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Results of the Final Status Radiological Survey at Building K-1006, East Tennessee Technology Park, Oak Ridge, Tennessee

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K. S. Brown

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LIFE SCIENCES DIVISION

Materials and Chemistry Laboratory-Midwest Research Institute, Inc. (MCL-MRI)

Results of the Final Status Radiological Survey at Building K-1006, East Tennessee Technology Park, Oak Ridge, Tennessee

S. P. McKenzie and K. S. Brown

Report Issued - September 1999

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Survey Team Members

S. P. McKenzie R. E. Rodriguez

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
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ABSTRACT

Building K-1006 is owned by the Department of Energy and leased, in part, by Materials and Chemistry Laboratory-Midwest Research Institute, Inc. (MCL-MRI) as part of the privatization of the former K-25 Site. The leasing agreement was contingent upon decontamination or removal of analytical exhaust hoods in six rooms on the ground floor of the building. Five hoods were removed and four were decontaminated.

At the request of the Department of Energy, the Measurement Applications and Development (MAD) Group from Oak Ridge National Laboratory (ORNL) conducted a radiological final status survey of the locations of the nine hoods in April 1999 to thoroughly survey all accessible areas on and surrounding the hoods and along removal routes, and to comply with DOE requirements for assessment of properties prior to release for unrestricted use. Such release can only be granted if the property is found to be within applicable authorized limits as defined by DOE Order 5400.5.

Surface beta-gamma radiation levels exceeded guideline levels in two locations, based on an assumed instrument efficiency for technetium-99, and in a total of four locations in two rooms, based on an assumed instrument efficiency for uranium-238. Although the uranium radiation levels are located in fairly inaccessible areas, those levels coupled with the high levels of technetium-99, and the potential for future contamination from modifications of currently inaccessible surfaces may make further decontamination efforts necessary for free release.

Even though no contamination significantly different from background was found on two hoods and in two hood locations, and contamination below guidelines was found in one hood location, none of the hoods can be assumed to be below free release guidelines following the survey. There are numerous panels and exhaust ducts that could contain contamination above guidelines that were inaccessible during this survey. The survey did, however, encompass all areas of the hoods normally accessible by workers during normal operations. Recommendations for future use are given in the conclusions of the report.

Results of the Final Status Radiological Survey at Building K-1006, East Tennessee Technology Park, Oak Ridge, Tennessee*

INTRODUCTION

Building K-1006 was constructed in 1960 and, as originally built, was a single-story structure with approximate dimensions of 120 feet wide by 150 feet long. The building now contains five hallways A through E. Building K-1006 was constructed as a laboratory facility and continues to function as such. It also contains offices and administrative spaces for laboratory personnel. The building contains several laboratories and support offices that historically provided research and development support to East Tennessee Technology Park environmental, health and safety; to the Toxic Substances Control Act incinerator; to the Central Neutralization Facility; and other multi-site waste treatment activities. It also served as the chemistry laboratory for Environmental Technology Technical Services Organization.[1]

Building K-1006 is owned by the Department of Energy and leased, in part, by Materials and Chemistry Laboratory-Midwest Research Institute, Inc. (MCL-MRI) as part of the privatization of the former K-25 Site. The leasing agreement was contingent upon decontamination and/or removal of analytical exhaust hoods in six rooms on the ground floor of the building, based on detection of the following contaminants of concern: depleted uranium (DU), technetium-99 (Tc-99), and thorium-232. Analytical hoods that had been previously posted as radiologically contaminated by DOE K-25 Health Physics Technical Services were addressed during these actions. The remedial activities resulting from these surveys included decontamination of four hoods and removal of five hoods based on the potential for routine accessibility by workers. Decontamination and removal of hoods was conducted by IT under the direction of MCL-MRI.[1] Figures 1 through 8 are views of chemical exhaust hoods or former locations of hoods.

At the request of the Department of Energy, the Measurement Applications and Development (MAD) Group from Oak Ridge National Laboratory (ORNL) conducted a radiological final status survey of the locations of the nine hoods in April 1999 to thoroughly survey all accessible areas on and surrounding the hoods and along removal routes, and to comply with DOE requirements for assessment of properties prior to release for unrestricted use. Such release can only be granted if the property is found to be within current applicable authorized limits as defined by DOE Order 5400.5.**

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*The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division at Oak Ridge National Laboratory.

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

SURVEY OBJECTIVES

The objectives of the survey were to confirm (1) that the previous survey adequately described the radiological status of the areas adjacent to the hoods in the rooms after the hoods were decontaminated or removed, and (2) that the remedial action reduced contamination levels to within authorized limits prior to release for uncontrolled use. Applicable DOE guidelines for protection against radiation are shown in Table 1.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Total residual surface contamination[a]	^{238}U, ^{235}U, U-natural (alpha emitters)	
	or	
	Beta-gamma emitters[b]	
	Maximum	15,000 dpm/100 cm^2
	Average	5,000 dpm/100 cm^2
	Removable	1,000 dpm/100 cm^2

[a]Averaged over 1 m^2. DOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material,* May 1987.

[b]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{129}I, ^{126}I, ^{125}I.

Sources: Adapted from U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990.

SURVEY METHODS

A comprehensive description of the methods and instrumentation used in this survey is given in *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[2]

The final status radiological survey included the following:

- a scan for alpha and beta-gamma contamination in accessible areas from the floor to the top of each remaining hood, the floor at former locations of hoods, an area of 3-5 feet around each hood location and the routes by which hoods were removed, including the loading dock. The two hoods in Room C-108 were formerly located back to back.

- timed counts for alpha and beta-gamma contamination.
- collection of smears from inner and outer areas of each hood for evaluation of alpha contamination.
- collection of a smear and concrete sample from Room B-108 for radiochemical analysis.

Gamma radiation levels were determined using a portable sodium iodide (NaI) gamma scintillation probe connected to a Victoreen Model 490 Thyac III ratemeter. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute are normalized to pressurized ionization chamber measurements to estimate gamma exposure rates in microroentgen per hour (μR/h).

Bicron miniscaler/ratemeters with Geiger-Mueller (GM) pancake detectors were used to detect beta-gamma radiation. Radiation levels in counts per minute (cpm) were converted to disintegrations per minute (dpm) per 100 cm^2.

Floors were surveyed for alpha and beta contamination with the Ludlum Model 239-1F gas flow proportional detector system ("floor monitor"), which includes a Ludlum Model 2221 scaler/ratemeter connected to a Ludlum Model 43-37 detector probe mounted on a roll-around cart. The floors were surveyed twice with the floor monitor; once in the beta mode and once in the alpha mode.

Alpha contamination levels were measured with Bicron scaler/ratemeters connected to zinc sulfide scintillation probes. Smear samples were obtained by wiping selected surfaces in order to assess removable alpha and beta-gamma activity levels. Smears were counted using a gross alpha smear counter and a gross beta smear counter. The concrete sample and a smear were analyzed for technetium-99.

SURVEY RESULTS

DOE guidelines are summarized in Table 1. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Table 2 is a list of identification numbers for remaining hoods. Table 3 shows the conversion factors for the pancake detector for Tc-99 and U-238. An area factor of 6 is applied for areas larger than the pancake probe size, and an area factor of 1 is applied for areas smaller than the probe size. Table 4 is a summary of survey results for each hood or limited area of a room that was surveyed. Appendix A is a collection of survey maps/data sheets.

Radiation Levels

An efficiency of 10% is assumed for technetium-99 for the pancake detector (see Table 3). This is a lab-based conversion factor that is consistent with DOE implementation guidelines. The actual efficiency may be higher or lower due to surface texture, paint, shielding, etc. This efficiency is only applicable to radiation levels from two locations in Room B-108, where technetium contamination is suspected. These levels exceeded the DOE guideline for surface contamination in two locations (see Table 4). An efficiency of 20% is assumed for uranium-238 in the other locations (see Table 3). Contamination levels in a total of four locations in two rooms in the building exceeded the applicable guideline for uranium (see Table 4).

Smears and Samples

Chemical analysis of the concrete sample and a smear indicated the presence of technetium-99. Other smears did not show contamination in excess of applicable guidelines.

CONCLUSIONS

This independent radiological final status survey was performed to verify that the remedial action had reduced contamination levels to within authorized limits. Surface beta-gamma radiation levels exceeded guideline levels in two locations, based on an assumed instrument efficiency for technetium-99, and in a total of four locations in two rooms based on an assumed instrument efficiency for uranium-238. Although the uranium radiation levels are located in fairly inaccessible areas, those levels coupled with the high levels of technetium-99, and the potential for future contamination from modifications of currently inaccessible surfaces may make further decontamination efforts necessary for free release (see Table 4).

Even though no contamination significantly different from background was found on two hoods and in two hood locations, and contamination below guidelines was found in one hood location, none of the hoods can be assumed to be below free release guidelines following the survey. There are numerous panels and exhaust ducts that could contain contamination above guidelines that were inaccessible during this survey. The survey did, however, encompass all areas of the hoods normally accessible by workers during normal operations. It is recommended that radiological controls be implemented prior to service and maintenance activities on the two contaminated hoods in Room B-102. It is also recommended that the following locations be decontaminated and surveyed again:

- Room B-102, Hood 1, drain panel;
- Room B-102, Hood 2, metal lip; and
- Room B-108, former Hood 1 location.

REFERENCES

1. *Decontamination and Removal of Radiologically-Contaminated Analytical Laboratory Hoods for Building K1006, Oak Ridge, Tennessee,* IT Corporation, February 1999.

2. *Measurement Applications and Development Group Guidelines,* ORNL-6782, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., January 1995.

Table 2. Hood identification numbers

Location	DOE Number	Property Number	Inspection Number
B-102, east wall	X156668	X-81576	ND
B-102, west wall	ND	249674	49-0509
B-104	ND	249678	49-0510
D-101	K308888	249726	49-0502

Table 3. Instrument conversion factors[a]

Nuclide	E, Detector Efficiency, cpm/dpm		A, Area factor		Conversion Factors, cpm to dpm/100 cm^2	
	Range	Used	Area < probe size, A_1	Area > probe size, A_2	Spot A_1/E	Area A_2/E
Tc-99	0.05 - 0.2	0.1	1	6	10	60
U-238	0.05 -0.3	0.2	1	6	5	30

[a]Contamination level (dpm/100 cm^2) = CPM minus background times conversion factor. CPM = Gross count rate, background = 50 cpm.

Table 4. Data from K-1006 survey

Item Number	Location	Radiation Levels (dpm/100 cm^2)[a,b]	Above Guidelines?	Comments
1	Room B-102, Hood 1, drain panel	3,000	Unknown	Underneath metal plate (drain cut off underneath). Not thoroughly surveyed, some not accessible. Actual radiation levels may be higher
2	Room B-102, Hood 1 behind upper panel	360,000	Yes	Entire length of metal on back panel
3	Room B-102, Hood 2, metal lip	40,000	Yes	North end of lip, contamination beneath hood floor under lip
4	Room B-102, Hood 2, lower hood panel	—	No	Suspected contamination, elevated readings south end, difficult to access
5	Room B-104, Hood	<1,200	No	
6	Room B-108, Former Hood 1 location along baseboard	15,000-45,000	Yes	North wall (near west wall), possible ^{99}Tc contamination
7	Room B-108, Former Hood 1 location, floor northeast corner	32,000-42,000	Yes	Under former hood, possible ^{99}Tc contamination
8	Room B-108, Former Hood 2 location along baseboard	15,000-40,000	Yes	East wall
9	Room B-108, Former Hood 2 location, floor northwest corner	42,000	Yes	Contamination. Highest count approximately 750 cpm/100 cm^2
10	Room C-108, Former hood locations	<600	No	All locations
11	Room D-101, Hood	<600	No	All locations

Table 4 (continued)

Item Number	Location	Radiation Levels (dpm/100 cm^2)[a,b]	Above Guidelines?	Comments
12	Room D-105, Approx. 1 m from south wall (west wall)	2300 alpha	No	Instrument efficiency 13.2%
13	Room D-105, West wall	<MDA[c]	No	Smear
14	Room D-105, Former hood location	<MDA[c]	No	Smear
15	Room D-105, Path to door	<MDA[c]	No	Smear

[a]Radiation levels are for beta-gamma contamination unless otherwise noted.
[b]An instrument efficiency for ^{99}Tc is assumed for Room B-108. An instrument efficiency for ^{238}U is assumed for other rooms.
[c]MDA is minimum detectable activity for removable alpha and beta radiation levels.

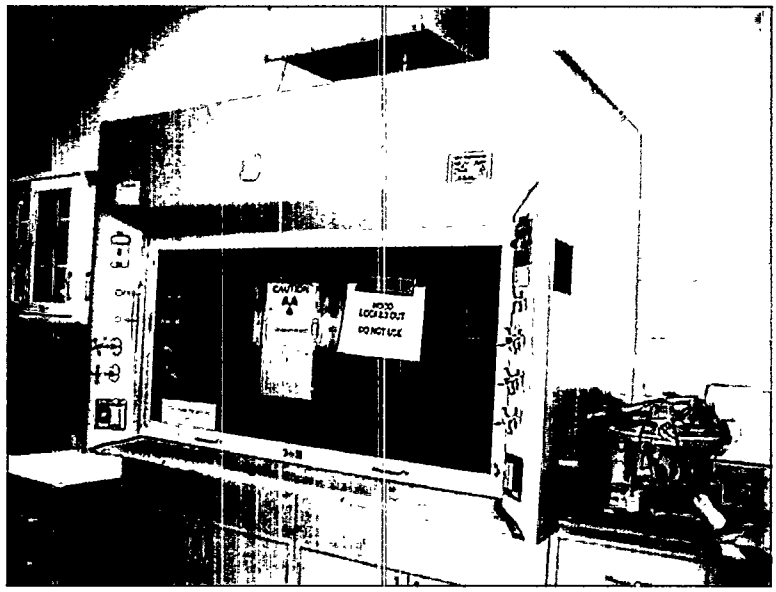


Fig. 1. View of hood in Room B-102, west wall.

Fig. 2. View of hood in Room B-102, east wall.

Fig. 3. View of hood in Room B-104.

Fig. 4. Former location of hood in Room B-108, east wall.

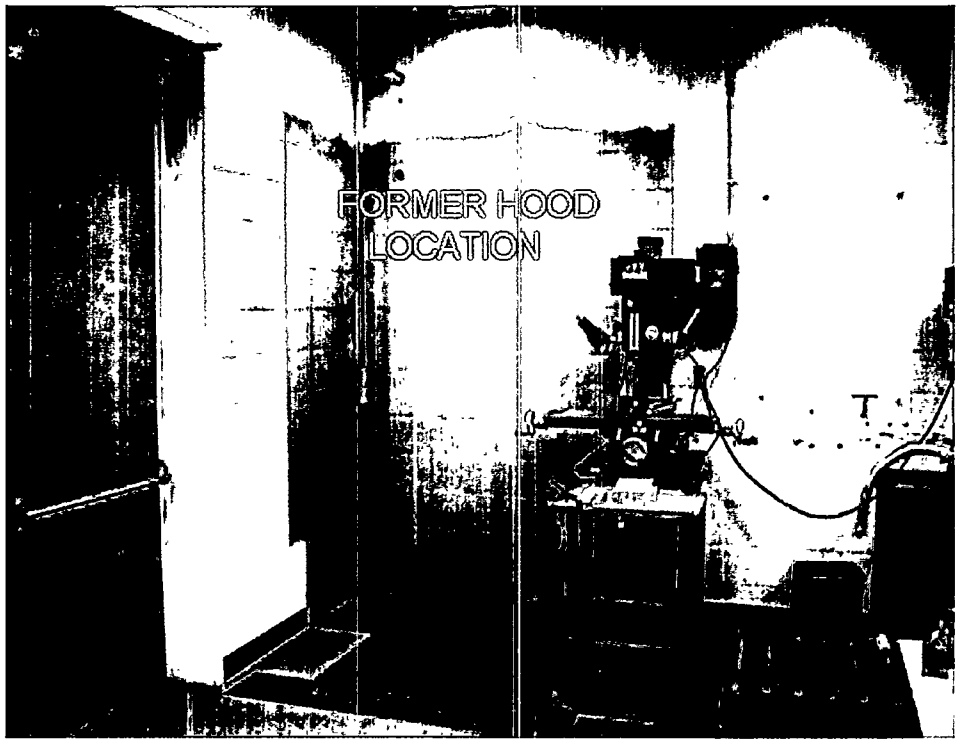


Fig. 5. Former location of hood in Room B-108, northwest corner of room.

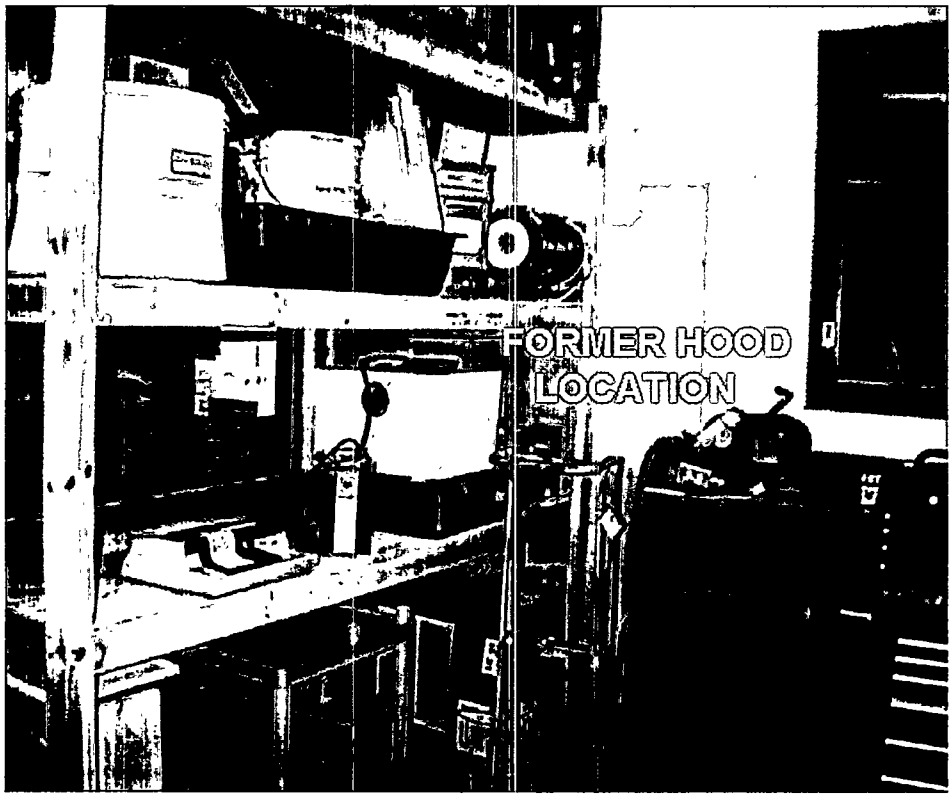


Fig. 6. Former location of two hoods in Room C-108, north view.

Fig. 7. Former location of two hoods in Room C-108, south view.

Fig. 8. View of hood in Room D-101, south wall.

APPENDIX A

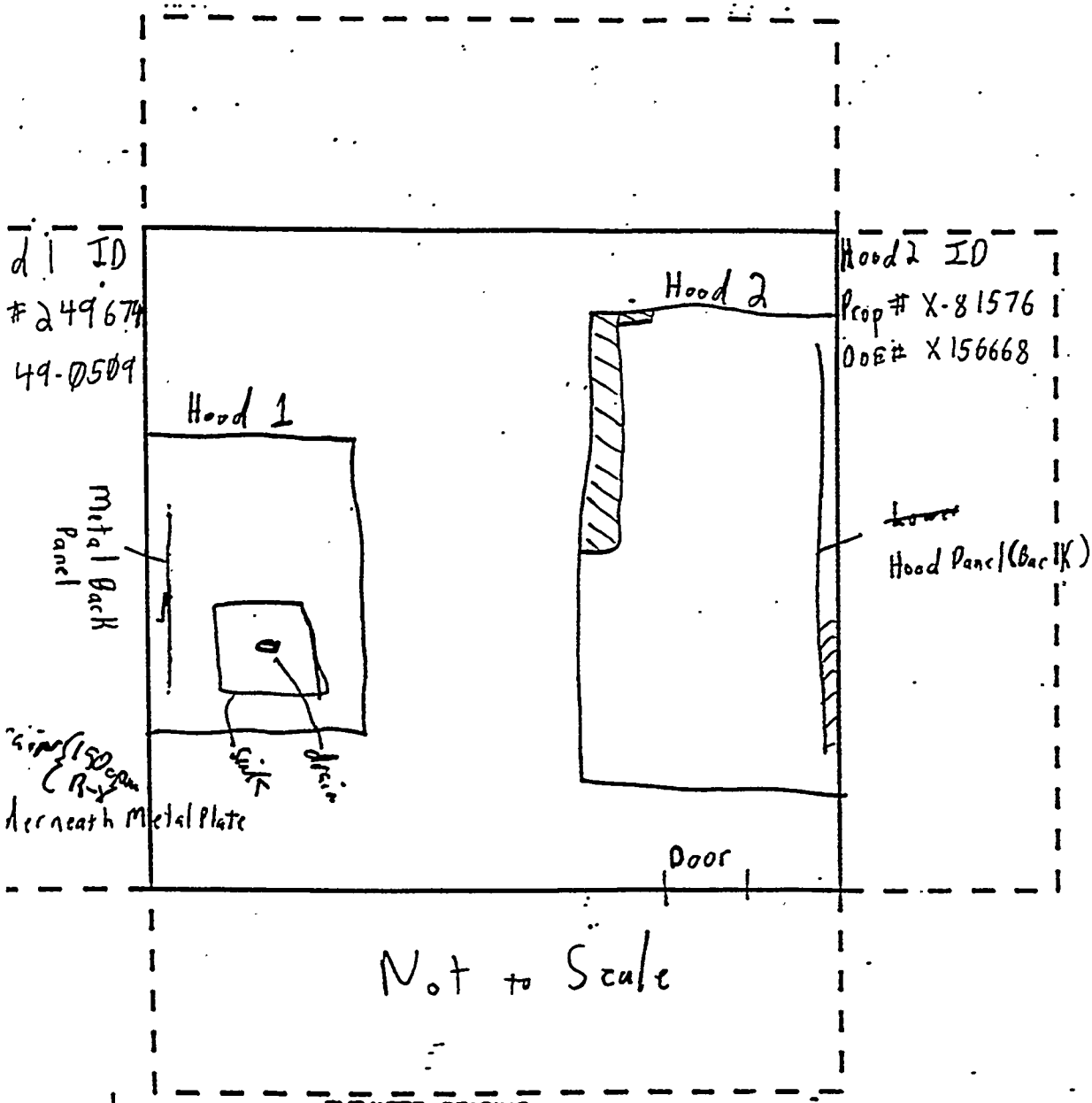
SURVEY MAPS/FIELD DATA

AREA SCAN AND RADIATION LEVEL SURVEY

SITE: ETTP K1006 INSTRUMENT: 3490-07S 11P90

DATE: 4/16/99 ROOM: B102

SURVEYOR(S): RER, SPM



ELEVATED READING

GRID LOCATION	cpm	COMMENTS
Hood 1 Drain	150 BY	Underneath Metal Plate (Drain cut off underneath)
" Behind Upper Band ~~Sash~~	12K Hot Spot	Runs entire length of ~~Sash (Metal~~ Metal Back.
Hood 2 - Hood Lip (Metal)	1.3K " "	North End of Lip Contam. underneath Floor of Hood (under Lip)
" " Lower Hood Panel		Suspect Contam. Elev. readings South End. Difficult to access

REMARKS:

CALCULATIONS BY: REVIEWED BY:

DATE: DATE:

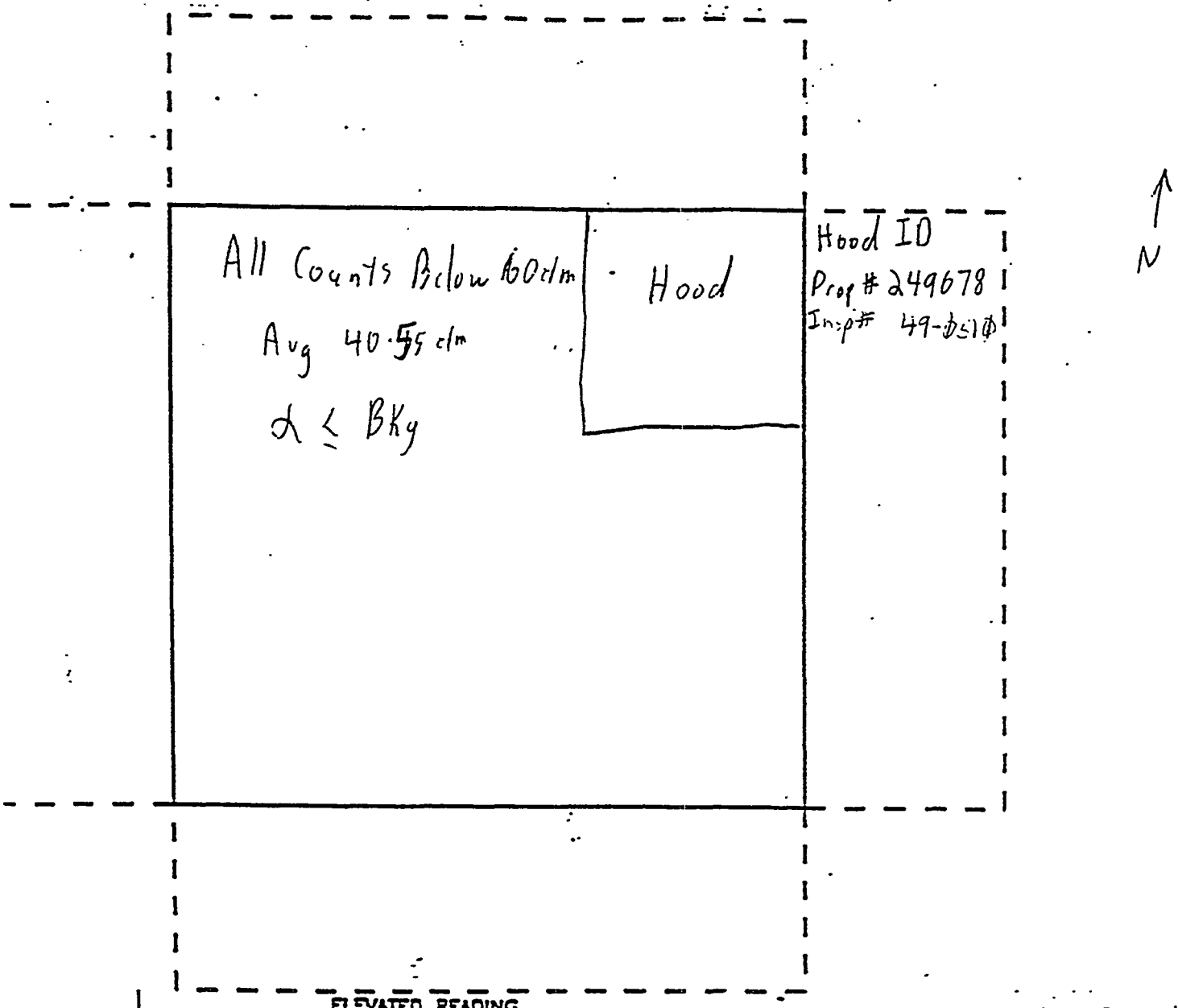
FORM14a(10-9

AREA SCAN AND RADIATION LEVEL SURVEY

SITE ETTP K1006 INSTRUMENT 3490

DATE 4/16/99 ROOM B104

SURVEYOR(S) SPM, RER



ELEVATED READING

GRID LOCATION	cpm	COMMENTS

REMARKS:

CALCULATIONS BY: REVIEWED BY:

DATE: DATE:

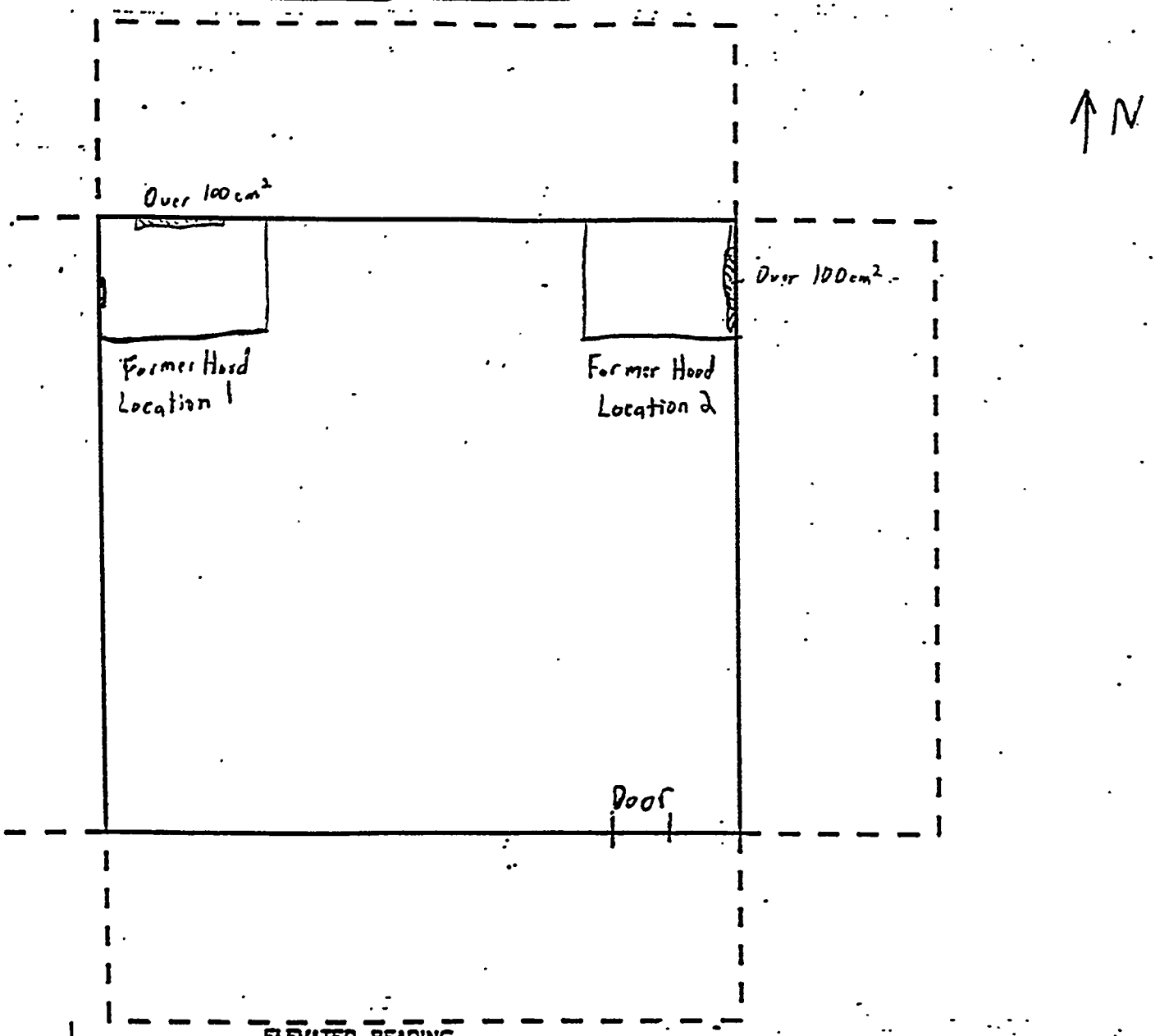
FORM 14a(10-

AREA SCAN AND RADIATION LEVEL SURVEY

SITE ETTP - K1006 INSTRUMENT 3490-09P, 07S

DATE 4/16/99 ROOM B108

SURVEYOR(S) SPM, RER



ELEVATED READING

GRID LOCATION	cpm	COMMENTS
Hood 1 Along Baseboard	300-800	North Wall (Some West Wall <100cm²) Possible Tc-99 Contamination
Hood 2 " "	300-700	East Wall " " "
Floor NW Corner	600-750	Under Former Hood 1
Floor Monitor Readings (Hood 2) Higher than Normal (Not over DOE Guidelines)		

REMARKS:

CALCULATIONS BY: REVIEWED BY:

DATE: DATE:

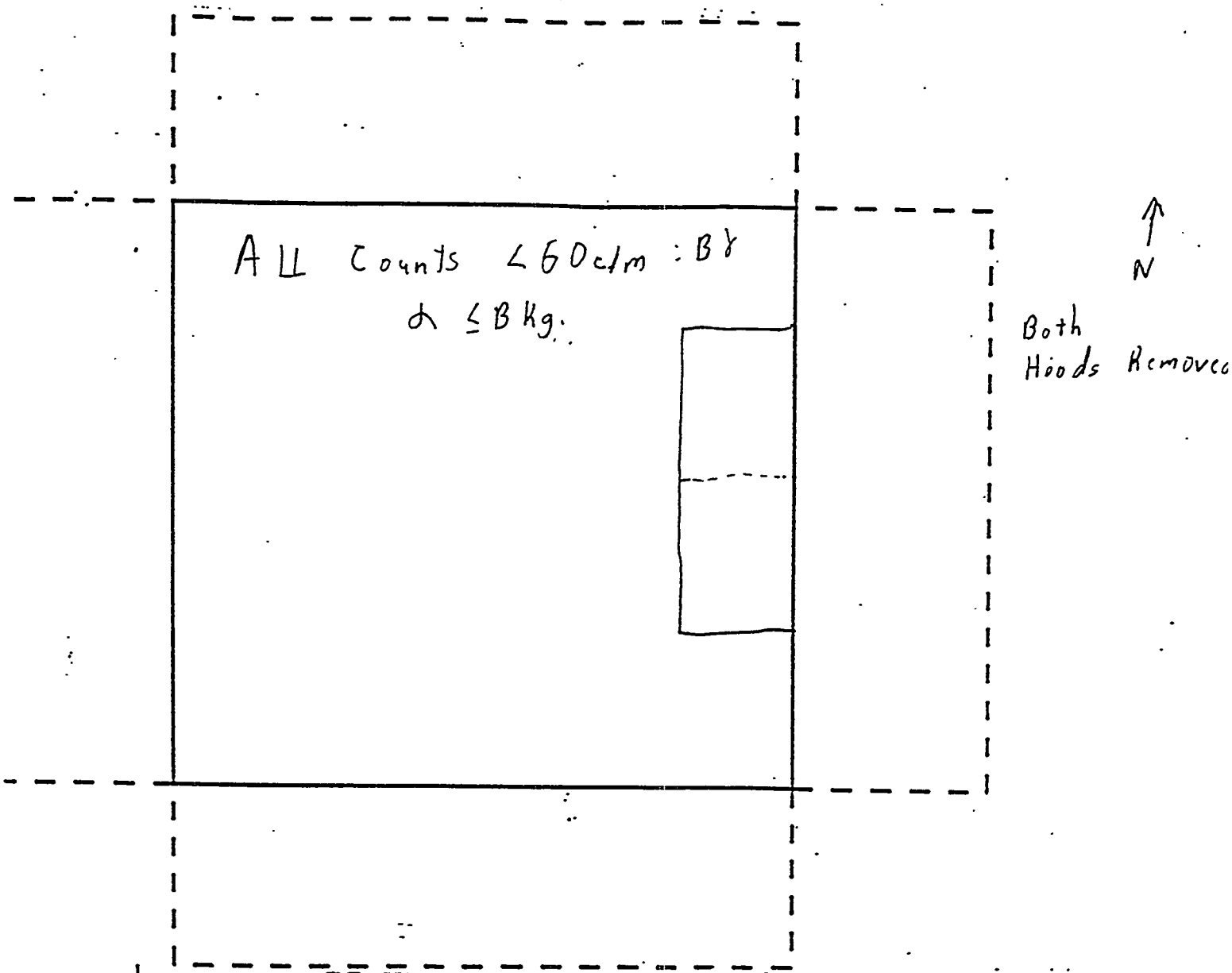
FORM14a(10-90)

AREA SCAN AND RADIATION LEVEL SURVEY

SITE ETTP K1006 INSTRUMENT

DATE 4/19/99 ROOM C108

SURVEYOR(S) RER, SPM.



ELEVATED READING

GRID LOCATION	cpm	COMMENTS

REMARKS:

CALCULATIONS BY: REVIEWED BY:

DATE: DATE:

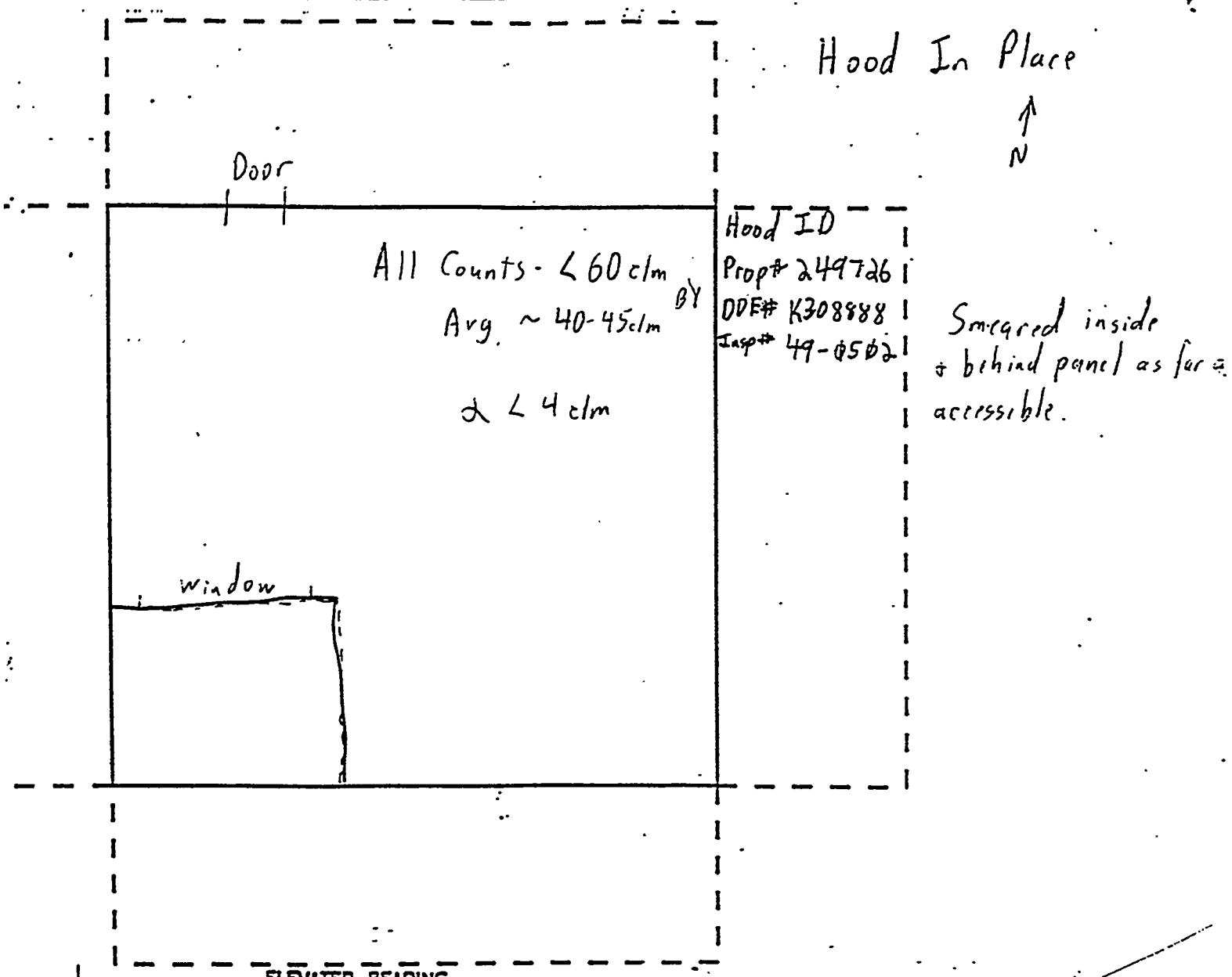
FORM14a(10

AREA SCAN AND RADIATION LEVEL SURVEY

SITE ETTP K1006 INSTRUMENT 3490 075, 09

DATE 4/16/99 ROOM 0101

SURVEYOR(S) SPM, AER



ELEVATED READING

GRID LOCATION	cpm	COMMENTS

REMARKS:

CALCULATIONS BY: REVIEWED BY:

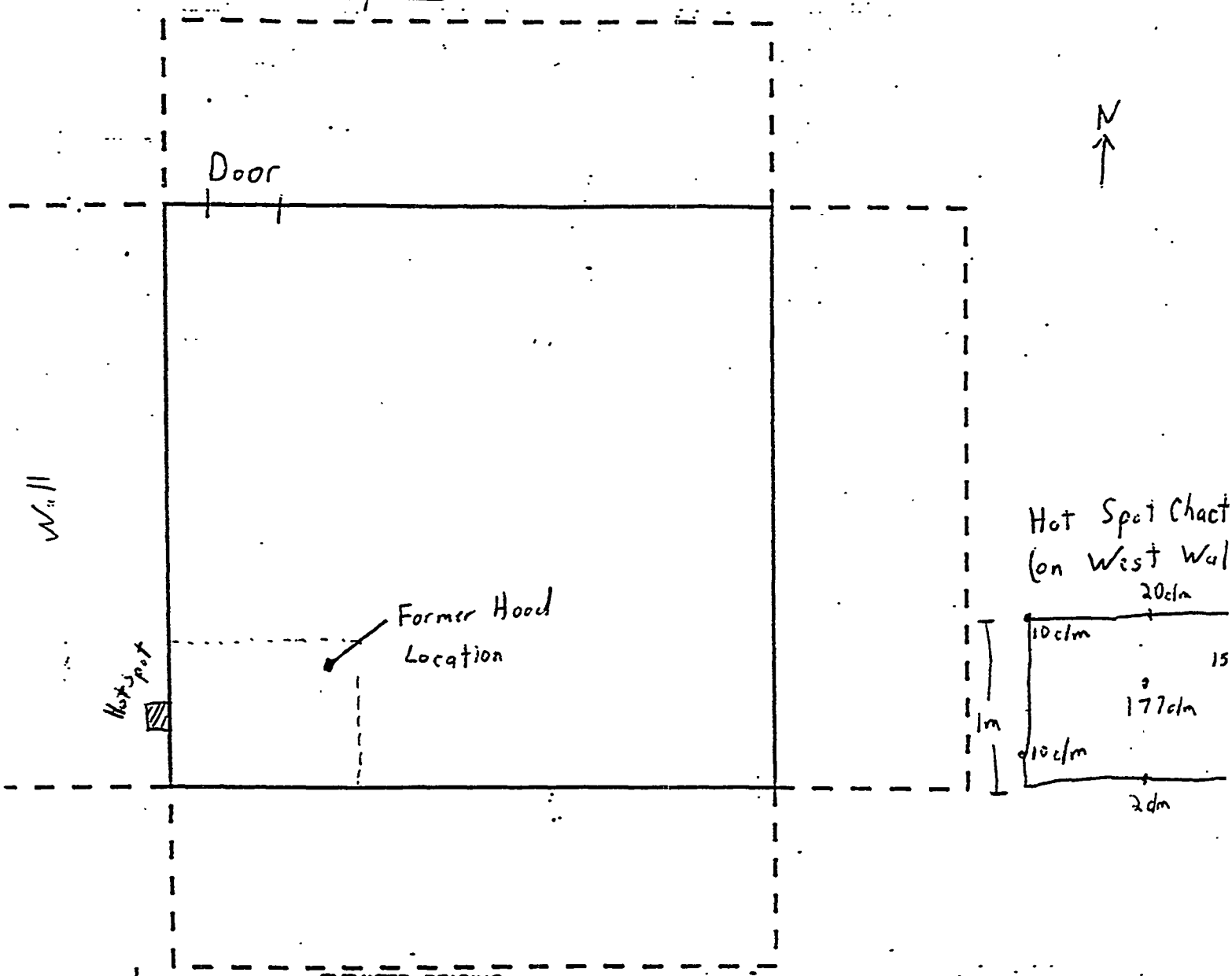
DATE: DATE:

FORM14a(10-90)

SITE K1006 ETTP INSTRUMENT 3490-11P, 075

DATE 4/16/99 ROOM D105

SURVEYOR(S) SPM, RER



ELEVATED READING

GRID LOCATION	cpm	COMMENTS
~1m from South Wall	177a	Spot ~ Probe Size w/eff 13.2%

REMARKS:

CALCULATIONS BY: REVIEWED BY:

DATE: DATE:

FORM14a(10

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