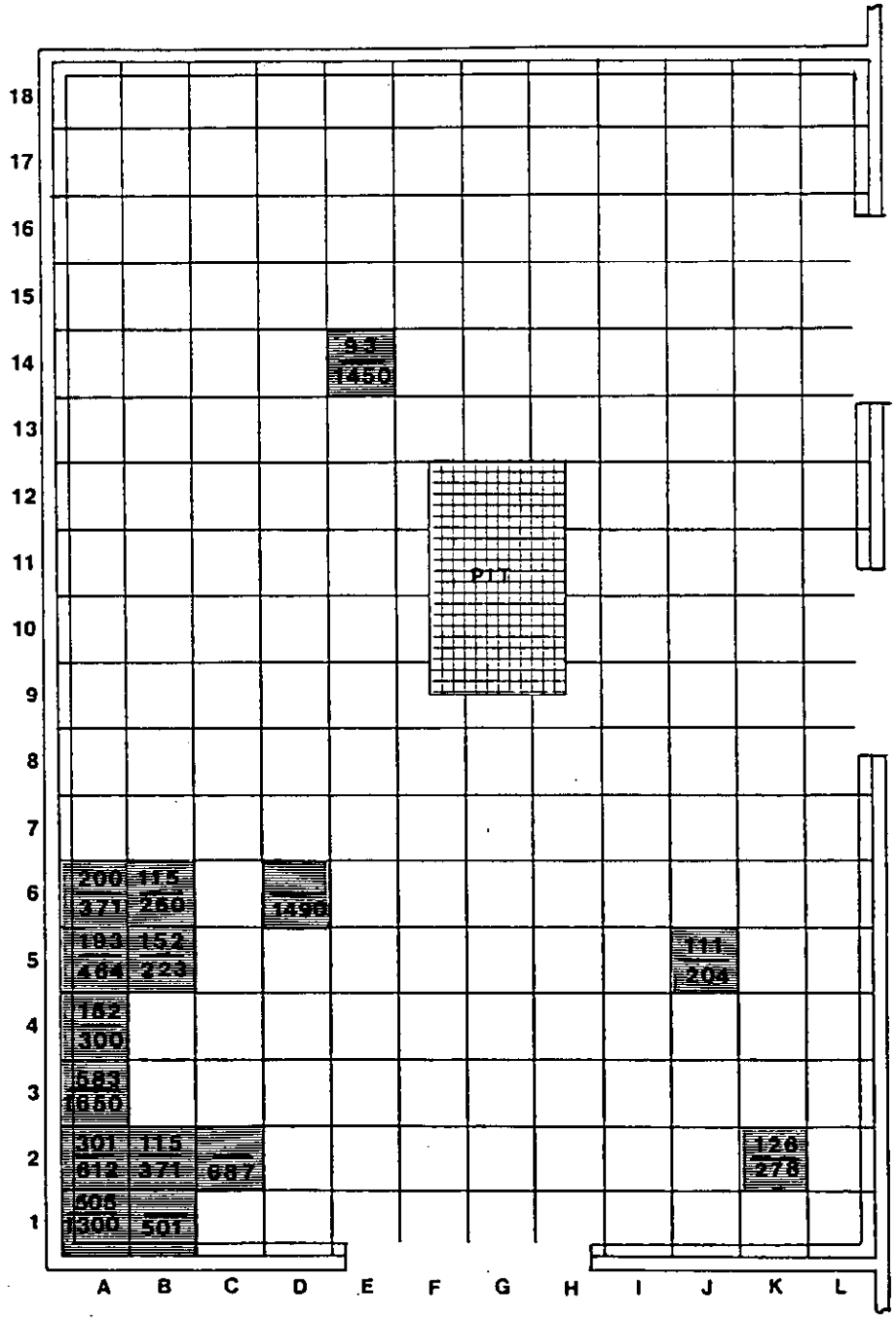

FIGURE 7: Shipping and Receiving Area Floor: Grid Blocks Identified to Exceed Release Criteria.

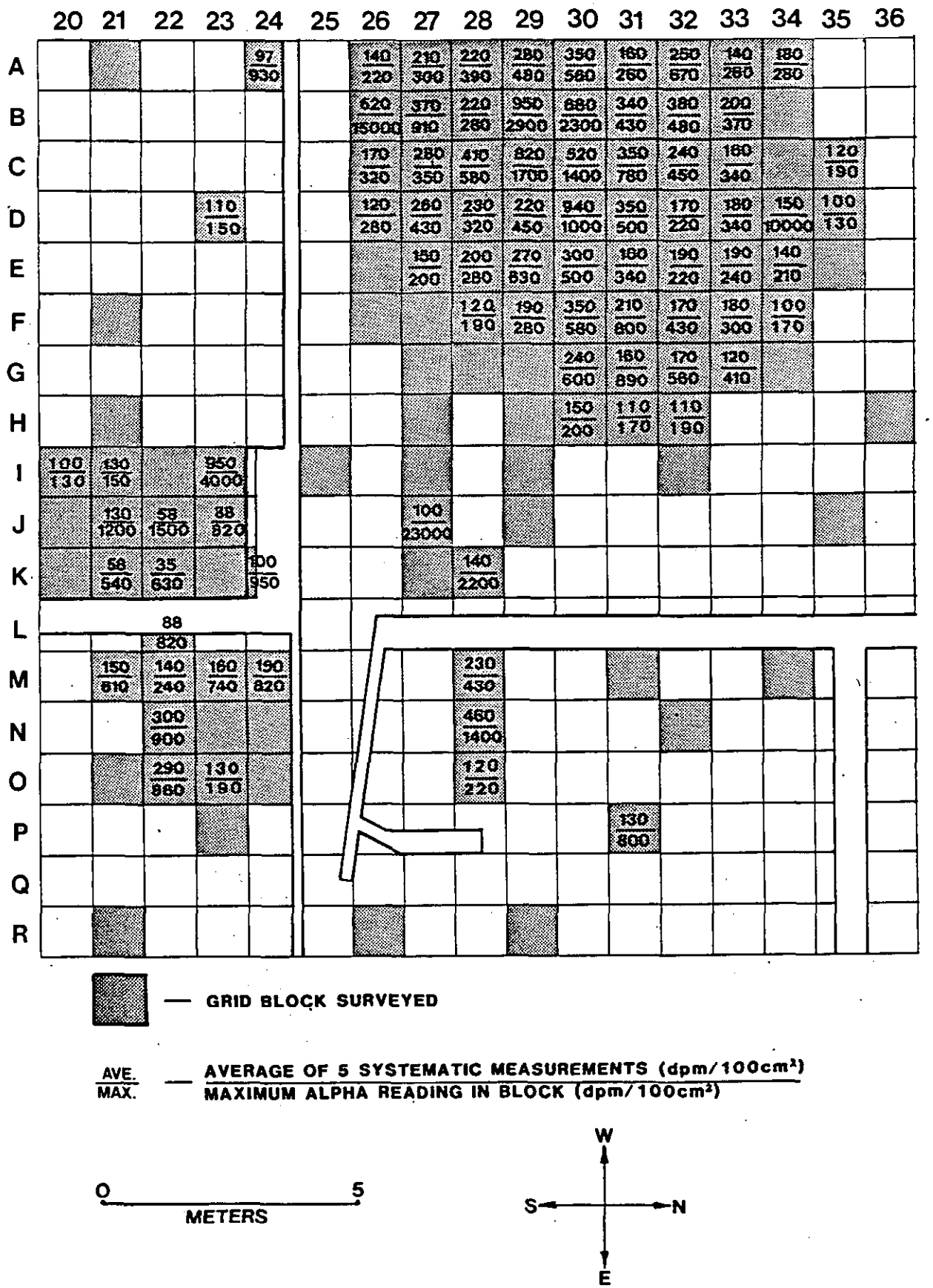

FIGURE 8: Main Laboratory Area Floor: Grid Blocks Identified to Exceed Release Criteria.

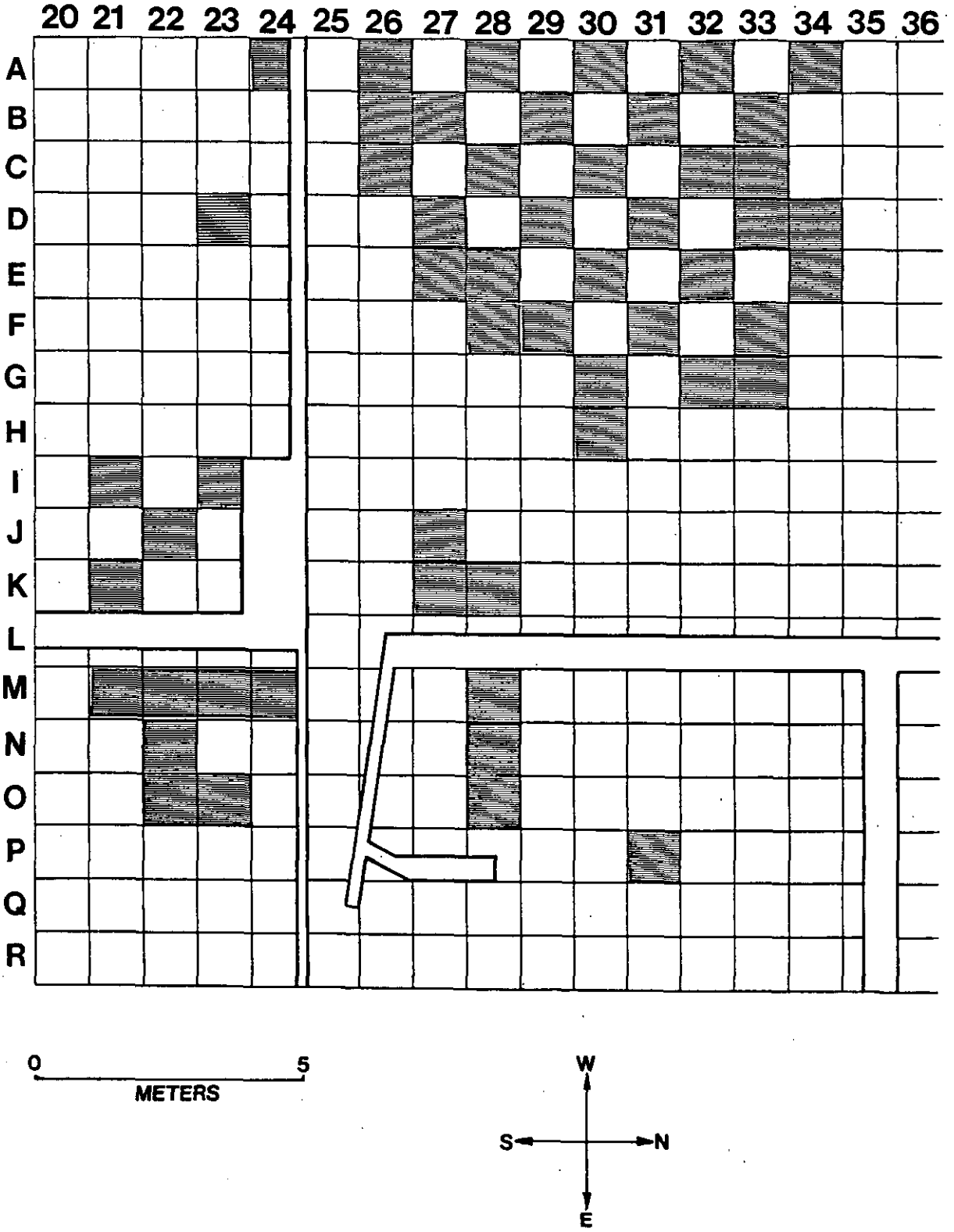

FIGURE 9: Main Laboratory Area Floor: Pattern of Grid Blocks Selected to Confirm Decontamination (all measurements were below release criteria).

TABLE 1

SUMMARY OF DIRECT MEASUREMENTS IN
AUXILLARY AREAS OF BUILDING 8

Room	Surface	No. of Measurements[a]	Total Alpha Contamination[b] (dpm/100 cm^2)	Removable Alpha Contamination (dpm/100 cm^2)
Office Area: Entry	Floor	18	<37 - 74	<2 - 4
	Walls	10	45 - 93	<2 - 3
	Ceiling	6	40 - 74	<2 - 3
Photocopy Room	Floor	7	<37	<2 - 3
	Walls	7	<37 - 56	<2
	Ceiling	2	46 - 56	<2 - 4
South Corridor	Walls	6	<37 - 93	<2 - 3
Hallway	Floor	12	<37	<2 - 3
	Walls	11	<37 - 74	<2 - 3
	Ceiling	10	<37 - 74	<2
Vending	Floor	5	<37	<2 - 4
	Walls	6	40 - 74	<2
	Ceiling	2	46 - 56	<2
Conference Room	Floor	13	<37 - 427[c]	<2 - 11
	Walls	12	<37	<2 - 3
	Ceiling	6	<37 - 74	<2
Lunch Room	Floor	12	<37	<2
	Walls	12	<37 - 93	<2
	Ceiling	6	<37 - 56	<2 - 3
Office Area B	Floor	18	<37 - 74	<2 - 4
	Walls	4	<37 - 93	<2
	Ceiling	6	<37 - 56	<2

TABLE 1, cont.

SUMMARY OF DIRECT MEASUREMENTS IN
AUXILLARY AREAS OF BUILDING 8

Room	Surface	No. of Measurements[a]	Total Alpha Contamination[b] (dpm/100 cm^2)	Removable Alpha Contamination (dpm/100 cm^2)
Office Area C	Floor	12	<37 - 56	<2 - 3
	Walls	12	42 - 74	<2
	Ceiling	6	<37	<2
Office Area D	Floor	6	<37 - 56	<2 - 6
	Walls	8	44 - 93	<2 - 3
Office Area Y	Floor	12	<37	<2 - 6
	Walls	12	40 - 74	<2 - 3
	Ceiling	6	50 - 111	<2 - 3
Men's Restroom	Floor	9	<37 - 56	<2 - 3
	Walls	10	59 - 111	<2 - 3
	Ceiling	3	<37 - 56	<2 - 3
Ladies Restroom	Floor	8	<37 - 74	<2 - 3
	Walls	10	61 - 111	<2 - 4
	Ceiling	2	<37	<2
Heating & Ventilation Utility Room	Floor	51	52 - 6900[c]	<2 - 6
	Walls	15	<37 - 111	<2
	Ceiling	4	<37 - 56	<2
Health Physics Room	Floor	6	<37 - 74	<2 - 3
	Walls	6	<37 - 74	<2
	Ceiling	4	<37 - 56	<2

TABLE 1, cont.

SUMMARY OF DIRECT MEASUREMENTS IN
AUXILLARY AREAS OF BUILDING 8

Room	Surface	No. of Measurements[a]	Total Alpha Contamination[b] (dpm/100 cm^2)	Removable Alpha Contamination (dpm/100 cm^2)
Contamination Control Point Hallway	Floor	10	<37 - 56	<2 - 3
	Walls	10	<37 - 56	<2 - 4
	Ceiling	5	<37	<2 - 3
Locker Room	Floor	22	51 - 186	<2 - 6
	Walls	12	71 - 130	<2
	Ceiling	2	<37 - 56	<2
Change Room	Floor	22	53 - 130	<2 - 3
	Walls	12	105 - 186	<2 - 4
	Ceiling	2	<37 - 56	<2
Shower Area	Floor	4	51 - 111	<2 - 3
	Walls	4	79 - 111	<2
	Ceiling	4	<37 - 56	<2 - 3
Toilet Area	Floor	6	40 - 74	<2 - 6
	Walls	8	74 - 130	<2
	Ceiling	4	<37 - 56	<2
Laundry Room	Floor	5	<37	<2 - 3
	Walls	6	<37 - 56	<2 - 16
	Ceiling	6	<37 - 56	<2
Controlled Access Area: Decon Room	Floor	1	74	<2
	Walls	6	<37 - 6790[c]	<2 - 250[b]
	Ceiling	2	<37 - 56	<2

TABLE 1, cont.

SUMMARY OF DIRECT MEASUREMENTS IN
AUXILLARY AREAS OF BUILDING 8

Room	Surface	No. of Measurements[a]	Total Alpha Contamination[b] (dpm/100 cm^2)	Removable Alpha Contamination (dpm/100 cm^2)
Controlled	Floors	1	56	<2
Access Area:	Walls	3	<37 - 56	<2
Janitors Closet	Ceiling	2	56 - 130	<2

[a] One measurement includes both total and removable alpha contamination measurements.
[b] The first value in this column represents the highest average of five systematic measurements performed in any individual grid block; the second value is the maximum single measurement obtained on the area or surface of interest. Where only one value is listed, it represents the average of systematic measurements on the surface and indicates that no isolated locations of elevated surface contamination were identified in this area.
[c] Measurement was in excess of release criteria, see Table 3.

TABLE 2

SUMMARY OF GRID BLOCK SURVEYS
ASSOCIATED WITH CONTROLLED ACCESS AREA

Room	Surface	No. of Blocks Measured	Blocks Exceeding Release Criteria[a]	Total Alpha[b] Contamination (dpm/100 cm^2)	Removable Alpha Contamination (dpm/100 cm^2)
Shipping & Receiving Area: Pit	Floor	2	0	<37 - 93	<2
	Walls	4	0	<37 - 74	<2
Shipping & Receiving Area	Floor	45	15	583 - 1650	<2 - 9
	Walls	24	1	71 - 1130	<2 - 10
	Ceiling	9	0	48 - 93	<2 - 3
Penthouse	Floor	65	3	204 - 1130	<2 - 4
	Walls	54	3	52 - 2810	<2
	Ceiling	22	1	52 - 353	<2 - 3
Controlled Access Area	Floor	228	81	947 - 23400	<2 - 47
	Walls	74	0	45 - 93	<2 - 6
	Ceiling	39	3	59 - 1520	<2 - 60
Controlled Access Area: Vault	Floor	2	0	<37 - 41	<2
	Walls	6	0	<37 - 41	<2 - 3
	Ceiing	2	0	<37	<2

[a] See Table 3 for areas exceeding release criteria.
[b] The first value in this column represents the highest average of five systematic measurements performed in any individual grid block; the second value is the maximum measurement obtained on the area or surface of interest. Where only one value is listed, it represents the average of systematic measurements on the surface and indicates that no isolated locations of elevated surface contamination were identified in this area.

TABLE 3

AREAS IDENTIFIED AS EXCEEDING RELEASE CRITERIA

Room	Surface	Grid Block	Before Decontamination			After Decontamination		
			Total Alpha (dpm/100 cm^2)		Removable Alpha (dpm/100 cm^2)	Total Alpha (dpm/100 cm^2)		Removable Alpha (dpm/100 cm^2)
			Average	Maximum		Average	Maximum	
Conference Room	Floor	K-2	a	336	11	<37	<37	<2
H&V Utility Room	Floor	J-8	<37	6,920	17	<37	<37	<2
Decon Room	South Wall	B-1	a	6,790	9	<37	<37	<2
Decon Room	East Wall	B-1	a	3,730	249	<37	37	<2
Penthouse	South Wall	D-5	a	928	<2	<37	<37	<1
Penthouse	West Wall	D-30	a	2,810	13	<37	<37	1
Penthouse	West Wall	D-54	<37	2,060	<2	<37	<37	<1
Penthouse	Floor	G-47	<37	3,550	<2	<37	<37	2
Penthouse	Floor	H-26	204	1,130	4	<37	<37	<1
Penthouse	Floor	E-32	a	935	a	56	56	2
Shipping & Recv.	East Wall	D-18	71	1130	<2	<37	56	<2
Shipping & Recv.	Floor	A-1	505	1300	3	b	b	<2
Shipping & Recv.	Floor	A-2	301	612	<2	<37	93	<2
Shipping & Recv.	Floor	A-3	583	1650	<2	<37	93	<2
Shipping & Recv.	Floor	A-4	152	300	<2	<37	93	3
Shipping & Recv.	Floor	A-5	193	464	<2	56	93	<2
Shipping & Recv.	Floor	A-6	200	371	<2	45	130	3
Shipping & Recv.	Floor	B-1	a	501	3	<37	74	4
Shipping & Recv.	Floor	B-2	115	371	<2	93	223	<2
Shipping & Recv.	Floor	B-5	152	223	4	<37	186	<2
Shipping & Recv.	Floor	B-6	115	260	<2	74	130	4
Shipping & Recv.	Floor	C-2	a	687	<2	96	204	<2
Shipping & Recv.	Floor	D-6	a	1490	<2	100	167	<2
Shipping & Recv.	Floor	E-14	93	1450	6	52	93	<2
Shipping & Recv.	Floor	J-5	111	204	7	<37	37	<2
Shipping & Recv.	Floor	K-2	126	278	3	67	148	<2

TABLE 3, cont.

AREAS IDENTIFIED AS EXCEEDING RELEASE CRITERIA

Room	Surface	Grid Block	Before Decontamination			After Decontamination		
			Total Alpha (dpm/100 cm^2)		Removable Alpha (dpm/100 cm^2)	Total Alpha (dpm/100 cm^2)		Removable Alpha (dpm/100 cm^2)
			Average	Maximum		Average	Maximum	
Main Lab. Area	Floor	A-24	97	928	13	<37	37	<2
Main Lab. Area	Floor	A-26	141	223	<2	<37	56	<2
Main Lab. Area	Floor	A-27	212	297	6	---c	---	---
Main Lab. Area	Floor	A-28	215	390	10	<37	93	<2
Main Lab. Area	Floor	A-29	278	483	6	---	---	---
Main Lab. Area	Floor	A-30	349	557	13	<37	167	3
Main Lab. Area	Floor	A-31	156	260	<2	---	---	---
Main Lab. Area	Floor	A-32	252	668	7	<37	<37	<2
Main Lab. Area	Floor	A-33	141	260	4	---	---	---
Main Lab. Area	Floor	A-34	175	278	7	<37	93	<2
Main Lab. Area	Floor	B-26	624	14800	4	<37	56	<2
Main Lab. Area	Floor	B-27	371	909	<2	<37	93	<2
Main Lab. Area	Floor	B-28	223	278	<2	---	---	---
Main Lab. Area	Floor	B-29	947	2880	47	<37	93	<2
Main Lab. Area	Floor	B-30	683	2260	47	---	---	---
Main Lab. Area	Floor	B-31	338	427	10	<37	56	<2
Main Lab. Area	Floor	B-32	379	483	14	---	---	---
Main Lab. Area	Floor	B-33	204	371	11	<37	56	<2
Main Lab. Area	Floor	B-37	130	204	<2	<37	56	<2
Main Lab. Area	Floor	C-26	171	316	<2	56	167	<2
Main Lab. Area	Floor	C-27	278	353	<2	---	---	---
Main Lab. Area	Floor	C-28	412	577	7	89	148	<2
Main Lab. Area	Floor	C-29	824	1690	17	---	---	---
Main Lab. Area	Floor	C-30	523	1380	4	<37	74	<2
Main Lab. Area	Floor	C-31	345	781	16	---	---	---
Main Lab. Area	Floor	C-32	241	446	6	56	74	<2
Main Lab. Area	Floor	C-33	160	335	6	89	111	<2

TABLE 3, cont.

AREAS IDENTIFIED AS EXCEEDING RELEASE CRITERIA

Room	Surface	Grid Block	Before Decontamination			After Decontamination		
			Total Alpha (dpm/100 cm^2) Average	Total Alpha (dpm/100 cm^2) Maximum	Removable Alpha (dpm/100 cm^2)	Total Alpha (dpm/100 cm^2) Average	Total Alpha (dpm/100 cm^2) Maximum	Removable Alpha (dpm/100 cm^2)
Main Lab. Area	Floor	C-35	115	186	<2	---	---	---
Main Lab. Area	Floor	D-23	108	149	<2	---	---	---
Main Lab. Area	Floor	D-26	119	279	<2	---	---	---
Main Lab. Area	Floor	D-27	264	428	<2	74	130	<2
Main Lab. Area	Floor	D-28	230	316	<2	---	---	---
Main Lab. Area	Floor	D-29	219	446	7	<37	93	<2
Main Lab. Area	Floor	D-30	935	1000	10	---	---	---
Main Lab. Area	Floor	D-31	345	502	7	59	167	<2
Main Lab. Area	Floor	D-32	171	223	7	---	---	---
Main Lab. Area	Floor	D-33	178	335	6	45	148	<2
Main Lab. Area	Floor	D-34	152	10000	4	100	167	<2
Main Lab. Area	Floor	D-35	100	130	<2	---	---	---
Main Lab. Area	Floor	E-27	152	205	<2	<37	37	3
Main Lab. Area	Floor	E-28	197	279	4	<37	56	<2
Main Lab. Area	Floor	E-29	267	632	<2	---	---	---
Main Lab. Area	Floor	E-30	301	502	7	45	74	<2
Main Lab. Area	Floor	E-31	156	335	<2	---	---	---
Main Lab. Area	Floor	E-32	189	223	7	62	93	<2
Main Lab. Area	Floor	E-33	189	242	<2	74	---	---
Main Lab. Area	Floor	E-34	141	205	<2	52	111	<2
Main Lab. Area	Floor	F-28	119	186	<2	---	130	<2
Main Lab. Area	Floor	F-29	189	279	<2	<37	93	<2
Main Lab. Area	Floor	F-30	353	577	<2	---	---	---
Main Lab. Area	Floor	F-31	208	800	<2	<37	56	<2
Main Lab. Area	Floor	F-32	168	428	4	---	---	---
Main Lab. Area	Floor	F-33	182	298	4	<37	93	<2
Main Lab. Area	Floor	F-34	104	167	4	---	---	---
Main Lab. Area	Floor	G-30	238	595	<2	41	130	<2

TABLE 3, cont.

AREAS IDENTIFIED AS EXCEEDING RELEASE CRITERIA

Room	Surface	Grid Block	Before Decontamination: Total Alpha (dpm/100 cm^2) Average	Before Decontamination: Total Alpha (dpm/100 cm^2) Maximum	Before Decontamination: Removable Alpha (dpm/100 cm^2)	After Decontamination: Total Alpha (dpm/100 cm^2) Average	After Decontamination: Total Alpha (dpm/100 cm^2) Maximum	After Decontamination: Removable Alpha (dpm/100 cm^2)
Main Lab. Area	Floor	G-31	160	893	<2	---	---	---
Main Lab. Area	Floor	G-32	167	558	4	56	130	<2
Main Lab. Area	Floor	G-33	119	409	<2	59	56	<2
Main Lab. Area	Floor	H-13	41	707	<2	41	74	<2
Main Lab. Area	Floor	H-30	149	205	<2	<37	56	<2
Main Lab. Area	Floor	H-31	111	167	<2	---	---	---
Main Lab. Area	Floor	H-32	108	186	<2	---	---	---
Main Lab. Area	Floor	I-20	100	130	<2	---	---	---
Main Lab. Area	Floor	I-21	134	149	<2	48	93	<2
Main Lab. Area	Floor	I-23	954	4000	<2	<37	74	<2
Main Lab. Area	Floor	J-21	130	1210	a	---	---	---
Main Lab. Area	Floor	J-22	58	1451	<2	56	74	<2
Main Lab. Area	Floor	J-23	88	818	<2	---	---	---
Main Lab. Area	Floor	J-27	100	23400	136	48	74	<2
Main Lab. Area	Floor	K-21	58	539	<2	<37	37	<2
Main Lab. Area	Floor	K-22	35	632	<2	---	---	---
Main Lab. Area	Floor	K-23	102	949	<2	<37	56	<2
Main Lab. Area	Floor	K-28	141	2210	<2	82	130	<2
Main Lab. Area	Floor	L-9	<37	800	<2	<37	<37	<2
Main Lab. Area	Floor	L-22	88	818	<2	---	---	---
Main Lab. Area	Floor	M-21	145	614	6	<37	56	<2
Main Lab. Area	Floor	M-22	140	241	<2	---	---	---
Main Lab. Area	Floor	M-23	156	744	<2	<37	37	<2
Main Lab. Area	Floor	M-24	152	818	<2	<37	56	<2
Main Lab. Area	Floor	M-28	275	428	<2	<37	37	<2
Main Lab. Area	Floor	M-46	89	670	6	<37	74	3
Main Lab. Area	Floor	N-22	293	893	<2	<37	37	<2
Main Lab. Area	Floor	N-28	460	1380	11	<37	74	<2

TABLE 3, cont.

AREAS IDENTIFIED AS EXCEEDING RELEASE CRITERIA

Room	Surface	Grid Block	Before Decontamination			After Decontamination		
			Total Alpha (dpm/100 cm^2) Average	Maximum	Removable Alpha (dpm/100 cm^2)	Total Alpha (dpm/100 cm^2) Average	Maximum	Removable Alpha (dpm/100 cm^2)
Main Lab. Area	Floor	N-45	149	409	a	45	56	<2
Main Lab. Area	Floor	N-71	100	484	4	52	130	3
Main Lab. Area	Floor	O-7	<37	2270	381	<37	37	<2
Main Lab. Area	Floor	O-22	286	856	<2	<37	37	<2
Main Lab. Area	Floor	O-23	130	186	<2	<37	56	<2
Main Lab. Area	Floor	O-28	119	223	<2	85	130	<2
Main Lab. Area	Floor	P-6	<37	10,300	671	<37	56	<2
Main Lab. Area	Floor	P-31	134	800	<2	82	148	<2
Main Lab. Area	Stairway	N/A	a	687	<2	<37	111	<2

[a] Measurement was not necessary to demonstrate that guidelines were exceeded.

[b] Direct measurement was not obtained; scanning indicated no evidence of contamination in excess of guidelines.

[c] Dash indicates that the grid block was not resurveyed; statistical resurvey of adjacent grid blocks demonstrated compliance with release guidelines.

TABLE 4

RADIONUCLIDE CONCENTRATIONS IN SOIL COLLECTED FROM EXCAVATED AREAS OF BUILDING 8

Location No.	Radionuclide Concentrations (pCi/g)[a]			
	Gross Alpha	Am-241	Pu-238	Pu-239/240
1[b]	24[c]	0.78 ± 0.77		
2	17	<0.31		
3	21	0.43 ± 0.39		
4	19	0.63 ± 0.43	0.10 ± 0.11[d]	0.16 ± 0.14[d]
5	2	<0.27		
6	15	<0.31		
7	18	<0.25		
8	18	<0.46		
9	22	<0.47		
10	22	<0.33	<0.22	<0.22
11	18	<0.30		
12	19	<0.29		
13	21	1.09 ± 0.90		
14	21	<0.40		
15	19	<0.25	0.14 ± 0.06	0.17 ± 0.07
16	17	<0.45		
17	22	<0.36		
18	24	<0.32		
19	14	<0.26		
20	16	0.71 ± 0.97	0.03 ± 0.05	0.08 ± 0.09
21	18	0.83 ± 0.74		
22	16	<0.26		
23	21	<0.20		
24	19	<0.05		
25	24	0.66 ± 0.94	0.05 ± 0.02	0.10 ± 0.03
26	14	<0.27		
27	24	0.74 ± 0.43		
28	18	1.30 ± 0.20		
29	16	0.87 ± 0.81	0.28 ± 0.10	0.19 ± 0.08
30	19	<0.27		
31	16	<0.23		
32	10	<0.43		
33	19	0.62 ± 0.59		
34	23	<0.27		
35	14	<0.27	0.08 ± 0.04	0.24 ± 0.07
36	18	<0.04		
37	19	0.81 ± 0.83		

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SOIL COLLECTED FROM EXCAVATED AREAS OF BUILDING 8

Location No.	Radionuclide Concentrations (pCi/g)			
	Gross Alpha	Am-241	Pu-238	Pu-239/240
38	15	<0.25	<0.02	<0.02
39	19	<0.17		
40	14	0.06 ± 0.07		
41	24	0.30 ± 0.067	0.07 ± 0.03	0.04 ± 0.02
42	13	<0.20		
43	18	<0.19		
44	18	<0.04	0.06 ± 0.03	0.10 ± 0.04
45	4	1.20 ± 0.60		
46	13	<0.25		
47	14	<0.16	0.04 ± 0.03	0.04 ± 0.03
48	13	<0.04		
49	12	0.56 ± 0.66		
50	11	<0.22	0.28 ± 0.11	0.28 ± 0.11
51	19	0.60 ± 0.39		
52	18	0.11 ± 0.11		
53	13	0.64 ± 0.54		

[a] Concentrations for uranium radioisotopes are not listed, nearly all results were below detectable quantities.
[b] Refer to Figure 4.
[c] MDA for gross alpha analysis is: 2.1 pCi/g.
[d] Plutonium analysis was conducted on composites of soil sample groups, therefore, concentrations are reported for alpha spectroscopy results on the composited sample containing equal quantities of soil from each location.
[e] Errors are 2σ, based on counting statistics.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL COLLECTED
FROM FLOOR CORING IN BUILDING 8

Location No.	Radionuclide Concentrations (pCi/g)[a]			
	Gross Alpha	Am-241	Pu-238	Pu-239/240
1[b]	33[c]	6.78 ± 0.45[d]	2.6 ± 0.1	2.7 ± 0.1
2	7	<0.04		
3	7	<0.11	0.16 ± 0.03[e]	0.20 ± 0.04[e]
4	17	0.23 ± 0.07		

[a] Concentrations for uranium radioisotopes are not listed, nearly all results were below detectable quantities.
[b] See Figures 5 and 6.
[c] MDA for gross alpha analysis is 2.1 pCi/g.
[d] Errors are 2σ based on counting statistics.
[e] Plutonium analysis was conducted on composites of soil samples 2, 3, and 4; therefore, concentrations are reported for alpha spectroscopy results on the composited sample containing equal quantities of soil from each location.

APPENDIX A

MAJOR ANALYTICAL EQUIPMENT

APPENDIX A

Major Analytical Equipment

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

A. Direct Radiation Measurements

Eberline "RASCAL"
Portable Scaler/Ratemeter
Model PRS-1
(Eberline, Sante Fe, NM)

Eberline PRM-6
Portable Ratemeter
(Eberline, Sante Fe, NM)

Ludlum Floor Monitor
Model 239-1
(Ludlum, Sweetwater, TX)

Eberline Alpha Scintillation Probe
Models AC-3-7
(Eberline, Sante Fe, NM)

Eberline Low-Energy Gamma Scintillation Probe
Model PG-2
(Eberline, Sante Fe, NM)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

B. Laboratory Analyses

Low Background Alpha-Beta Counter
Model LB5100-2080
(Tennelec, Inc., Oak Ridge, TN)

Ge(Li)Detectors (2)
Model LGCC2220SD, 23% efficency
(Princeton Gamma-Tech, Princeton, NJ)

Used in Conjunction with:
Lead Shield, SPG-16
(Applied Physical Technology, Smyrna, GA)

High-Purity Germanium Detector
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield, G-16
(Gamma Products Inc., Palos Hills, IL)

Pulse Height Analyzer, ND680
Model 88-0629
(Nuclear Data, Inc., Schaumburg, IL)

Alpha Spectrometer
Tennelec TC-256
(Tennelec Inc., Oak Ridge, TN)

Surface Barrier Detector
Model CR-25-450-100
(EG&G ORTEC, Oak Ridge, TN)

APPENDIX B

ANALYTICAL PROCEDURES

Appendix B

Analytical Procedures

Alpha Measurements

Measurements of direct alpha radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeter with Model AC-3-7 ZnS alpha scintillation probes. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for active area of the detector. Effective window area is 59 cm^2 for the ZnS probes. Background count rates for the ZnS alpha probes averaged approximately 1 cpm; however, a conservative value of 0 cpm was employed for the calculations. Using this technique, the count rates recorded by the detector are converted to contamination levels as if the distribution was constant over a 100 cm^2 area. This conservatively overestimates disintegration rates for small areas.

Surface Scans

Surface scans of grid blocks were performed by passing the probe slowly (20-30 cm/s) over the surface. The distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Alpha scans of large surface areas on the floor were accomplished by use of a gas proportional alpha floor monitor, with 600 cm^2 sensitive area. The instrument is slowly moved in a systematic pattern to cover 100% of the accessible area. Combinations of detectors and instruments for the scans were:

Low-Energy Gamma - Thin-window NaI scintillation detector with PRM-6 ratemeter

Alpha - ZnS probe with "Rascal" scaler/ratemeter

Alpha - Gas proportional floor monitor with PRM-6 ratemeter and headphones.

Gamma Exposure Rate

Measurements of gamma exposure rates were performed using a Reuter-Stokes pressurized ionization chamber. The chamber was placed at 1 m above the floor at various locations throughout the facility and the average of several readings was determined at each location.

Transferable Contamination Measurements

Smear measurements were performed on numbered filter paper disks, 47 mm in diameter. Each smear was sealed in an labeled envelope with the location and other pertinent information recorded. A low-background alpha-beta counting system was used to count individual smears.

Soil and Residue Sample Analysis

Samples were dried at 120° C, finely ground, mixed, and a portion placed in a 0.5 liter Marinelli beaker. The quantity placed in each beaker was chosen to reproduce the calibrated counting geometry and typically ranged from 500 to 800 g of soil. Net weights were determined and the samples counted using either Ge(Li) or high purity germanium detectors coupled to a Nuclear Data Model ND 680 pulse height analyzer. The following energy peaks were used for determination of the radionuclides of concern:

Am-241 - 0.060 MeV
U-235 - 0.143 MeV
U-238 - 1.001 MeV from Pa-234m (secular equilibrium assumed)

Peak identification and calculations of concentrations, statistical errors, and detection sensitivities were performed by the computer capabilities inherent in the analyzer system.

Finely ground soil samples were analyzed by a gross alpha technique to provide screening prior to plutonium analysis by alpha spectroscopy. Those samples indicating gross alpha concentrations, significantly above normal background, were analyzed for specific alpha emitting radionuclides individually, otherwise samples were composited for further analysis.

Alpha spectroscopy was performed on composites of the prepared samples to identify plutonium radioisotopes. Samples were dissolved utilizing nitric-hydrofluoric acid digestion and plutonium was eluted by an anion exchange process. The residue was electrodeposited on stainless steel discs and subsequently counted. Relative quantities and yields were determined by the use of plutonium 242 as a tracer. Surface barrier detectors coupled to a Nuclear Data Model ND 680 pulse height analyzer enabled identification of the characteristic alpha energy peaks and activity determination.

Errors and Detection Limits

The errors associated with the analytical data presented in the tables of this report, represent the 95% (2σ) confidence levels for that data. These errors were calculated, based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 2σ statistical deviation of the background count, the sample concentration was reported as less than the minimum detectable activity (<MDA). This means that the radionuclide was not present, to the best of our ability to measure it, utilizing the analytical techniques described in this appendix. Because of variation in background levels, caused by other constituants in the samples, the MDAs for specific radionuclides differ from sample to sample.

Calibration and Quality Assurance

Portable survey equipment and laboratory and analytical instruments were calibrated using NBS-traceable standards. Standardization of the gross-alpha-in-soil technique was accomplished by the use of NBS-traceable soil standards. Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BY-PRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Divison of Fuel Cycle & Material Safety
Washington, D.C. 20555

July 1982

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of

the survey report shall be filed with the Division of Fuel Cycle and Material Safety, USNRC, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223 Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

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

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

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.