Princeton University OFFICE OF OCCUPATIONAL HEALTH & SAFETY
JAMES FORRESTAL CAMPUS
PRINCETON, NEW JERSEY 08540
609-452-5294

February 28, 1977

Mr. Robert H. Bauer, Manager
Energy Research & Development Administration
Chicago Operations Office
9800 South Cass Avenue
Argonne, IL 60439

RE: Re-survey Program MED/AEC - Palmer Hall

Dear Mr. Bauer:

As indicated in Provost A. Rees' response to your letter of February 2, 1977, we have been performing a radiation survey of those parts of the Palmer Physical Laboratory which were used in support of the Manhattan Engineering District and Atomic Energy Commission projects in the early 1940's. You will be happy to learn that the survey has been completed. It was done under the direction of Mr. Thomas J. Bauer, the University Health Physics Officer. Two copies of Mr. Bauer's report and supporting appendices are enclosed for your information and use. The survey confirmed the presence of low level Uranium contamination in several areas of Palmer hall; the principal contamination is confined to one suite of rooms. The nature and location of the Uranium contamination is such that no radiation hazard exists with normal laboratory or office occupancy of the space.

On the other hand, a significant radiation and inhalation hazard could arise should substantial and major renovations of the spaces be undertaken in the future by persons unaware of the existence of the contamination. Since the building in question will, as are most academic structures, be used for many decades and more likely than not by persons totally unfamiliar with radioactive materials, discussions have been undertaken with the appropriate University officials in order to determine the desirability of effecting a thorough decontamination of these areas. No decision has been reached in this matter as of this date. I will, of course, keep you informed of our decision and our future actions.

I trust that this report meets your needs and that it discharges our obligation with respect to the agreed-upon survey. If you have any questions about the report or the findings or if you desire additional information, please feel free to contact me. I should, perhaps, advise you that a copy of this report has been made available to the appropriate New Jersey state officials who have responsibility for radiation safety within the State of New Jersey. If we can be of further service, please advise.

Very truly yours,

Jack C. Faust

Jack C. Faust
Director

JCF:lv

cc: T. Bauer
C. Green (ERDA-Forrestal Office)
A. Rees
file Physics (z-2)

Attachments (2 each):

Radiation Survey (January 10-18, 1977)
Appendices:
Appendix A: Survey map NW corridor Palmer Hall
Appendix B: Smear Survey results
Appendix C: Gamma Spectra results
Appendix D: Survey map cyclotron area

OFFICE OF OCCUPATIONAL HEALTH & SAFETY

RADIATION SURVEY REPORT

P.U. Reg. # _____

N.J. Reg. # _____

Date of Survey 1/10/77-1/18/77

User J. C. Faust Phone (609) 452-5204

Department Physics & others Building Palmer Hall Room # _____

Assistant(s) _____ Phone _____

Laboratory and/or Room Surveyed Northwest wing & Cyclotron Area (see attached maps)

Device Follow-up of Manhattan Project work from 1940's; requested by ERDA

Surveyed by T. Bauer, R. Milwicz, O. Griesbach, J. Ives Time _____

Survey Equipment Used Eberline gas proportional counter PAC-4G-3, P.U. #24246, Serial #1858 with beta probe AC-2IB, P.U. #24246

Date of Last Calibration 12/15/76 by T. Bauer, J. Ives

Checked Out On 1/10/77-1/18/77 before each survey by T. Bauer

Background

The Energy Research & Development Administration (ERDA) has included Princeton University on a list of about 50 sites which are to be "evaluated" and possibly surveyed by ERDA for the existence of radioactive contamination attributable to activities carried on during the Manhattan Project in the early 1940's. On September 28, 1976, an inspector from ERDA, Mr. Ed Jascewsky, accompanied by two health physicists under contract with ERDA from Argonne National Laboratory, visited the University. The purpose of the visit was to enable ERDA to gather information about what kinds of activities went on at Princeton during the forties involving nuclear operations at a former Manhattan Engineering District and Atomic Energy Commission site (MED/AEC).

History

The Office of Occupational Health & Safety (OHS) provided the inspectors with information obtained from conversations with Dr. H. Smyth and Prof. M. White (both presently at Princeton University) and Dr. Ed Creutz (presently with the National Science Foundation, Washington, DC) about the Manhattan-related project activities in the Palmer Physical laboratories. Dr. Smyth explained that he headed the Isotron project located in Palmer Hall basement where very small

(continued)

cc: Departmental Coordinator - Physics (Boscarino)
Departmental File Physics (2-2)

research quantities (gram amounts) of natural Uranium were used. Dr. E. Creutz worked on related projects in the cyclotron area also in Palmer Hall basement where approximately 20-30 lbs. of normal Uranium was used mostly in the form of Uranium oxide and very little as Uranium metal. Prof. John Turkevich spoke with the inspectors about the activities conducted in the Frick Chemical Laboratory related to the Manhattan Project. He reported that there was no work performed using Uranium; projects conducted in chemistry were directed toward construction of the diffusion barrier material and some heavy water was used in this and other projects.

Copies of a number of routine radiological smear surveys performed over the past few years (not Manhattan related) for Palmer Hall basement areas were provided to ERDA. OHS agreed to perform a detailed direct beta probe survey of the appropriate areas in Palmer Hall and forward the data to ERDA. In this way, the radiological status could be determined and appropriate corrective action, if any, taken much sooner than would otherwise be possible were we to wait for an ERDA survey.

Identification of Affected Areas

As a follow-up to the September 28, 1976, ERDA information visit to Princeton University, a complete survey was planned of areas believed to have been used for work with Uranium during the Manhattan Project. The following rooms were identified:

Frick Chemistry - No Uranium work performed

(Probe and smear surveys were conducted on three floors occupied by Physical or Nuclear chemists where barrier studies would have been conducted. All results were negative.)

Palmer Physical Laboratory*

The Northwest Corridor

Rooms 122, 122A, 122B, 122C, 123, 123A, 123B, 124, 124A, 124B, 125, 126, 127, 128, 129, 130, 131, 132

Cyclotron Area

Rooms 102, 102A, 104, 105, 106

*Principal rooms underlined as identified by Prof. H. Smyth during a tour of the laboratories

It has been established from numerous discussions that the work done at Princeton was of a very basic research nature--none of which would have been involved with any large quantities of Uranium or the ore. The surveys were conducted solely to

document the current radiological status of the rooms identified, not because of any previous concerns or positive findings.

Survey Description

Radiation surveys were performed using an Eberline Proportional Counter PAC-4G-3 with a beta probe AC-21B. The probe survey included all areas listed above and as a precaution was extended to connecting corridors and many adjoining areas (Appendix A). All general surveys of laboratory areas included floor surveys and spot checks of walls, pipes, ducts, etc., as appropriate. In each room identified above, a smear survey was performed for removable contamination and counted for alpha and beta activity (Appendix B). In any area where a positive indication was found by direct probe survey, a special and more extensive smear survey was performed.

Instrument and Calibration

All general surveys of floors, walls, pipes, ducts, etc., involved the use of an Eberline PAC-4G-3 type instrument. This is a gas flow (propane) proportional type instrument used in the beta mode with probe window area of 50 cm^2. Window material is double aluminized mylar (0.85 mg/cm^2). A beta plateau was run to determine the operating voltage setting of 2050 V.

Instrument: Eberline PAC-4G-3, Property #24246
Beta Probe: AC-21B
Calibration Source: Eberline TC-99 source set (traceable to NBS - July 1974 when agreement was 0.3%)

The calibration of this instrument was performed following instructions from the Eberline Instrument Manual, Section IV, pages 13, 14, and 15, and phone recommendations from Eberline Engineering Manager, Mr. Bill Hart. A comparison of calibration results and a TC-99 to natural Uranium correction factor was obtained from Mr. Walter Smith of Argonne National Laboratory.

An apparent efficiency of 63 percent was obtained for betas emitted from a 2 π surface of 1" diameter TC-99 source, assuming a 25 percent backscatter. For this TC-99 efficiency (63 percent) the Uranium Natural efficiency calculated at Argonne and used in this survey is 28 percent. The uncertainty of this calibration is 3 percent and is the sum of the random counting error at the 99 percent confidence level and the estimated upper limit of conceivable systematic error in this measurement. Minimum detectable activity for an instrument background of 250 cpm is 168 dpm at 28 percent efficiency for Natural Uranium.

Spectral Analysis

Whenever positive indications were observed on smear media, gamma spectrum analyses were conducted to determine the isotopic content. The analyzer used was a Nuclear Data model ND130A with a 4" x 4" NaI (Tl) detector in a low background shield. Data is provided in Appendix C for material scraped from floor

cracks in Room 122, Palmer basement. The material was obtained by scraping tightly bound dirt along the pipe trench with a razor edge instrument. The spectrum and counting data for the scrapings were identical to the spectrum and counting data for a 20 year old Natural Uranium source (property of J. C. Faust). Comparison of the curves definitely shows the material to be Natural Uranium.

Survey Results - Northwest Corridor Palmer Basement

1. Area surveys yielding positive beta contamination findings

   The following areas were found to have a net activity greater than the minimum detectable level of 168 dpm.

   a. Room 122--A survey of 90 percent of the floor area of this room located 22 positive (> 168 dpm to 62678 dpm) beta contamination locations. The principal activity is concentrated along a pipe trench, in manmade concrete expansion joints and concrete stress cracks. In addition to the standard wall/floor surveys, sample areas were checked on overhead pipes, ducts, and light fixtures and the tunnel extensions of the pipe trench; no activity above background was located. All contamination appeared to be beta or low energy X-ray, the radiation levels being reduced to background by ~ 1200 mg/cm^2.

   b. Room 126--A single location in a floor joint showed 9000 dpm.

   c. In a sink in Room 119, an area was located yielding 3000 dpm.

2. Area surveys yielding negative beta contamination findings

   The radiation survey for all other areas excepting those listed in Item 1 above included a complete scan of all exposed floor cracks including wall to floor joints, natural and expansion cracks and at least 25 percent of remaining accessible floor area. On the attached map, Appendix A, areas where activity was less than minimum detectable (< 168 dpm) are labeled as background.

Smear Survey Results - Northwest Corridor Palmer Basement

In each area identified above, a smear survey was performed for removable contamination and counted for alpha and beta activity. In Room 131, 26 dpm/100 cm^2 smear was located on August 25, 1976, in a preliminary smear survey. Follow-up probe and smear surveys in Room 131 did not locate any activity above background. As a result of a positive direct probe survey in Room 122, a special smear survey was performed. From 28 smears, two gave positive readings: (1) on a conduit close to the ceiling 5 dpm/100 cm^2 smear, and (2) on a wood beam ~ 7' high 8 dpm/100 cm^2 smear. Follow-up probe surveys did not locate further activity in these two areas above background.

Survey Results - Cyclotron Area Palmer Basement

1. Area surveys yielding positive beta contamination findings

The following areas were found to have a net activity greater than the minimum detectable level of 75 dpm, using the higher and more appropriate efficiency for TC-99 since no Uranium activity was found. (6.5 %).

a. Room 105 - Cyclotron Vault

In a survey of 25 percent of the floor area of this room (Appendix D) most of the area was found to be at 250 dpm to 350 dpm, a slightly higher background than in surrounding rooms. Only one point showed localized contamination, a point previously used for waste storage (~ 500 dpm).

The core area of the cyclotron (disassembled and not in use for ~7 years) showed slight residual activation (~ 0.3 mR/hr). An area in the cyclotron vault previously used for waste storage had residual contamination (~ 0.3 mR/hr).

Contamination in both of these areas is fixed and has been previously surveyed by OHS. The contamination is high energy beta-gamma and does not appear to be related to any Uranium usage.

b. Room 106 - Hot Chemistry Lab

Several areas in this room (see Appendix D) had fixed beta-gamma contamination associated with its previous use as a hot chemistry lab for the cyclotron. This room is still under the control of the Physics Department; however, it has not been used except for storage since the shut-down of the cyclotron.

2. Area surveys yielding negative beta contamination findings

The radiation survey for all other areas excepting those in Item #1 above included a complete scan of all exposed floor cracks including wall to floor joints, natural and expansion cracks, and at least 25 percent of remaining accessible floor area. On the attached map, Appendix D, areas where activity was less than minimum detectable (< 75 dpm) are labeled as background.

Smear Survey Results - Cyclotron Area

Fifteen smears were taken and all were found to be background (Appendix D). It should be noted that this room, as were all the cyclotron areas, were included in the OHS routine smear survey procedure until its shutdown in 1969.

Tests for Decontaminability

Room 122 is the only area identified containing removable Uranium contamination. As reported, the principal activity is concentrated along a pipe trench and in floor joints and cracks. In order to estimate the level, nature and scope of decontamination procedures which will be required to "clean up" the Uranium, small scale tests of a decontamination nature were conducted, primarily in Room 122. It proved possible to remove some tightly bound dirt along the pipe trench with a razor edge scraping instrument and collect it by vacuuming with an absolute filtered vacuum unit. In most cases this technique reduced the activity by a factor of two or so. The remaining contamination, the highest being ~ 25,000 dpm or 0.01 μCi, could not be reduced by simple and passive cleaning methods. The removal of this contamination will require a major decontamination effort of the room (removal of concrete sections, trenches, etc.).

Summary

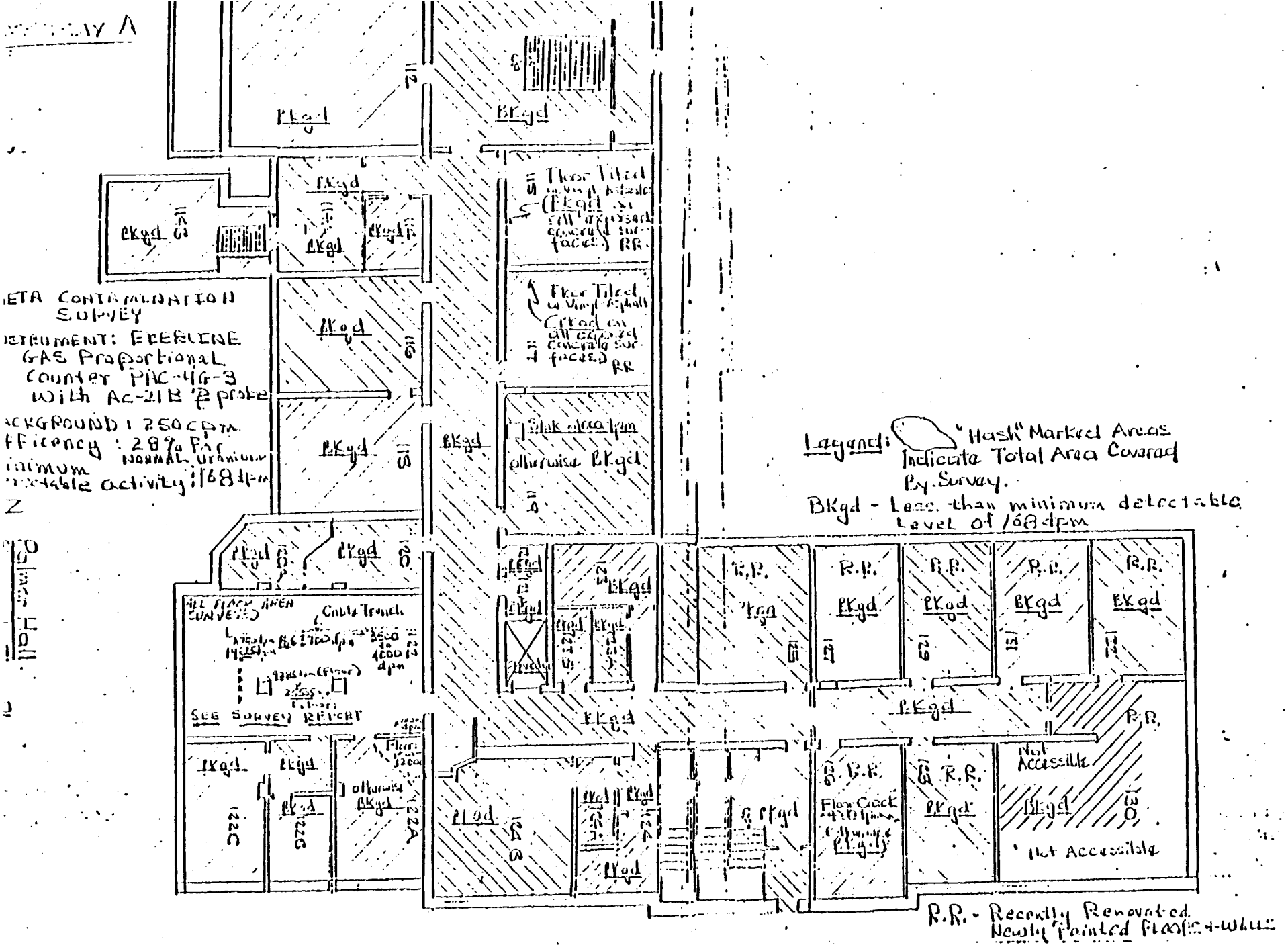
As stated earlier the objective of this survey was to locate all areas at Princeton University that may have been involved in nuclear operations as an MED/AEC site in the forties. It was determined that the only Uranium used in connection with this project was in the basement level of the Palmer Physical Laboratory (Physics Dept.) where no more than approximately 30 lbs of natural Uranium was used. The contamination levels and the distribution of the Uranium found by this survey is as one would expect for a 30 - 35 year old situation. Low level contamination was found in five areas of Palmer basement, concentrated along pipe trenches, floor joints and cracks. Removable contamination was found in only one area, this contamination was verified by spectral analysis as Uranium. No radiation hazard has been found to be present in the occupancy of any of the rooms. Using a Victoreen 440 ionization survey meter, the highest dose rate was found in the cyclotron area and was only 0.3 mRem/hr. There was no detectable dose rates from any known Uranium sources (<0.1 mRem/hr). However, further clean up and/or renovation is recommended for occupancy by the general public of Room 122 in order to alay public concern as to the radiological status of this area.

Thomas J Bauer 2/28/77

Thomas J. Bauer date
Health Physics Officer

Appendices:
Appendix A: Survey map NW corridor Palmer Hall
Appendix B: Smear Survey results
Appendix C: Gamma spectra results
Appendix D: Survey map cyclotron area

file Physics (z-2)

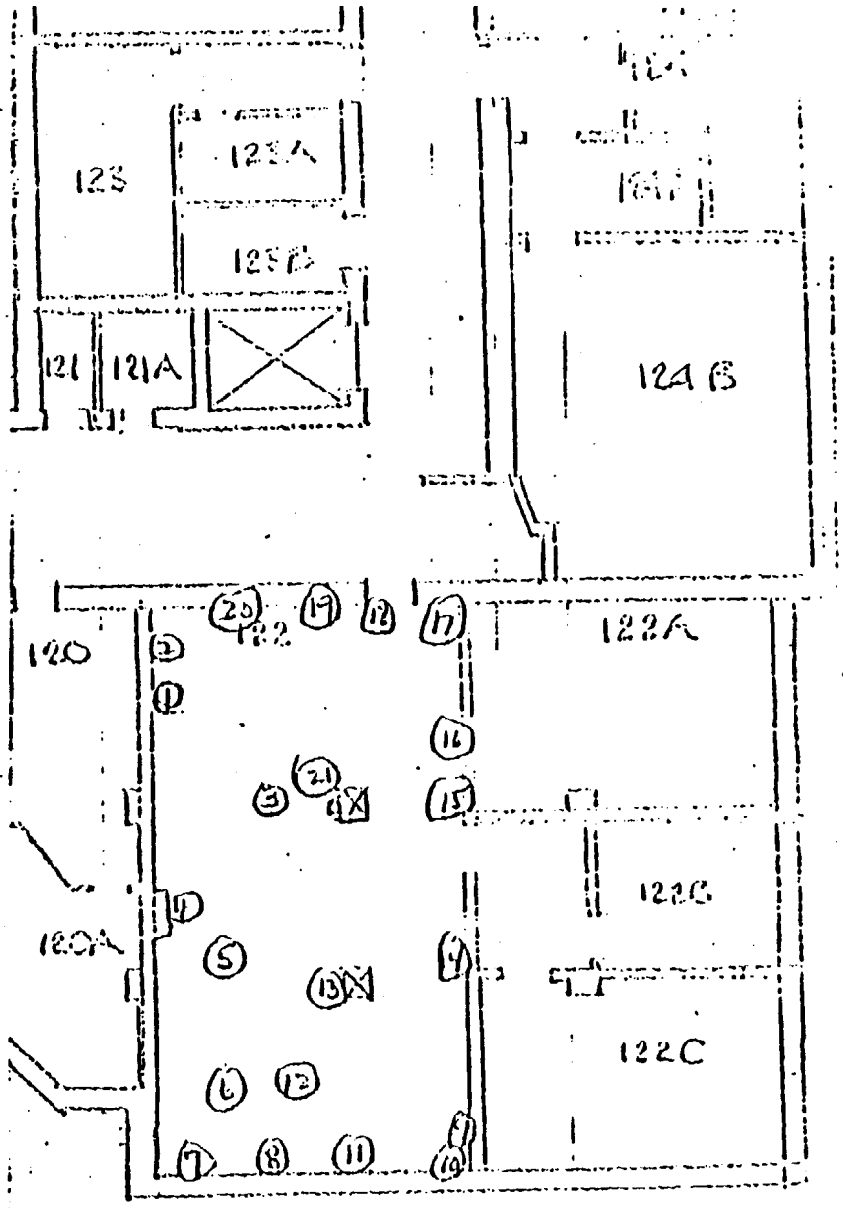

ETA CONTAMINATION SURVEY
INSTRUMENT: FERRITE GAS Proportional Counter PAC-4G-3 With AC-2IB 2π probe
BACKGROUND : 250 CPM
EFFICIENCY : 28% For NORMAL Uranium
MINIMUM DETECTABLE ACTIVITY: 168 dpm
Legend: "Hash" Marked Areas Indicate Total Area Covered By Survey.
BKgd - Less than minimum detectable Level of 168 dpm
BKgd
Floor Tiled
Floor Tiled on Vinyl Asphalt
Floor Tiled on all exposed concrete surfaces
BR
Slab area 1pm otherwise BKgd
R.P.
Cable Trench
SEE SURVEY REPORT
Floor area
Not Accessible
R.R. - Recently Renovated. Newly Painted Flat Off-White

APPENDIX B - SMEAR SURVEYS

SHEAR SURVEY OF ROOM 122
IN PALMER HALL

Feb. 7, 1977

1 CONDUIT CLOSE TO CEILING
2 DUCT
3 OVERHEAD PIPES
4 TOP OF VENT
5 I BEAM - CEILING
6 OVERHEAD PIPE (TOP)
7 WALL - 2' FROM CEILING
8 CEILING
9 WALL OPENING
10 WALL & CONDUIT
11 COUNDUIT 4' FROM FLOOR
12 OVERHEAD PIPES
13 COLUMN SIDE 8' HIGH
14 WALL AT 5'
15 TOP OF TRANSFORMER
16 TOP OF DOOR FRAME
17 WALL AT 7'
18 CONDUIT OVERHEAD
19 GRILL WORK ON WALL
20 CONDUIT AT 4' HIGH
21 WOOD BEAM AT 7' HIGH



SHEAR SURVEY OF ROOM 122
Feb. 7, 1977
J. SUNDRA / J. IVES

Palmer Hall

PRINCETON UNIVERSITY
OFFICE OF OCCUPATIONAL HEALTH & SAFETY
Smear Survey Report

Date of Smear Survey 02-07-77

Survey Report of PLANT - PLANNING - PROPERTIES - PALMER HALL

Counted for: ☐ α ☒ α + β Other _____

User _____ Phone _____

Assistant _____ Phone _____

Isotopes in Use or Suspected	☐ NAT						
Radiation & Energy (MeV)	VARIOUS β⁻ γ α						
Efficiency	30%						

Detector Used: Gas flow, thin window 0.8 mg/cm², geiger or prop. counter

Other LIQUID SCINTILLATOR SL-30

Detector Background Rate 0.8 CPM for 10 min 3 std. dev. (bkg) 0.8

Blank - cpm: 0.8 std used: BRC.14 Exp't cpm: 900 Obs'd cpm: 811

Room No.	Location or Area	Total Counts	Total Time (min)	Count Rate CPM (net) ± 1 std. dev.	DPM per 100 cm² smear ± std. dev.
122	SWIPE # 1	23	10	1.5 ± 0.55	5 ± 1.8
	2	13		BKG	
	3	16			
	4	15			
	5	12			
	6	12			
	7	6			

Comments: Liquid Scintillation. No significant activity was detected by Liquid scintillation

Room 122 + adjacent area

CTL — AR 2/11/77

PRINCETON UNIVERSITY
OFFICE OF OCCUPATIONAL HEALTH

Date 02-07-77 Page 2 of 3

Smear Survey Report of (cont.) PALMER HALL

Counted for: ☐ α ☒ α + β Other

Room No.	Location or Area	Total Counts	Total Time (min)	Count Rate CPM (net) ± 1 std. dev.	DPM per 100 cm² smear ± std. dev.
122	SMEAR NO. 8	8	10		
	9	11			
	10	9			
	11	12			
	12	6			
	13	13			
	14	4			
	15	10			
	16	5			
	17	11			
	18	16			
	19	13			
	20	12			
	21	31	↓	1.3 ± 0.22	7.6 ± 2
	CYCLOTRON AREA				
	FLOOR AREA IN CYCLOTRON VAULT - NEAR RIGHT WALL	17			
	[illegible]	7			
	ON PIPES ABOVE CYCLOTRON	10			
	[illegible] STEEL "I" B[illegible]	10	↓		

PRINCETON UNIVERSITY
OFFICE OF OCCUPATIONAL HEALTH

Date 02.07.77 Page 2 of 3

Smear Survey Report of (cont.)

Counted for: ☐ α ☒ α + β Other

Room No.	Location or Area	Total Counts	Total Time (min)	Count Rate CPM (net) ± 1 std. dev.	DPM per 100 cm^2 smear ± std. dev.
	ON CEILING	7	10		
	AIR CONDITIONER OPENING IN OLD SHOP AREA				
	BEHIND CYC. CONTROL PANEL	6			
	LEDGE NEAR EMERGENCY EXIT IN OLD SHOP AREA	6			
	FLOOR AREA NEAR CORNER OF "L" IN OLD SHOP AREA	4			
	FLOOR AREA NEAR LADDER IN OLD SHOP AREA	11			
	ON LEDGE IN OLD SHOP AREA	11			
	FLOOR AREA NEAR LADDER AND RAISED AREA OF FLOOR	12			
	UNDER STEPS LEADING TO OPERATING CONSOLE	7			
	OLD DRAINAGE AREA ABOVE CYCLOTRON CONSOLE				
	TOP OF CONSOLE	5			
	WINDOW SILL	10			
	TOP OF AIR DUCT	2			

MICHIGAN STATE UNIVERSITY
OFFICE OF OCCUPATIONAL HEALTH & SAFETY

Smear Survey Report

Date of Smear Survey 2-2-77

Survey Report of PALMER

Counted for: ☐ α ☒ α + β Other —

User PLANT PLANNING PROPERTIES Phone

Assistant Phone

Isotopes in Use or Suspected	UNAT						
Radiation & Energy (MeV)	VARIOUS	$\beta^- \gamma + \alpha$					
Efficiency	30%						

Detector Used: Gas flow, thin window: 0.5 mg/cm², ~~geiger~~ or prop. counter

Other

Detector Background Rate 0.0 CPM for 10 min 3 std. dev. (bkg) 0.0

Blank - cpm: 0.5 std used: U^nat Exp't cpm: 1.5 x 10² Obs'd cpm: 1.5±0.5 x 10

Room No.	Location or Area	Total Counts	Total Time (min)	Count Rate CPM (net) ± 1 std. dev.	DPM per 100 cm² smear ± std. dev.
122	FLOOR AREA FROM PIPE TRENCH		10		
	1	23		1.5 ± 0.55	
	2	14		[illegible]	
	3	14			
	4	6			
	5	9			
	6	11	↓	↓	

Comments: Final Smear Survey

Pipe Trench after test decontam

TDV — AB — 2/11/77

APPENDIX C

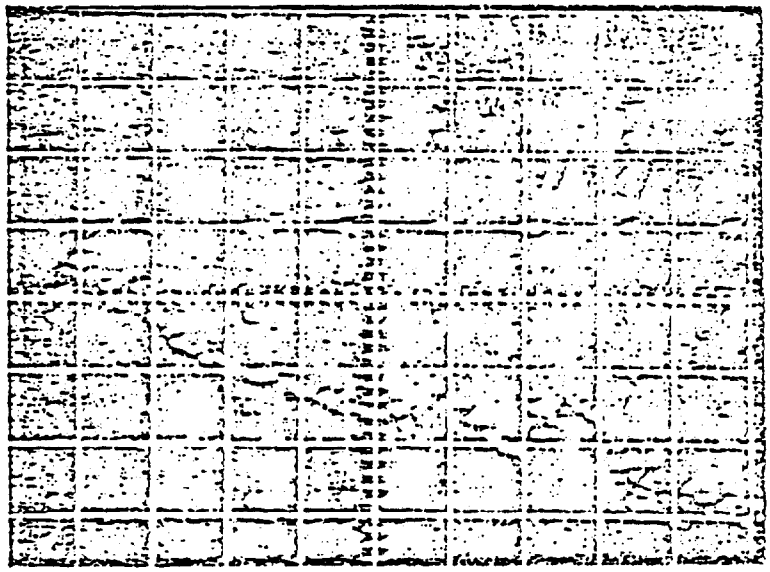
GAMMA SPECTRA

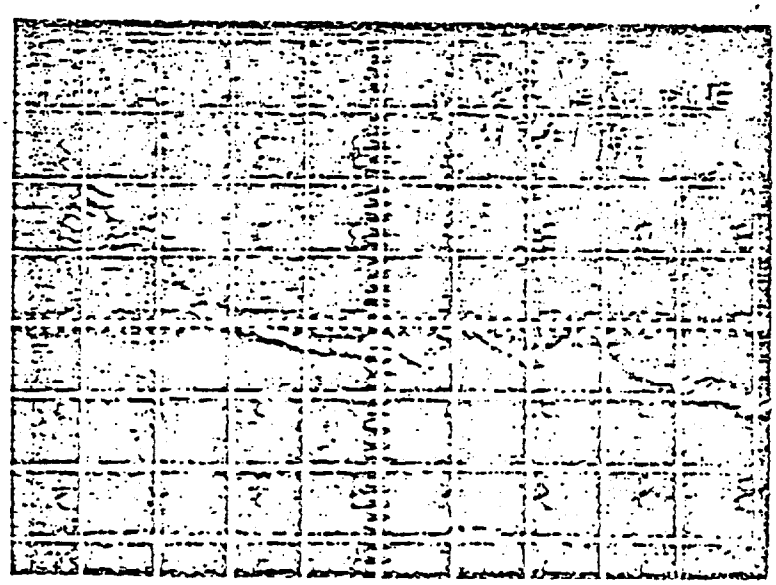
Samples: Known Natural Uranium Source
Dust Sample Room 122

Detector: 4" x 4" NaI (Tl)

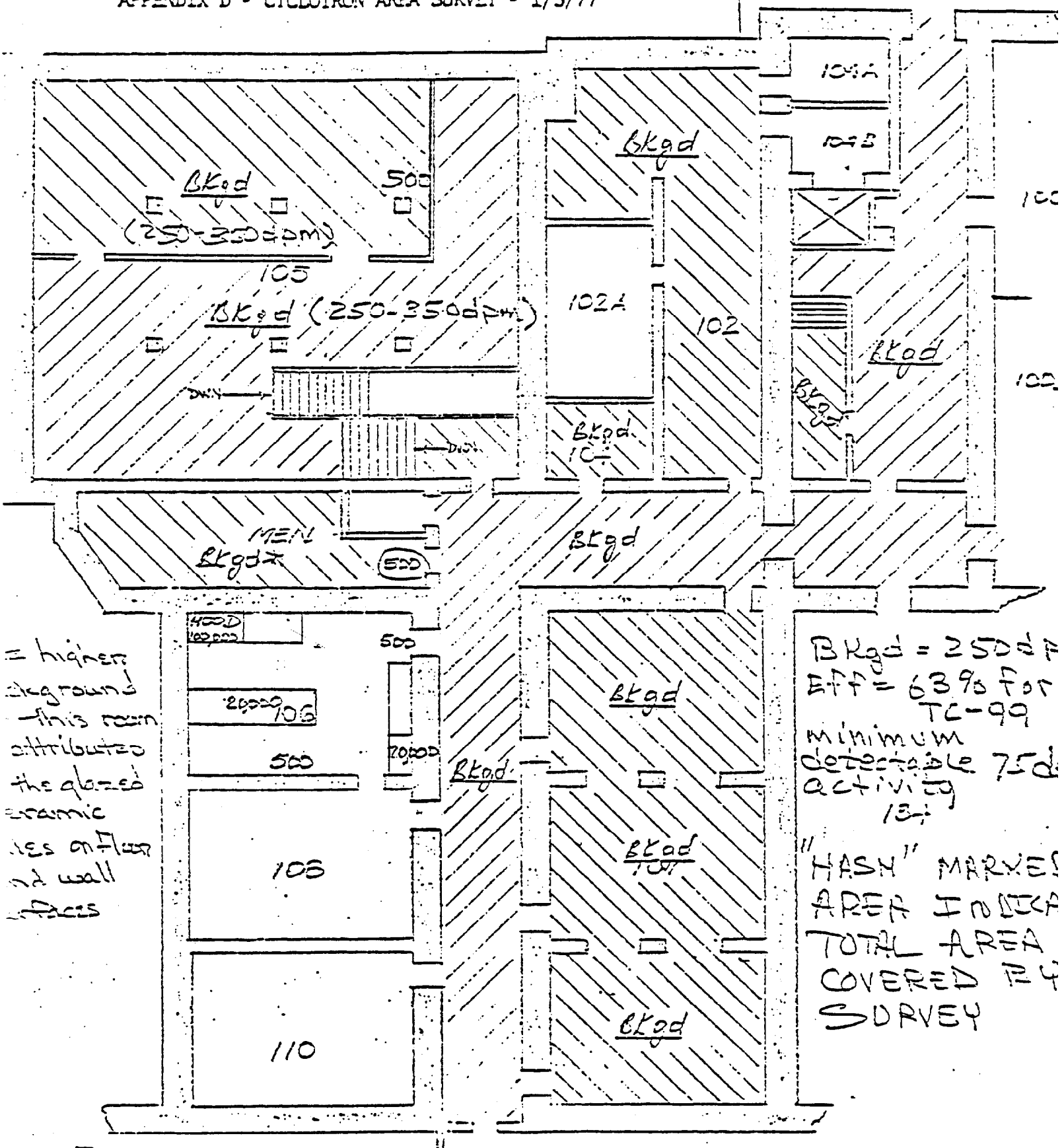
Calibration: 0 - 1 MeV

Date: January 26, 1977





APPENDIX D - CYCLOTRON AREA SURVEY - 1/3/77



Instruments

Victoreen 440
EBERLINE PRC-4G-3 Probe #C-21B
Victoreen 491 #2427