DOE/CD-ETEC-4019

DRAFT DOCKET

FOR THE RELEASE OF BUILDING 4019 AT THE FORMER ENERGY TECHNOLOGY ENGINEERING CENTER

September 1999

U.S. DEPARTMENT OF ENERGY
OAKLAND OPERATIONS OFFICE
ENVIRONMENTAL RESTORATION

LR-66334

FORWARD

The purpose of this Docket is to document the successful decontamination & decommissioning of Facility 4019 at the former Energy Technology Engineering Center (ETEC) at the Santa Susana Field Laboratory (SSFL), Area IV; and that the facility is suitable for release for unrestricted use. The material in this Draft Docket consists of documents supporting the status that conditions at the former facility 4019 are in compliance with applicable DOE and proposed Environmental Protection Agency and Nuclear Regulatory Commission standards and criteria established to protect human health, safety, and the environment.

CONTENTS

EXHIBIT I

DOCUMENTS SUPPORTING THE CERTIFICATION FOR THE UNRESTRICTED USE OF FACILITY 4019 IN AREA IV AT SANTA SUSANA FIELD LABORATORY (SSFL)

DOE F 1325.8
(8-89)

United States Government **Department of Energy**

memorandum

DATE: September 2, 1999

REPLY TO
ATTN OF: DOE Oakland Operations Office/OEPD

SUBJECT: Release of Decontaminated Building 4019 without Radiological Restrictions at the site formerly known as the Energy Technology Engineering Center.

TO: Robert Fleming, EM-44

The Oakland Operations Office (OAK) has implemented environmental restoration projects at the site formerly known as the Energy Technology Engineering Center (ETEC) as part of the Environmental Restoration Program (ERP) per Headquarters Northwestern Area Program Office direction. The objective of the program is to identify and cleanup or otherwise control facilities where residual radioactive contamination remains from activities carried out under contract to the Atomic Energy Commission and the Energy Research and Development Administration during the early years of the Nation's atomic energy program.

The Energy Technology Engineering Center performed testing of equipment, materials, and components for nuclear and energy related programs. These nuclear energy research and development programs began in 1946 and ended in 1995. Numerous buildings and land areas became radiologically contaminated as a result of facility operations and site activities. One such area that has been designated for cleanup under the ERP is Building 4019.

Building 4019 was constructed in 1962 and served as the SNAP System Nuclear Qualification Test Facility wehre SNAP reactors were tested, using fully encapsulated higly enriched uranium, at zero power, until termination of the SNAP program in 1970. All SNAP components were then removed a a facility survey was performed in 1988. Documentation indicated that there were no releases of the uranium fuel or fission products.

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education (ORISE) has completed independent verification of the Building decontamination project.

Post remedial action surveys have demonstrated, and the DOE Oakland Operations Office hereby certifies, that the subject property is in compliance with DOE decontamination criteria and standards established to protect members of the general public and occupants of the property.

Final project closeout documents have been submitted to your office under separate cover.

DOE/OAK requests approval for release of this property without radiological restrictions to Rockwell International, in accordance with the closeout provisions of the contract, and authorization to remove this facility from the DOE/OAK real property records.

Michael Lopez
ETEC PM
Oakland Environmental
Programs Division

EXHIBIT II

SITEWIDE RELEASE CRITERIA FOR REMEDIATION OF FACILITIES AT SSFL AND ASSOCIATED DOCUMENTATION

(8-89)
United States Government Department of Energy

memorandum

DATE: 05 SEP 1996

REPLY TO
ATTN OF: DOE Oakland Operations Office(ERD)

SUBJECT: Radiological Site Release Criteria for ETEC

TO: Sally Robison, EM-44

I am requesting the approval of the radiation site release criteria for the Energy Technology Engineering Center. The release criteria are a critical component in the DOE process for releasing facilities for unrestricted use. The California Department of Health Services has approved the site release criteria in a letter dated August 9 (see attachment 1).

The proposed limits were developed in the following way:

1) Annual exposure dose. Rocketdyne proposes to use a dose limit of 15 mrem/yr to comply with the 100 mrem plus ALARA as required by DOE 5400.5). This limit is also consistent with the anticipated rules of the NRC and EPA.

2) Ambient exposure rate. The proposed limit of 5μR/hr above natural background complies with the limit of 20μR/hr, plus ALARA, as stated in DOE Order 5400.5. This proposed limit is consistent with NRC limits for Rocketdyne facilities at the Santa Susana Field Laboratory. This limit would be imposed for accessible, or potentially accessible, structures and land.

3) Surface contamination. Surface contamination limits comply with DOE Order 5400.5 and specify the potential contaminants present in the Rocketdyne facilities.

4) Generic Limits for Soil and Water. The generic limits for soil and water were established using the DOE pathway analysis code RESRAD.

09/16/96

The proposed site release criteria are included in "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL", Revision A, N001SRR140127.

Your approval is requested by September 16,1996.

Laurence McEwen
Acting Director
Environmental
Restoration Division

Attachments

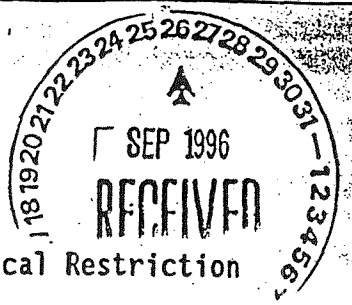
cc: R. Liddle, ESO
M. Lopez, ERD
D. Williams, EM-443

96-ER-095/

United States Government

Department of Energy

memorandum



DATE: SEP 17 1996

REPLY TO ATTN OF: EM-44 (D. Williams, 903-8173)

SUBJECT: Sitewide Limits for Release of Facilities Without Radiological Restriction

TO: R. Liddle, Oakland Operations Office

We have reviewed Rocketdyne's proposed sitewide limits for release of facilities at the Santa Susana Field Laboratory (SSFL) without radiological restriction and are satisfied that our previous concerns and comments have been addressed.

The proposed limits are consistent with the Department of Energy (DOE) Order 5400.5 requirement for a Total Effective Dose Equivalent limit of 100 mrem/yr plus As low As Reasonably Achievable (ALARA) for future occupants, the Nuclear Regulatory Commission proposed a radiological guideline of 15 mrem/yr ALARA, and the Environmental Protection Agency proposed a guideline of 15 mrem/yr for release of properties.

Corrective actions taken by Rocketdyne for the sampling and statistical approach to final survey data validation for DOE projects are now comparable to methodologies or standard practices used at other DOE sites and the requirements of Nuclear Regulatory Commission Nuclear Regulation (NUREG)/CR-5489 (Manual for Conducting Radiological Surveys in Support of License Termination).

We also received a copy of the letter from the California Department of Health Services stating concurrence with the proposed release guidelines and the intent to incorporate these guidelines into Rocketdyne's California Radioactive Material License.

Based upon the above information, the proposed sitewide release criteria for remediation of facilities at the SSFL are hereby approved for use.

If you have any questions, please call Mr. Don Williams of my staff at 301-903-8173.

Sally A. Robison, Ph.D.
Director
Office of Northwestern Area Programs
Environmental Restoration

007857 RC

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, Governor

DEPARTMENT OF HEALTH SERVICES
714/744 P STREET
P.O. BOX 942732
SACRAMENTO, CA 94234-7320

(916) 323-2759

96ETEC-DRF-0455

August 9, 1996

Ms. Majelle Lee, Program Manager
Environmental Management
Rocketdyne Division
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309-7930

Subject: Authorized Sitewide Radiological Guidelines for Release of Unrestricted Use

Dear Ms. Lee:

This letter is to acknowledge the receipt of your letter dated June 28, 1996 requesting concurrence of the above subject. The above mentioned letter and its attachments have been reviewed by the staff of this office. The Radiologic Health Branch (RHB) concurs that the proposed release guidelines provide adequate assurance for the release of the facilities and properties at Rocketdyne's Santa Susana Field Laboratory (SSFL) and DeSoto sites without further radiological restrictions. Your letter dated June 28, 1996 with attachments will be incorporated into Rocketdyne's California Radioactive Material License # 0015-70 upon receipt of a commitment letter signed by Mr. Phil Rutherford.

If you have any questions concerning this matter, please feel free to call Mr. Stephen Hsu of this office at (916) 322-4797.

Sincerely,

Gerard Wong, Ph.D., Chief
Radioactive Material Licensing Section
Radiologic Health Branch

BOEING

Supporting Document

GO NO.	S/A NO.	PAGE 1 OF	TOTAL PAGES	REV. LTR/CHG. NO.	NUMBER
90127		28	28	New	N001SRR140131

PROGRAM TITLE
Radiation Safety

DOCUMENT TITLE
Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL

DOCUMENT TYPE
Safety Review Report

RELATED DOCUMENTS

ORIGINAL ISSUE DATE
12/18/98

RELEASE DATE
RELEASE 2-18-99 E.M.

APPROVALS / DATE

P. D. Rutherford — 12/16/98

M. E. Lee — 12/16/98

J. Willenberg — 12/18/98

PREPARED BY/DATE / DEPT. / MAIL ADDR

P. D. Rutherford — 12/14/98 — 641 — T487

IR&D PROGRAM? YES NO X

IF YES, ENTER AUTHORIZATION NO.

DISTRIBUTION

✱	NAME	MAIL ADDR
*	P. D. Rutherford	T487
*	M. E. Lee	T038
*	P. H. Horton	T038
*	J. G. Barnes	T487
*	P. Liddy	T487
*	F. E. Dahl	T100
*	E. R. McGinnis	T487
	S. R. Lafflam	T487
*	Radiation Safety Library	T487

ABSTRACT

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use.

A complete set of release criteria for facilities at the SSFL has been developed, and are presented in this report. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines were obtained from regulatory values where available. Where not available, for example for soil, guidelines were calculated by use of the DOE computer code, RESRAD. For these calculations, the annual dose limit is 15 mrem/year, which is consistent with proposed EPA and NRC guidelines and ALARA principles.

✱ COMPLETE DOCUMENT

NO ASTERISK, TITLE PAGE/SUMMARY OF CHANGE PAGE ONLY.

RESERVED FOR PROPRIETARY/LEGAL NOTICES

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use. Copies of approval letters from DOE and DHS are included in Appendix B.

At several locations at the Santa Susana Field Laboratory (SSFL), low levels of radiological contamination in buildings and in soil have occurred and have been or will be cleaned up for eventual release for use without radiological restrictions. The DOE requirements for allowable residual radioactivity in sites suitable for release without radiological restrictions ("unrestricted release") are established in DOE Order 5400.5 (Ref. 1). Specific guidelines are given in 5400.5 for surface contamination and for direct gamma exposure. However, except for radium and thorium in soil, no specific guidelines are provided for residual contamination in soil or water. It became clear that a set of DOE-authorized limits for the SSFL would greatly facilitate the process of determining that a facility is acceptably clean, and verifying this with a confirmatory survey. Approval of such a set of authorized limits is provided for in DOE Order 5400.5, Chapter IV, Section 5, and in draft 10 CFR 834.301(c).

The purpose of this report is to document the set of approved guideline values for the release without radiological restriction of DOE facilities at the SSFL. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines presented in this report are for residual radioactivity above background. When feasible, the local background activity of the suspect radionuclides should be determined and these background values subtracted from the measured release survey data.

The goal for these limits is to provide assurance that reasonable future uses of the property will not result in individual doses exceeding 15 millirem per year. This is consistent with current EPA and NRC guidance, and is supported by a generic cost-benefit analysis presented in Reference 2.

2. ANNUAL DOSE LIMITATION

DOE Order 5400.5 specifies a base Total Effective Dose Equivalent (TEDE) limit of 100 millirem per year for any potential future occupant of a remediated site. The Order also requires the use of the As Low As Reasonably Achievable (ALARA) principle to establish Authorized Limits at a level that is below the base limit. Rocketdyne will apply a value of 15 millirem per year for the calculation of derived limits for the cleanup of DOE sites at the SSFL, consistent with EPA and NRC guidance. A limit of 15 millirem per year (mrem/year) is adopted to assure that future uses will contribute small doses compared to natural background doses, which are in the range of 250-400 mrem/year (Ref. 3). This limit is considered to be as low as reasonably achievable below the basic DOE dose limit of 100 mrem/year. The 15 mrem/year value corresponds to a calculated increased lifetime cancer risk to a potential future user of the site of 3×10^{-4}.

For any reasonable assigned cost per person-rem, further reduction of anticipated dose due to exposure to residual radioactivity at the site is difficult to justify. For example, the EPA proposed TEDE of 15 mrem/year was arrived at after extensive ALARA analysis of cleanup costs and benefits at sixteen "Reference Sites" representing a wide range of conditions found at contaminated sites throughout the United States. Their analyses assumed a residential use of the decontaminated sites, and their conclusions were that the 15 mrem/year limit represented the most effective value considering all the technical and socio-political issues involved.

Furthermore, at the SSFL, conservative choices in the development, measurement, and interpretation of limits and final surveys provide a firm bias towards overestimation of the remaining risk. These include, 1) a conservative residential scenario for the pathway analyses, 2) use of calibration sources that tend to underestimate the detector efficiency for the likely contaminants, and 3) both qualitative and quantitative tests that provide assurance that the decommissioned facility is suitable for release without radiological restrictions.

3. SOIL AND WATER GUIDELINES

Since there are no federal or state regulatory limits for soil contamination for many of the potential or actual radionuclides of concern at SSFL, site-specific guidelines must be developed. This development is done, as required by the DOE Order, by use of a "pathways" analysis program, which estimates the radiological dose (total effective dose equivalent) that a future user of the property might receive, considering the residual radioactivity and various conditions of use. An effort is made to make these use conditions as reasonable for the use and the local area as can be achieved, without greatly over-estimating or under-estimating potential doses.

To establish these guidelines for cleanup operations at SSFL, the pathways analysis program RESRAD (Ref. 4), developed at Argonne National Laboratory (ANL) for use by DOE, has been used to calculate single radionuclide guidelines for the radionuclides of potential concern at SSFL.

For soil, a dose limit of 15 millirem per year is used. For consideration of radiological contamination in water, which may be collected from wells, sumps, below-grade seepage, or surface water, concentration guidelines were calculated from the Dose Conversion Factors (DCFs) in RESRAD, using the EPA limit of 4 millirem per year for ingested drinking water (Ref. 5), and the EPA assumed intake of water, 2 liters per day. These limits are more restrictive than those imposed on releases from operating facilities, as provided by DOE Order 5400.5 (Ref. 1), NRC (Ref. 6), the State of California (Ref. 7), and EPA for uranium mines and mills (Ref. 8).

3.1 Pathway Analysis

Pathways analysis involves calculating the doses received by a person through several pathways: direct radiation exposure; inhalation of airborne radioactivity; drinking water containing radioactivity; eating foods that have accumulated radioactivity, through uptake of water with radioactivity from the soil, or with airborne radioactivity deposited on the foliage; and ingestion of small amounts of contaminated soil.

The pathways analysis program RESRAD, was developed in the late 1980's for DOE by Argonne National Laboratory for the purpose of performing pathways analysis for a broad range of applications. Considerable flexibility is provided in the program for representing the site-specific conditions of exposure, to permit making the calculation as reasonable for the application as is possible.

Four general types of use may be considered for land for the purpose of calculating dose, other than the obvious zero-dose case of non-use. These may be identified as the industrial scenario, the wilderness scenario (or recreational, such as a park or golf course), the residential scenario, and the family farm scenario. Within these general use scenarios, choices are made for occupancy time (indoors and outdoors), water use, and food sources. Further choices are made to represent the contamination situation, geology, and hydrology. The program comes with a

complete set of generally conservative default values, and these may be changed as appropriate to reflect local reality in terms of usage practices and physical conditions, to produce a realistic pathways analysis for the specific site. The default values and the values actually used by the program in the analysis are listed in the output for each calculation, so departures from the default set are well recorded. The printed results from the calculations described in this report are stored in the Radiation Safety library file.

The family farm, on which family members spend 100% of their time, drinking water from the surface or from wells, eating vegetables and fruit grown on the land and irrigated with the same water, raising their meat, milk, and fish on that land, is not a reasonable scenario for the site. Although commercial farming is practiced in low-lying valley and coastal areas west of the facility, the rugged nature and topography of the SSFL, combined with poor soil quality, would reasonably preclude a family farm activity on the site. Further, recent land use trends in the area have been to conversion of previous farming property to other non-farming uses. Thus, the industrial, wilderness, and residential scenarios are all perhaps equally probable for the future of the site, and should be the scenarios considered.

3.2 Property Usage Scenarios

The basic usage conditions (per year) modeled in these calculations, for each of the three realistic scenarios, are summarized in Table 1. A complete listing of all RESRAD input data, for the three scenarios, is given in Appendix A. Discussion on specific RESRAD input parameters is given below in Section 3.3

Table 1. Property Usage Conditions for Three Realistic Scenarios

	Industrial	Wilderness	Residential
Occupancy, indoors (hours/year)	1752	0	4380
Occupancy, outdoors (hours/year)	350	876	2190
Occupancy, off site (hours/year)	6664	7890	2190
Drinking water (liters/year)	0	0	510
Fruit, vegetables, grain (kg/year)	1.6	1.6	16
Leafy vegetables (kg/year)	0	0	1.4
Cover thickness (meters)	0	0	0
Contamination area (m^2)	10000	10000	10000
Contamination thickness (meters)	1	1	1
Depth to water table (meters)	5	5	5

3.3 RESRAD Input Parameters

Default values provided in RESRAD are considered to be conservative estimates intended for use when no site-specific information is available. Users of the program are encouraged, however, to use input data that most closely reflects actual conditions existing on their site. As

part of several earlier efforts at the SSFL, a number of screening evaluations were performed using the RESRAD code to determine which of the approximately 80 input parameters required by RESRAD were of significance to the general SSFL area. These screening evaluations also were useful in determining conservative site-specific values for input to the code, when the default values were not used. In general, changes to most of the parameters were found to have a negligible effect on the final results because certain dose pathways were either not applicable or negligible for the given scenarios.

Contaminated Zone Parameters: Default values for the area of contamination (10,000 m^2) and the length parallel to aquifer flow (100 m) were assumed. For the depth of contamination, a conservative value of 1 meter is assumed. Measurements conducted at the site have indicated historical maximum values ranging from about 0.4 to 0.6 m for this parameter.

Occupancy Parameters: The default RESRAD values for occupancy of a residence on an affected site are 50% of the time spent indoors and 25% of the time spent outdoors, on the site. Thus, 25% of the time the occupancy is assumed to be off site. For the residential scenario, assuming 8,760 hours in a year, this translates into 4,380 hours spent indoors, 2,190 hours spent outdoors on the site, and 2,190 hours spent off site. For the industrial scenario, the corresponding percentages are assumed to be 20%, 4%, and 76% respectively. For the wilderness scenario, the corresponding percentages are 0%, 10%, and 90%.

Shielding Factors: The annual dose estimates calculated by RESRAD from either direct exposure or by inhalation (dust) are functions of two "structural" shielding parameters and the fraction of time an individual is assumed to spend inside a structure built on the site. Both shielding factors range from 0 to 1, and may be changed by the user to more appropriately match actual site conditions. For inhalation, the RESRAD default is 0.4, and this value is assumed for the present evaluations. For direct gamma exposure, the RESRAD default is 0.7, which is a rather conservative estimate of gamma shielding by a structure. For the present calculations, this latter value was adjusted from the default, for both the industrial and residential scenarios, to account for local construction practice which dictate a minimum 4-inch (0.1 m) concrete slab under the structure.

The gamma shielding factor used as input to RESRAD was calculated by modeling a typical two-story residential structure, and a single story industrial structure using the computer code MicroShield[1]. MicroShield is a point-kernel gamma shielding code developed for IBM-compatible personal computers, based on the mainframe code ISOSHLD. For the residential structure, a conservative lower bound footprint (area) value of 93 m^2 (1,000 ft^2) was assumed. For the industrial structure, a 186 m^2 (2,000 ft^2) area was assumed. A circular area was used with MicroShield to obtain maximum code accuracy with minimum computational time. Screening

[1] MicroShield, Version 4.0, Grove Engineering, Inc., 15215 Shady Grove Road, Suite 200, Rockville, MD 20850.

calculations indicated no significant differences between the results for circular and square areas of the same volume.

In all cases the contaminated soil was assumed to have a density of 1.5 g/cm^3, and a thickness of 1 meter. Dose calculations were performed for two vertical distances (1m for the ground floor and 3.6 m for the second story) and for three radial distances (center, midpoint, and edge of structure). The isotopic mix input to MicroShield was the same as that used for the present RESRAD calculations, with a concentration of 1 pCi/g for each isotope. Resulting gamma energy groups for this isotope mix ranged from 0.1 to 1.5 MeV. A factor of 0.89 was used to account for gamma shielding from a typical structural wall composed of approximately 1 inch of stucco and 5/8 inch of drywall, and a window area of approximately 10% of the wall area.

Effective gamma shielding factors obtained from the MicroShield calculations are given in Appendix A. For the residential scenario (the most credible), it is assumed that 12 hours are spent inside the structure per day. If it is further assumed that 8 of these hours are spent upstairs in a bedroom, 4 hours are spent downstairs in a family room, and that a person (on average) is located at the midpoint between the center and the edge of the structure, then the effective gamma shielding factor would be: (0.67)(0.61) + (0.33)(0.31) = 0.51. For the industrial scenario, the value is 0.25, which is the shielding value at the midpoint location for the single story structure.

Table 2. Gamma Shielding Factor Calculations for Typical SSFL Structure

Radial Location	Gamma Shielding Factor	
	1st Floor	2nd Floor
Residential Structure (93 m^2 footprint, two story)		
Center	0.27	0.57
Midpoint[a]	0.31	0.61
Perimeter[b]	0.57	0.71
Industrial Structure (186 m^2 footprint, single story)		
Center	0.22	-
Midpoint[a]	0.25	-
Perimeter[b]	0.58	-

[a]Midpoint between the center and the perimeter of the structure
[b]Edge of the structure.

It should be noted, that these values do not take into account any out-structures such as garages and patios, both of which would result in additional gamma shielding, and both of which would almost certainly be part of any residences built on the site.

Dietary Parameters: Default RESRAD input values for food and water consumption are based on the family farm scenario, where a significant portion of the diet is grown or raised on the site. For the three credible scenarios considered here, these parameters were adjusted as follows: for the residential scenario, it is conservatively assumed that a small fraction (10% of that grown on a family farm) of the fruit and leafy vegetables consumption would be from material grown on site. The values used are 16 kg/year per person and 1.4 kg/year per person, respectively. It was further assumed that water for the residence would be obtained from a well on the site (510 liters/year per person).

For the industrial and wilderness scenarios, it was assumed that no water would be used that was taken from the site; thus, all water pathways were suppressed with the exception of a secondary pathway via plant ingestion. In the industrial case, bottled drinking water is supplied. Since essentially all surface water at present is a result of the current industrial operations, no surface water would be available in the wilderness scenario. It is also assumed that perhaps 1% of the family farm fruit consumption value might be collected from wild sources, thus, 0.14 kg/year is used for these scenarios.

Contaminated Zone Hydrology Data: The SSFL facility is located in the Simi Hills in eastern Ventura County, California. The Simi Hills are in the northern part of the Transverse Range geomorphic province, and are composed primarily of exposures of the Upper Cretaceous Chatsworth Formation. This formation is a marine turbidite sequence of sandstone with interbedded siltstone/mudstone and minor conglomeratic lenses. The Chatsworth Formation is at least 1,800 m thick in locations east and north of the Facility.

The principal geologic units at the SSFL are the Chatsworth Formation and the shallow alluvium which overlies the Chatsworth Formation in some parts of the Facility, notably in Area IV of the SSFL where the decommissioning and decontamination of nuclear sites is taking place. This layer is Quaternary alluvium consisting of mixtures of unconsolidated sand, silt, and clay, and would include the contaminated zone. Drill holes indicate that the layer may be as thick as 6 meters in some locations.

The density of this alluvium layer is approximately 1.5 g/cm^3. The total and effective porosity of the contaminated zone are assumed to be 0.43 and 0.20 based on the average of data for sand, silt, and clay as given in the RESRAD manual. Precipitation at the facility is measured annually by a rain gauge located in the northeastern portion of the SSFL (Ventura County Rain Gauge Number 249). Based on measured data since 1959, the mean annual precipitation at the SSFL is approximately 18.6 inch, or 0.47 meters. In general, the majority of the precipitation occurs during the months of January through March.

Saturated Zone Hydrology Data: There are two groundwater systems at the SSFL: 1) a shallow system in the surficial alluvium and the underlying zones of weathered sandstone and siltstone/claystone, and isolated shallow fracture systems; and 2) a deeper regional system in the fractured Chatsworth Formation. The shallow zone is discontinuous, with depths to groundwater ranging from land surface to over 9 m. For the present study, we assume that this shallow region most conservatively represents the saturated zone, with an average depth to the water table of about 5 m. Hydraulic conductivity in the saturated zone generally ranges from about 30 to 3,000 m/year. Here, the higher value has been assumed.

Typical pumping rates for deep wells in the Chatsworth Formation (rock) range from 60 to 70 m^3/year up to a maximum of about 300 m^3/year. For the shallow (alluvium) region, however, pumping rates are significantly lower, typically about 35 m^3/year. Further, in the shallow region, many wells would be dry for a good fraction of the year as the replenishment rate is generally low. Water table drop rates, therefore, would range up to 10 m as a result of on-site pumping. Without pumping, however, no data is available on any inherent lowering of the water table. For conservatism, therefore, the default value of 0.001 m/year has been assumed.

Radon Pathway: Two default values were modified for the radon pathway. The thickness of the foundation was set at 0.1 m (4 inches) to correspond to the gamma shielding calculations discussed above. Also, the depth below ground surface was also set at 0.1 m, as basement structures are not typical for the local area.

3.4 Calculated Soil and Water Guidelines from RESRAD

The guidelines calculated from the RESRAD code for various single radionuclides are listed in Table 3 for comparison of the three scenarios. Values for each of the scenarios were determined from separate RESRAD calculation runs using the input parameters given in Appendix A. Water guideline values in Table 3 were calculated from the dose conversion factors used in RESRAD for ingestion, using an EPA value of 2 liters/day total water consumption (per person) from the site, and an EPA dose limit of 4 mrem/year (Ref. 5).

For radionuclides specifically regulated by the EPA (and the State of California), the Safe Drinking Water Act (and CCR Title 22) limits were used. These are (in pCi/l):

H-3	20,000
Combined Ra-226 and Ra-228	5
Sr-90	8
Gross alpha (not including radon and uranium)	15
Gross beta	50
Uranium (U-234 + U-235 + U-238)	20

For U-234, U-235, and U-238, DOE imposes the EPA regulations in 40 CFR 192 (and parts 190 and 440). Similarly, for Ra-226, Th-228 and Th-232, DOE imposes the limits in DOE Order 5400.5.

3.5 Soil and Water Guidelines

Based on the data in Table 3, conservative guidelines, consistent with the several applicable regulations governing residual radioactivity discussed above, are listed in Table 4. With the exception of uranium, radium, and thorium, the soil guidelines are those calculated from RESRAD for the residential use scenario. For uranium, the guidelines are those adopted by the NRC (30, 30, and 35 pCi/g for U-234, U-235, and U-238, respectively, see Ref. 9). For

Table 3. RESRAD-Calculated Single Isotope Guideline Values

	Soil Guidelines (pCi/g)			
Radionuclide	**Industrial**	**Wilderness**	**Residential**	**Water (pCi/l)[a]**
Am-241	120	162	5.44	1.50
Co-60	10.9	9.83	1.94	204
Cs-134	18.7	16.9	3.33	74.7
Cs-137	51.9	46.7	9.20	110
Eu-152	25.3	22.8	4.51	845
Eu-154	23.0	20.7	4.11	573
Fe-55	2,370,000	4,780,000	629,000	9,020
H-3	129,000	129,000	31,900	85,600[b]
K-40	162	147	27.6	294
Mn-54	34.4	30.9	6.11	1,980
Na-22	13.0	11.7	2.31	476
Ni-59	1,390,000	1,560,000	151,000	26,100
Ni-63	511,000	572,000	55,300	9,490
Pu-238	140	192	37.2	1.71
Pu-239	127	175	33.9	1.55
Pu-240	127	175	33.9	1.55
Pu-241	4,740	6,430	230	79.9
Pu-242	133	183	35.5	1.63
Ra-226	0.520	13.6	0.199	4.12[b]
Sr-90	370	376	36.0	35.8[b]
Th-228	14.8	14.7	2.81	6.78
Th-232	7.94	7.98	1.53	2.01
U-234	519	647	106	19.3[b]
U-235	163	160	32.1	20.5[b]
U-238	399	445	90.9	20.4[b]

[a]Water guidelines calculated from RESRAD ingestion dose conversion factors, assuming the EPA dose limit of 4 mrem/year (see text).

[b]For these radionuclides, the EPA Safe Drinking Water Act or the State of California CCR Title 22 limits should be used (see Table 4).

Table 4. Soil and Water Guidelines for SSFL Facilities

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[a]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[c] and 15[c]	4.1
Sr-90	36.0	8[a]
Th-228	5[c] and 15[c]	6.8
Th-232	5[c] and 15[c]	2.0
U-234	30[b]	
U-235	30[b]	total uranium 20[a]
U-238	35[b]	
Gross alpha (not including radon and uranium)		15[a]
Gross beta		50[a]

[a]State of California Maximum Contaminant Levels, CCR Title 22
[b]Generally more conservative NRC limits for uranium isotopes are used.
[c]DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm).

radium and thorium, DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm, see Ref. 1). Guidelines established from the residential use scenario are the most restrictive of the three scenarios considered.

The choice of a basic dose limit of 15 mrem/year for all pathways combined leads to lower limits than would result from the use of the dose limits established by the EPA for the uranium fuel cycle (Ref. 10) and by DOE for unrestricted release of contaminated property (Ref. 1). The water guidelines are those calculated from the RESRAD dose conversion factors, using the EPA values for the basic dose limit and daily water intake, with the Maximum Contaminant Levels (MCL) specified for certain radionuclides by the State of California (Ref. 11).

4. SURFACE CONTAMINATION GUIDELINES

Surface contamination limits are specified in Figure IV-1 of Chapter IV in DOE Order 5400.5. For SSFL facilities, these limits have been modified by specifying the potential contaminants present in the Rocketdyne facilities, and eliminating those that are not pertinent. The proposed guidelines are given in Table 5. 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.

Table 5. Surface Contamination Guidelines for SSFL Facilities

Radionuclide	Average over 1 m^2 (dpm/100 cm^2)	Maximum in 100 cm^2 (dpm/100 cm^2)	Removable (dpm/100 cm^2)
Plutonium, Radium	100	300	20
Thorium	1,000	3,000	200
Uranium	5,000	15,000	1,000
Mixed fission products	5,000	15,000	1,000
Activation products	5,000	15,000	1,000
Tritium	-	-	10,000

As included in Table 5, Pu, Ra, U, Th, mixed fission products, and activation products, refer to those forms of radioactive material that comprise the residual activity at the SSFL. Plutonium is predominately Pu-239; Radium is Ra-226. It is assumed that thorium is sufficiently aged that all daughters are in equilibrium, Th-natural. Uranium will occur in depleted, normal, or enriched forms; U-233 is not present. Mixed fission products include Sr-90 and Cs-137 as components of the mixture. Possible activation products include Co-60, Fe-55, Mn-54, Eu-152, Eu-154, Al-26, and similar radionuclides.

Tritium contamination limits are based on interim guidelines for removable surface contamination (Ref. 12). This level of removable contamination insures that any non-removable or volumetric contamination will not cause unacceptable exposures.

These guidelines will be imposed for accessible (or potentially accessible) surfaces and structures.

5. AMBIENT GAMMA EXPOSURE RATE

A guideline of 5 μR/hr above natural background, measured at 1 meter above the surface, is used. This value has been imposed by the NRC for decommissioning research reactors (Ref. 13). It is as low as reasonably measurable, due to variations in background, and is significantly lower than the guideline of 20 μR/hr stated in DOE Order 5400.5, Chapter IV, Section 4.c. This guideline is imposed for accessible (or potentially accessible) structures and land. Our experience has been that this level can be achieved and verified in facilities that would be suitable for continued use.

6. APPLICATION OF GUIDELINES

Note: The survey protocols described below were those employed at the time of issue of N001SRR140127 and have been in use up until the end of 1998. As of the beginning of 1999, MARSSIM protocols will be employed (Reference 19) utilizing the guidelines developed in this report as the DCGLWs (derived concentration guideline limits).

The guidelines presented above should be used in planning any decontamination effort at the SSFL. Analytical capability for detection of each radionuclide should be, if possible, less than one-tenth of the guideline values. That is, the Minimum Detectable Activity (MDA, our LLD) should be less than 0.1 x guideline. Field measurements used to direct removal of contaminated soil should be capable of practical measurements below the guideline value. Survey measurements and sample analyses should be corrected for the local background activity of each radionuclide.

6.1 Soil Guidelines

Sample analysis is necessary to demonstrate the successful decontamination of soil areas. A qualitative scan will be performed using gamma-sensitive and/or beta-sensitive detectors to identify any significant areas of residual contamination. Soil samples will be taken from locations based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. This selection assures a reasonably uniform sampling of the ground areas, at a sample density of approximately 11 samples per 100 m^2.

Results from individual samples will be compared with the limit for hotspots of 9-m^2 area, that is, 3.3 x the adopted concentration limit. Averages of adjacent samples, covering 100 m^2, will be compared with the average limit. The overall average, assuming that the individual and 100-m^2 area averages satisfy the applicable limits, will be used for a RESRAD confirmatory calculation. This calculation will be performed to demonstrate that the maximum expected annual dose for the indicated reasonable use scenario for the facility *does not exceed* the proposed 15 mrem/year guideline value.

For mixtures of radionuclides in soil, the "Sum of Fractions" rule is used. The sum of the ratios of concentration of each radionuclide to the corresponding guideline must not exceed 1. This value must be satisfied when samples are averaged over each 100-m^2 region. For cases in which the relative concentrations are known or assumed, this method is used to generate combined radionuclide guidelines for each radionuclide in the mixture.

The guidelines are not intended to be spot limits, and should not be applied to individual measurements. If the specific sampling provides only (or fewer than) one measurement per 100-

m^2 area, each measurement becomes, by default, the "average" for that 100-m^2 area, and the guidelines have the effect of acting as spot limits. In cases where an individual sample exceeds the guideline value, additional samples should be taken from within the same 100-m^2 area, and used to define the average contamination in this area.

The maximum concentrations remaining as "hot spots" must have contamination less than that calculated by the hot-spot rule presented in DOE Order 5400.5, Chapter IV, page 4. The average contamination within any area not exceeding 25 m^2 shall not be greater than $\sqrt{100 / A}$ guideline, where A is the area in m^2. Reasonable efforts shall be made to remove any soil with contamination that exceeds 30 x guideline (Ref. 4).

6.2 Surface Contamination Guidelines

The proposed surface contamination guidelines would be applied to all accessible surfaces and structures. This would include ceilings, floors, and walls, and other potentially accessible locations such as attics. Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the guidelines established for alpha- and beta-gamma-emitting radionuclides should apply independently. Measurements of average contamination are averaged over an area of 1 m^2. For objects of less surface area, the average should be derived for each such object. The maximum contamination level applies to an area of not more than 100 cm^2. Surfaces of facilities which are likely to be contaminated, but are inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the applicable limits.

Following a complete qualitative scan of the facility, quantitative surface contamination measurements will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. Results from individual locations will be compared with the applicable limits.

Total surface contamination is measured by use of detectors primarily or exclusively sensitive to alpha or beta-gamma radiation. After a qualitative survey of the surfaces of the entire subject area, quantitative measurements are made on 1-m^2 areas selected uniformly throughout the area. These measurements are made with the detectors connected to a scaler set to accumulate counts for a 5-minute period. The detector is slowly scanned over the 1-m^2 grid location and the numerical result, after correction for background, count time, and detector efficiency, yields the 1-m^2 average surface activity. These detectors are calibrated against Th-230 for alpha activity and Tc-99 for beta activity. The emission energies of these radionuclides is generally less than those radionuclides found as contamination at SSFL. This results in an

underestimate of the efficiency of the detectors for the actual contaminant radioactivity and hence an overestimate of the actual measurement.

The amount of removable activity per 100 cm^2 of surface area is 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. Typically at Rocketdyne, a low background gas flow proportional counter is used. 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 guidelines for removable contamination.

Smear methods for tritium detection are similar to that described above, with the exception that a wet swipe or piece of Styrofoam should be used. If the property has been recently decontaminated, a follow-up measurement (smears) should be conducted to ensure that there is no build-up of contamination with time.

6.3 Ambient Gamma Exposure

Measurements of the ambient gamma exposure rate provides a useful determination of residual volumetric radioactivity that may not be as easily detected by surface measurements or sampling and analysis. For the purpose of demonstrating suitability for release, this measurement provides an additional test.

The DOE established a limit of 20 μR/hr above natural background for screening radium-contaminated property. The NRC has imposed a 10μR/hr limit on the decommissioning of radioactive materials licensees, and a 5μR/hr limit on the decommissioning of research reactors. The 5 μR/hr limit above natural background is proposed for use at Rocketdyne. Because of the variability and differences in natural background, the limit of 5 μR/hr is about as low as can be reasonably implemented.

Quantitative measurements of the ambient gamma exposure rate will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3-meter master grid. One measurement, covering one 1-m^2 grid location, will be made at each grid location chosen for the surface contamination measurements. Results from individual locations will be compared with the applicable limits.

At Rocketdyne, gamma exposure rate is generally measured by use of a 1x1 inch NaI(Tl) detector/photomultiplier probe, connected to a scaler to provide objective numerical values. The

detector is placed 1 meter above the local (ground or floor) surface. This instrument is calibrated by reference to a High Pressure Ion Chamber (HPIC) in a background area.

6.4 Statistical Validation of Survey Data

The statistical approach employed at Rocketdyne/ETEC for establishing that survey data meets guideline values is a method referred to as Sampling Inspection by Variables (Ref. 14). This method has been widely applied in industry and the military and is essential where the lot size is impractically large. Application of this method to the remediation of contaminated sites has been discussed in detail elsewhere (see for example, Ref. 15).

In sampling inspection by variables, the number of data points on which measurements are obtained is first chosen to be large so that the parameters of the distribution are likely to have a normal distribution (i.e., Gaussian). The mean of the distribution, $\bar{x}$, and its standard deviation, s, are then related to a "test statistic", TS, as follows:

$$TS = \bar{x} + ks$$

where $\bar{x}$ = average (arithmetic mean of measured values)
s = observed sample standard deviation
k = tolerance factor calculated from the number of samples to achieve the desired sensitivity for the test

TS and $\bar{x}$ are then compared with an authorized acceptance limit, U, to determine acceptance or other plans of action, including rejection of the area as contaminated and requiring further remediation.

The sample mean and standard deviation are easily calculable quantities; the value of k, the tolerance factor, bears further discussion. Of the various criteria for selecting plans for acceptance sampling by variables, the most appropriate is the method of Lot Tolerance Percent Defective (LTPD), also referred to as the Rejectable Quality Level (RQL). The LTPD is defined as the poorest quality that should be accepted in an individual lot. Associated with the LTPD is a parameter referred to as consumer's risk (β), the risk of accepting a lot of quality equal to or poorer than the LTPD (or 10%). NRC Regulatory Guide 6.6 (Ref. 16) states that the value for the consumer's risk should be 0.10. Conventionally, the value assigned to the LTPD has been 10%.

The State of California, Department of Radiological Health Branch, has stated that the consumer's risk of acceptance (β) at 10% defective (LTPD) must be 0.1 (Ref. 17). For those choices of β and LTPD, $K_\beta = K_2 = 1.282$. The number of samples is n. Values of k for each sample size are calculated in accordance with the following equations:

$$k = \frac{K_2 + \sqrt{K_2^2 - ab}}{a}; \quad a = 1 - \frac{K_\beta}{2(n-1)}; \quad b = K_2^2 - \frac{K_\beta^2}{n}$$

where k = tolerance factor,
K_β = the normal deviate exceeded with probability of β, 0.10 (from tables, $K_2 = 1.282$, see Ref. 18),
K_2 = the normal deviate exceeded with probability equal to the LTPD, 10% (from tables, $K_\beta = 1.282$, see Ref. 18)[2], and
n = number of samples.

The statistical criteria for acceptance of a remediated area are presented below.

a) Acceptance: If the test statistic ($\bar{x} + ks$) is less than or equal to the guideline (U), accept the area as clean. If any single measured value exceeds 80% of the limit, decontaminate that location to as near background as is possible, but do not change the value in the analysis.

b) Collect additional measurements: If the test statistic ($\bar{x} + ks$) is greater that the limit (U), but $\bar{x}$ itself is less than U, independently resample and combine all measured values to determine if $\bar{x} + ks \leq = U$ for the combined set; if so, accept the area as clean. If not, the area is contaminated and must be remediated.

c) Rejection: If the test statistic ($\bar{x} + ks$) is greater than the limit (U) and $\bar{x} > = U$, the region is contaminated and must be remediated.

Thus, based on sampling inspection, we are willing to accept the hypothesis that the probability of accepting an area as not being contaminated which is, in fact, 10% or more contaminated is 0.10. Or in other words, the final survey acceptance criteria corresponds to assuring with 90% confidence that 90% of an area has residual contamination below 100% (a 90/90/100 test) of the authorized limit.

7. REFERENCES

1. "RADIATION PROTECTION OF THE PUBLIC AND ENVIRONMENT," DOE Order 5400.5, U. S. Department of Energy, February 8, 1989.

2. "Regulatory Impact Analysis for Radiation Site Cleanup Proposed Rule - Draft", U. S. Environmental Protection Agency, January 17, 1996.

3. "Health Effects of Exposure to Low Levels of Ionizing Radiation -- BEIR V," Committee on the Biological Effects of Ionizing Radiations, Board on Radiation Effects Research, Commission on Life Sciences, National Research Council. National Academy Press, Washington, 1990.

4. "A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH/8901, U. S. Department of Energy, June 1989.

5. "National Primary Drinking Water Regulations; Radionuclides," 40 CFR 141.15 and .16, U. S. Environmental Protection Agency, July 18, 1991.

6. "STANDARDS FOR PROTECTION AGAINST RADIATION," 10 CFR 20, U. S. Nuclear Regulatory Commission.

7. "CALIFORNIA RADIATION CONTROL REGULATIONS," CCR 17, State of California Department of Health Services.

8. "ORE MINING AND DRESSING POINT SOURCE CATEGORY," Subpart C--Uranium, Radium and Vanadium Ores Subcategory, 40 CFR 440, U. S. Environmental Protection Agency.

9. "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations," Federal Register . Vol. 46, No. 205, pp. 52061-52063, Friday, October 23, 1981. U. S. Nuclear Regulatory Commission.

10. "ENVIRONMENTAL PROTECTION STANDARDS FOR NUCLEAR POWER OPERATIONS," 40 CFR 190, U. S. Environmental Protection Agency.

11. "Environmental Health, Radioactivity," CCR 22, Article 5. State of California Department of Health Services.

12. "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", DOE Memorandum, DOE-OAK, January 5, 1996.

13. "Order Authorizing Dismantling of Facility and Disposition of Component Parts", Docket No. 50-375, Enclosure to NRC Letter dated February 22, 1983, D. Eisenhut to M. Remley.

14. DOE/CH/8901, A Manual for Implementing Residual Radioactive Material Guidelines, T. L. Gilbert, et al., June 1989.

15. "Statistical Treatment of Radiological Survey Data for Cleanup Decisions and Regulatory Compliance", Proc. Spectrum '92 Conference, Boise, Idaho, August 23 - 27, 1992.

16. "Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing By-Product Material", U. S. Nuclear Regulatory Commission Guide 6.6, dated June 1974.

17. DECON-1, State of California for Decontaminating Facilities and Equipment Prior to Release for Unrestricted Use, dated June 1977.

18. MIL-STD-414, Sampling Procedures and Tables for Inspection by Variables for Percent Defective, June 11, 1957.

19. NUREG-1575 (EPA 402-R-97-016), "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", December 1997.

Appendix A

Input Parameters for RESRAD Calculations (Sheet 1 of 3)

Parameter	Value Used for Scenario			RESRAD
	Industrial	Wilderness	Residential	Default
Area of contaminated zone (m^2)	1.000E+04	1.000E+04	1.000E+04	1.000E+04
Thickness of contaminated zone (m)	1.000E+00	2.000E+00	1.000E+00	2.000E+00
Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Basic radiation dose limit (mrem/yr)	1.500E+01	1.500E+01	1.500E+01	3.000E+01
Time since placement of material (yr)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Times for calculations (yr)	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Times for calculations (yr)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Times for calculations (yr)	1.000E+01	1.000E+01	1.000E+01	1.000E+01
Times for calculations (yr)	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Times for calculations (yr)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Times for calculations (yr)	3.000E+02	3.000E+02	3.000E+02	3.000E+02
Times for calculations (yr)	1.000E+03	1.000E+03	1.000E+03	1.000E+03
Times for calculations (yr)	3.000E+03	0.000E+00	3.000E+03	0.000E+00
Times for calculations (yr)	1.000E+04	0.000E+00	1.000E+04	0.000E+00
Cover depth (m)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Density of cover material (g/cm^3)	not used	not used	not used	1.500E+00
Cover depth erosion rate (m/yr)	not used	not used	not used	1.000E-03
Density of contaminated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Contaminated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Contaminated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Contaminated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Contaminated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Humidity in air (g/cm^3)	8.000E+00	8.000E+00	8.000E+00	8.000E+00
Evapotranspiration coefficient	5.000E-01	5.000E-01	5.000E-01	5.000E-01
Precipitation (m/yr)	4.700E-01	4.700E-01	4.700E-01	1.000E+00
Irrigation (m/yr)	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Irrigation mode	overhead	overhead	overhead	overhead
Runoff coefficient	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Watershed area for nearby stream or pond (m^2)	1.000E+06	1.000E+06	1.000E+06	1.000E+06
Accuracy for water/soil computations	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Density of saturated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Saturated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Saturated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Saturated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+02
Saturated zone hydraulic gradient	2.000E-02	2.000E-02	2.000E-02	2.000E-02
Saturated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Water table drop rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Well pump intake depth (m below water table)	1.000E+01	1.000E+01	1.000E+01	1.000E+01

Input Parameters for RESRAD Calculations (Sheet 2 of 3)

Parameter	Value Used for Scenario			RESRAD Default
	Industrial	Wilderness	Residential	
Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	ND	ND
Well pumping rate (m^3/yr)	not used	not used	7.000E+01	2.500E+02
Number of unsaturated zone strata	1	1	1	1
Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	4.000E+00	4.000E+00
Unsat. zone 1, soil density (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Unsat. zone 1, total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Unsat. zone 1, hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Inhalation rate (m^3/yr)	8.400E+03	8.400E+03	8.400E+03	8.400E+03
Mass loading for inhalation (g/m^3)	2.000E-04	2.000E-04	2.000E-04	2.000E-04
Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Exposure duration	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Shielding factor, inhalation	4.000E-01	4.000E-01	4.000E-01	4.000E-01
Shielding factor, external gamma	2.500E-01	7.000E-01	5.100E-01	7.000E-01
Fraction of time spent indoors	2.000E-01	0.000E+00	5.000E-01	5.000E-01
Fraction of time spent outdoors (on site)	4.000E-02	1.000E-01	2.500E-01	2.500E-01
Shape factor flag, external gamma	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Fruits, vegetables and grain consumption (kg/yr)	1.600E+00	1.600E+00	1.600E+01	1.600E+02
Leafy vegetable consumption (kg/yr)	0.000E+00	0.000E+00	1.400E+00	1.400E+01
Milk consumption (L/yr)	not used	not used	not used	9.200E+01
Meat and poultry consumption (kg/yr)	not used	not used	not used	6.300E+01
Fish consumption (kg/yr)	not used	not used	not used	5.400E+00
Other seafood consumption (kg/yr)	not used	not used	not used	9.000E-01
Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	3.650E+01	3.650E+01
Drinking water intake (L/yr)	not used	not used	5.100E+02	5.100E+02
Contamination fraction of drinking water	not used	not used	1.000E+00	1.000E+00
Contamination fraction of household water	1.000E+00	0.000E+00	1.000E+00	1.000E+00
Contamination fraction of livestock water	not used	0.000E+00	not used	1.000E+00
Contamination fraction of irrigation water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Contamination fraction of aquatic food	not used	not used	not used	5.000E-01
Contamination fraction of plant food	-1	-1	-1	-1
Contamination fraction of meat	not used	not used	not used	-1
Contamination fraction of milk	not used	not used	not used	-1
Livestock fodder intake for meat (kg/day)	not used	not used	not used	6.800E+01
Livestock fodder intake for milk (kg/day)	not used	not used	not used	5.500E+01
Livestock water intake for meat (L/day)	not used	not used	not used	5.000E+01
Livestock water intake for milk (L/day)	not used	not used	not used	1.600E+02
Livestock soil intake (kg/day)	not used	not used	not used	5.000E-01
Mass loading for foliar deposition (g/m^3)	1.000E-04	1.000E-04	1.000E-04	1.000E-04
Depth of soil mixing layer (m)	1.500E-01	1.500E-01	1.500E-01	1.500E-01
Depth of roots (m)	9.000E-01	9.000E-01	9.000E-01	9.000E-01

Input Parameters for RESRAD Calculations (Sheet 3 of 3)

Parameter	Value Used for Scenario			RESRAD Default
	Industrial	Wilderness	Residential	
Drinking water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Household water fraction from ground water	not used	not used	1.000E+00	1.000E+00
Livestock water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Irrigation fraction from ground water	not used	not used	not used	1.000E+00
C-12 concentration in water (g/cm^3)	not used	not used	not used	2.000E-05
C-12 concentration in contaminated soil (g/g)	not used	not used	not used	3.000E-02
Fraction of vegetation carbon from soil	not used	not used	not used	2.000E-02
Fraction of vegetation carbon from air	not used	not used	not used	9.800E-01
C-14 evasion layer thickness in soil (m)	not used	not used	not used	3.000E-01
C-14 evasion flux rate from soil (1/sec)	not used	not used	not used	7.000E-07
C-12 evasion flux rate from soil (1/sec)	not used	not used	not used	1.000E-10
Fraction of grain in beef cattle feed	not used	not used	not used	8.000E-01
Fraction of grain in milk cow feed	not used	not used	not used	2.000E-01
Storage times of contaminated foodstuffs (days):				
Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	1.400E+01	1.400E+01
Leafy vegetables	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Milk	not used	not used	not used	1.000E+00
Meat and poultry	not used	not used	not used	2.000E+01
Fish	not used	not used	not used	7.000E+00
Crustacea and mollusks	not used	not used	not used	7.000E+00
Well water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Surface water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Livestock fodder	not used	not used	not used	4.500E+01
Thickness of building foundation (m)	1.000E-01	not used	1.000E-01	1.500E-01
Bulk density of building foundation (g/cm)	2.400E+00	not used	2.400E+00	2.400E+00
Total porosity of the cover material	not used	not used	not used	4.000E-01
Total porosity of the building foundation	1.000E-01	not used	1.000E-01	1.000E-01
Volumetric water content of the cover material	not used	not used	not used	5.000E-02
Volumetric water content of the foundation	3.000E-02	not used	3.000E-02	3.000E-02
Diffusion coefficient for radon gas (m/sec):				
in cover material	not used	not used	not used	2.000E-06
in foundation material	3.000E-07	not used	3.000E-07	3.000E-07
in contaminated zone soil	2.000E-06	not used	2.000E-06	2.000E-06
Radon vertical dimension of mixing (m)	2.000E+00	not used	2.000E+00	2.000E+00
Average annual wind speed (m/sec)	2.000E+00	not used	2.000E+00	2.000E+00
Average building air exchange rate (1/hr)	5.000E-01	not used	5.000E-01	5.000E-01
Height of the building (room) (m)	2.500E+00	not used	2.500E+00	2.500E+00
Building interior area factor	0.000E+00	not used	0.000E+00	0.000E+00
Building depth below ground surface (m)	1.000E-01	not used	1.000E-01	-1.000E+00
Emanating power of Rn-222 gas	2.500E-01	not used	2.500E-01	2.500E-01
Emanating power of Rn-220 gas	not used	not used	not used	1.500E-01

Appendix B
Agency Approvals

1. Letter from Gerard Wong (DHS) to Majelle Lee (Rocketdyne), "Authorized Sitewide Radiological Guidelines for Release for Unrestricted Use", 96ETEC-DRF-0455, August 9, 1996.
2. Memorandum from Sally A. Robison (DOE-ER) to Roger Liddle (DOE-OAK), Sitewide Limits for Release of Facilities Without Radiological Restriction", 007857RC, September 17, 1996.

EXHIBIT III

INDEPENDENT VERIFICATION DOCUMENTATION OF THE RADIOLOGICAL CONDITION OF FACILITY 4019 IN AREA IV AT SSFL

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

February 16, 1999

Mr. Anand Gupta
U.S. Department of Energy
EM-43
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: ADDENDUM TO THE VERIFICATION SURVEY REPORT FOR BUILDINGS T019 AND T024, SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA (ORISE 1996a)

Dear Mr. Gupta:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) recently completed the follow-up verification of Building T019 (now known as Building 4019) at the Santa Susana Field (SSFL) Laboratory in Ventura County, California (Figure 1). Rocketdyne/Boeing, formerly known as Rockwell, operates the SSFL. The Energy Technology Engineering Center (ETEC) is that portion of the SSFL operated for the Department of Energy (DOE), where nuclear energy research and development programs were performed. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved engineering, developing, testing, and manufacturing operations for nuclear reactor systems and components. Rocketdyne/Boeing is currently decommissioning a number of those facilities that were associated with the various nuclear research programs.

Building 4019 was constructed in 1962 and served as the Systems for Nuclear and Auxiliary Power (SNAP) System Nuclear Qualification Test Facility where SNAP reactors, using fully encapsulated highly enriched uranium, were tested at zero power. Building 4019 is located on B Street in the north-central part of Area IV (Figure 2). Total area of the building is 595 m^2 divided among a high bay area that also includes a below-grade test vault, a low bay office-control center, and a storage vault that was originally built for nuclear fuel element storage (Figure 3). Building construction is of steel framing and siding and a built-up roof.

Subsequent to termination of the SNAP program in 1970, all SNAP components were removed and a facility survey performed. Documentation indicated that there were no releases of the uranium fuel or fission products and that neutron activation of construction materials was negligible (Rockwell 1988). Rockwell/Rocketdyne released the building from radiological controls and redesignated it as the ETEC Construction Staging and Computer Facility.

ESSAP performed verification activities for the facility during September 1995 that included document reviews and independent measurements and sampling. These activities identified deficiencies in the final status survey report and the presence of residual contamination on the floor of the Building 4019 high bay area. In addition, ESSAP was unable to access the test vault for survey at that time. The results of this initial verification were documented in a survey report that was previously submitted to the DOE (ORISE 1996a). Rocketdyne/Boeing has since completed the remediation of the residual contamination that ESSAP identified within the facility and performed additional radiological surveys to address deficiencies noted in their previous final status survey report (Boeing 1998 and ORISE 1996b). This letter report serves as an addendum to the 1996 ESSAP verification report.

On September 29, 1998, ESSAP performed a reverification of Building 4019 that included surveys of both the test vault as well as the previously identified contaminated area in the high bay area. The survey was conducted in accordance with a DOE approved site-specific survey plan (ORISE 1998). Survey procedures included alpha plus beta surface scans using gas proportional detectors coupled to ratemeter-scalers with audible indicators, measurements of total and removable surface activity levels, and exposure rate measurements using a microrem meter. Figures 4 and 5 show measurement locations.

ESSAP's surface scans of the high bay area and the test vault did not identify any locations of elevated direct radiation. Surface activity levels are summarized in Table 1. Total surface activity levels within the test vault ranged from -14 to -7 dpm/100 cm^2 for alpha and -190 to 330 dpm/100 cm^2 for beta. For the previously contaminated high bay area, the activity levels ranged from 0 to 43 dpm/100 cm^2 for alpha and 220 to 550 dpm/100 cm^2 for beta. Removable activity levels were all less than the respective minimum detectable concentration level of 9 dpm/100 cm^2 for alpha and 15 dpm/100 cm^2 for beta. The exposure rate within the test vault averaged 12 μR/h. ESSAP compared these exposure rate levels to the Rocketdyne/Boeing-determined average interior background exposure rate of 8 μR/h.

Surface activity levels were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for uranium and mixed fission and activation products (DOE 1990). The applicable guidelines for uranium are as follows:

Total Activity

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

and the guidelines for beta-gamma emitters are:

Total Activity
5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area
15,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity
1,000 β-γ dpm/100 cm^2

All surface activity levels satisfied these guidelines. The DOE's exposure rate guideline is 20 μR/h above background, although Rocketdyne/Boeing has elected to use a more restrictive guideline of 5 μR/h above background. Interior exposure rates at one meter above the surface were less than the more restrictive criterion of 5 μR/h above background.

Please contact me at (423) 576-5073 or Eric Abelquist at (423) 576-3740 should you have any questions or we may provide additional information.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
Environmental Survey and
Site Assessment Program

TJV:dkh

cc. M. Lopez, DOE/OAK
H. Joma, DOE/OAK
W. Beck, ORISE/ESSAP
E. Abelquist, ORISE/ESSAP
Files/386 archive and 402

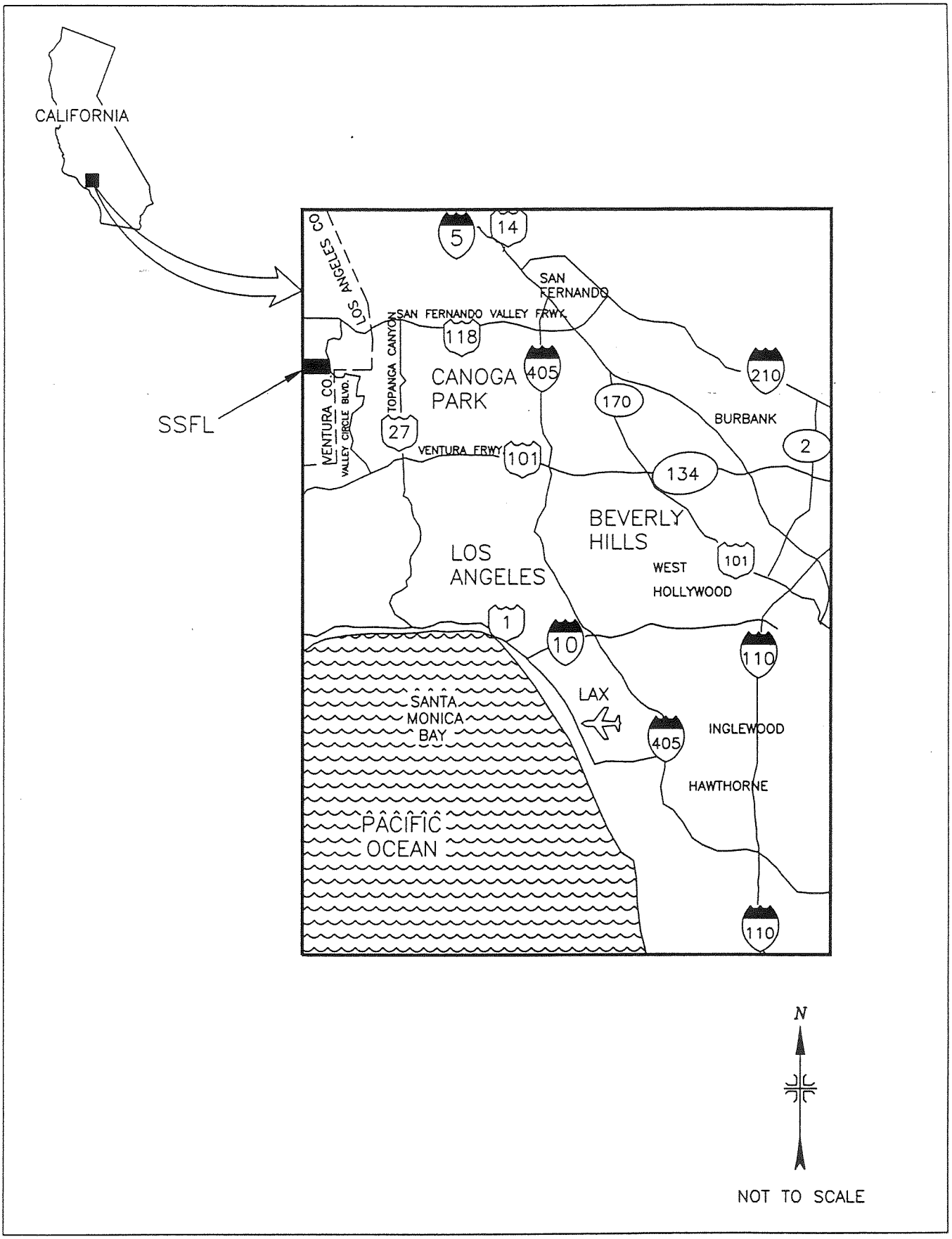


FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

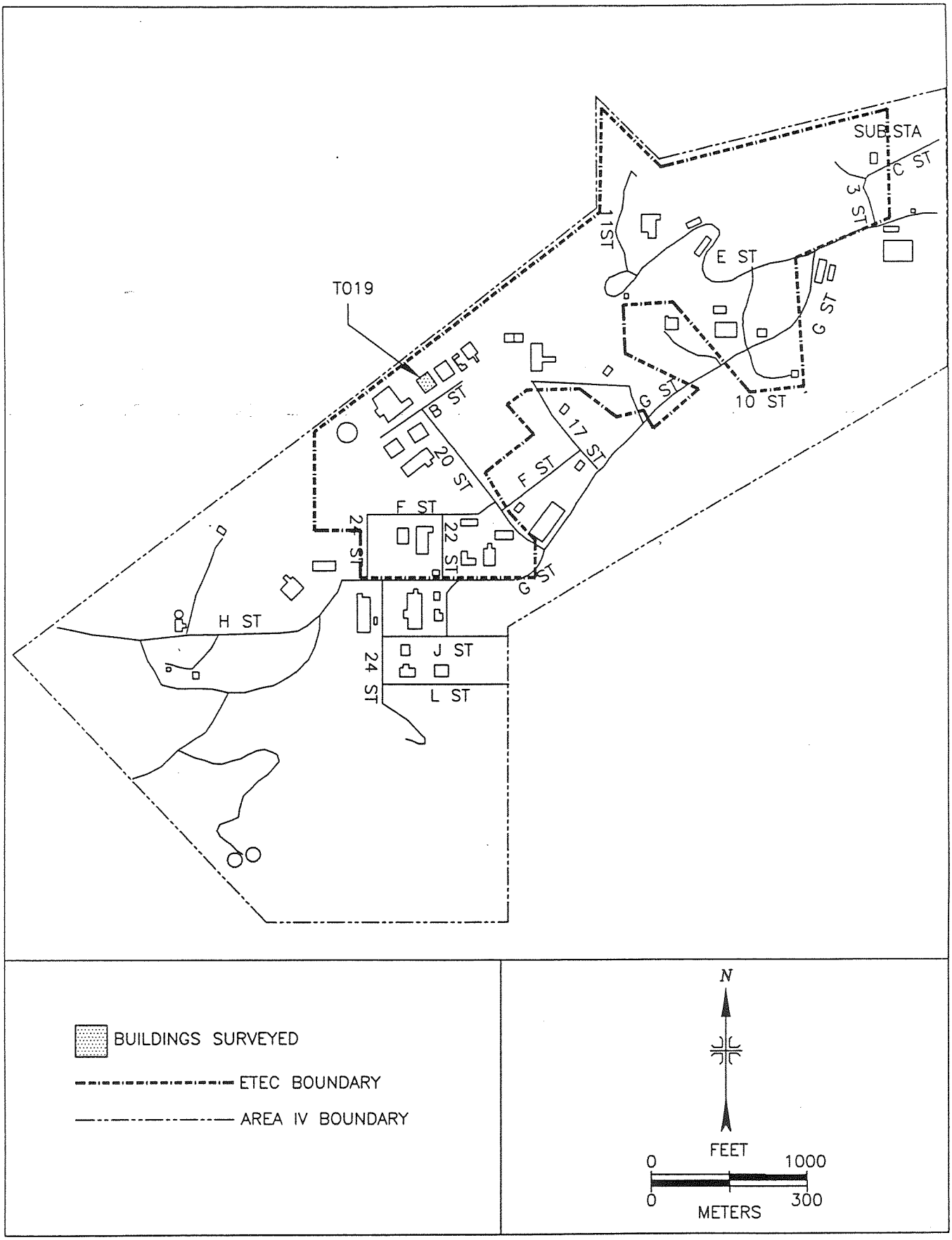


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Surveyed Areas

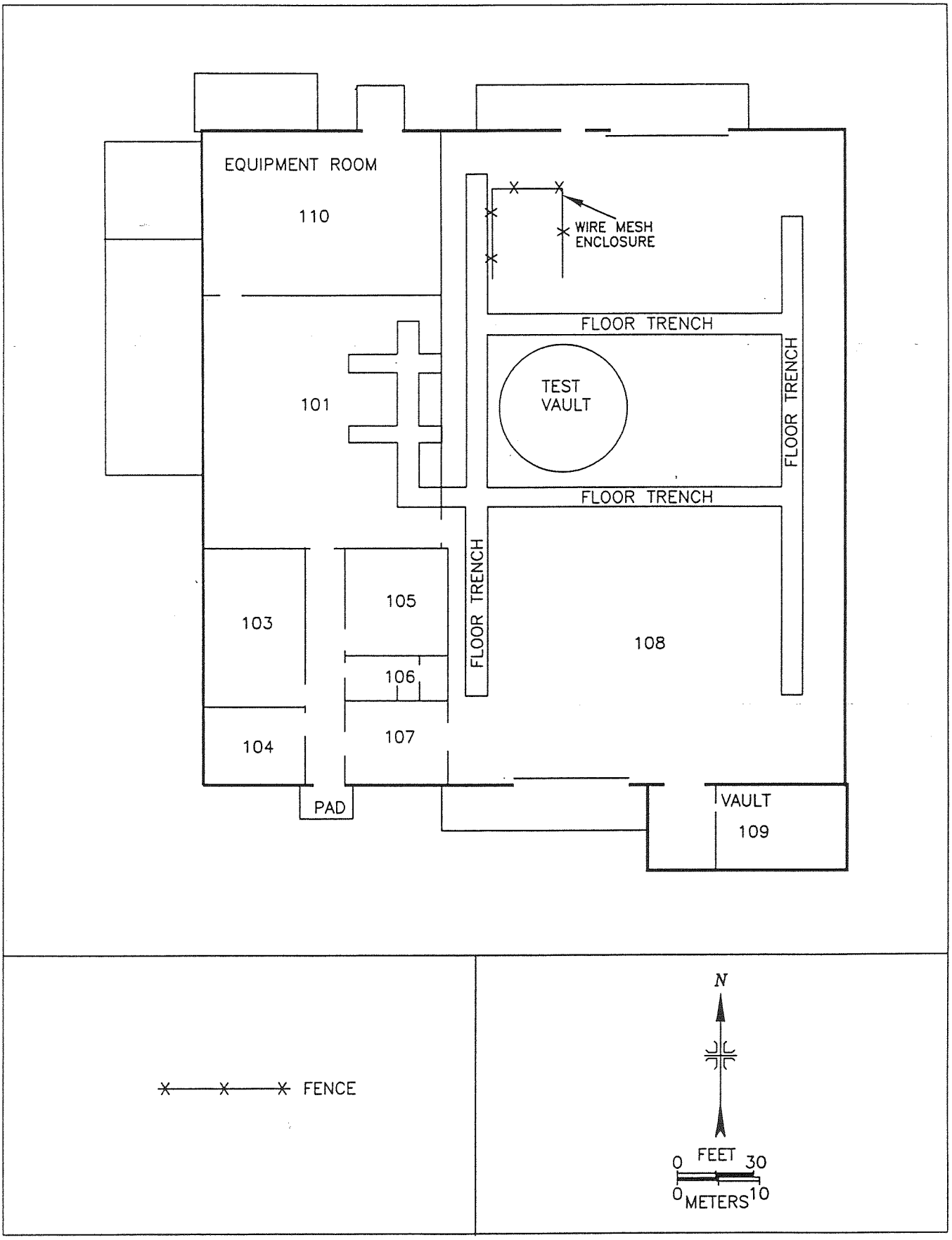


FIGURE 3: Building 4019 – Floor Plan

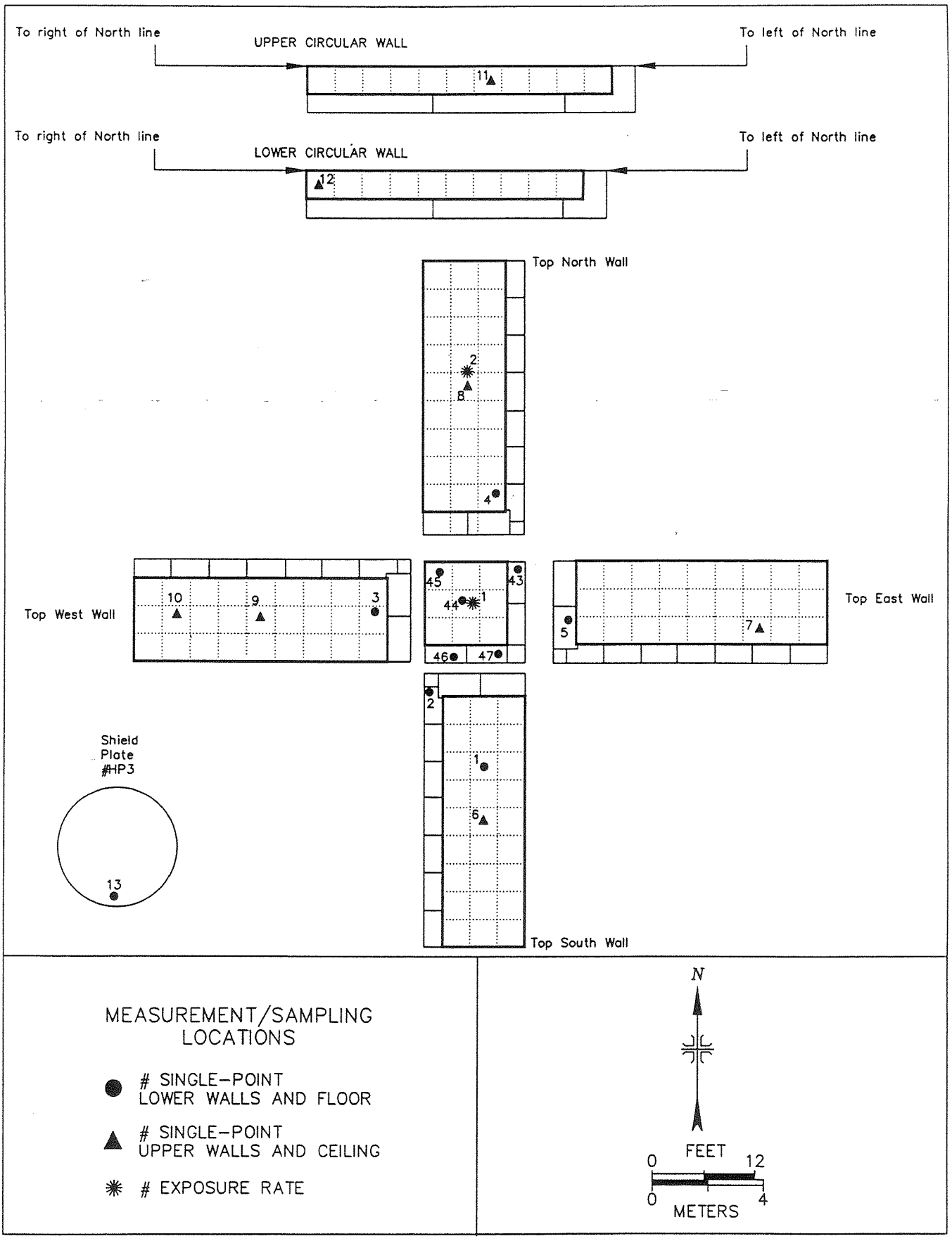


FIGURE 4: 4019 Test Vault – Measurement and Sampling Locations

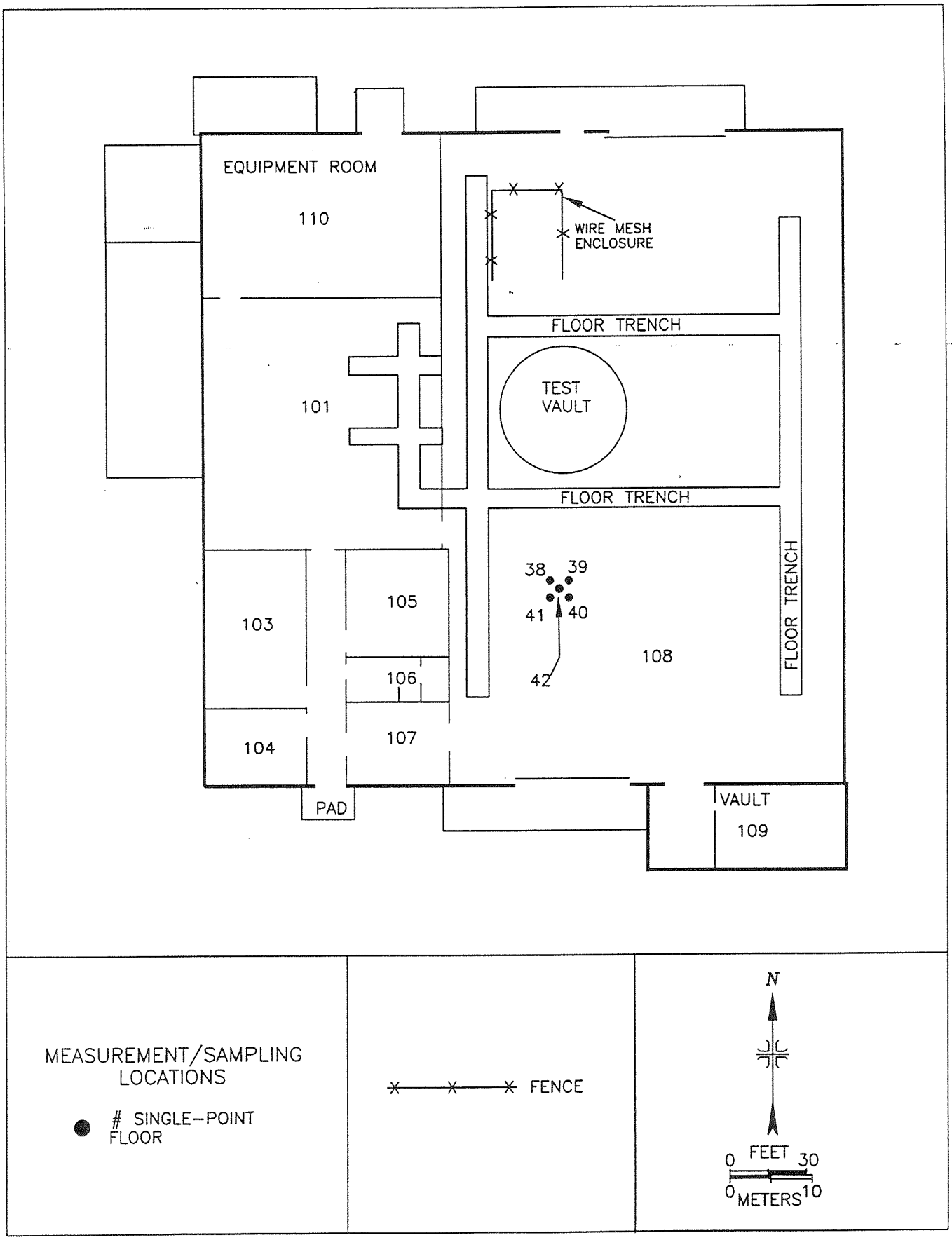


FIGURE 5: Building 4019 – Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDING T019
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Location[a]	Surface Activity Level dpm/100 cm^2		Removable Activity Level dpm/100 cm^2	
	Alpha	Beta	Alpha	Beta
Building T019 Test Vault				
43	-14	-88	0	-3
44	-14	-170	0	5
45	-14	3	0	-6
46	-14	11	0	5
47	-7	-96	0	-2
1	-14	-104	0	2
2	-7	36	0	-5
3	-14	-148	0	-2
4	-14	-186	0	-3
5	-14	49	0	-3
6	-7	-115	0	4
7	-14	109	0	1
8	-14	-82	0	-5
9	-14	-131	2	1
10	-14	30	2	-3
11	-14	118	0	-1
12	-14	11	0	-1
13	-14	328	0	-1

TABLE 1 (continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDING T019
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Location[a]	Surface Activity Level dpm/100 cm²		Removable Activity Level dpm/100 cm²	
	Alpha	Beta	Alpha	Beta
Building T019 High Bay Post-Remedial Action				
38	43	545	0	3
39	36	219	0	1
40	0	271	0	5
41	7	454	0	1
42	36	490	0	-1

[a]Refer to Figures 4 and 5.

REFERENCES

Boeing North American, Inc./Rocketdyne Division (Boeing). SNAP Test Chamber, Building 4019, Final Survey Procedure. Canago Park, California; August 24, 1998.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; February, 1996a.

Oak Ridge Institute for Science and Education. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Buildings T013, T019, T024, T030, and T641; The Storage Yard West of Buildings T626 and T038; and The NW Area; Santa Susana Field Laboratory, Ventura County, CA. Oak Ridge, TN; January 11, 1996b.

Oak Ridge Institute for Science and Education. Proposed Verification Survey Plan for the Desoto Mass Spectrometry Laboratory (104), the Building 4019 Test Vault, and the T064 Side Yard, Santa Susana Field Laboratory, Boeing North America, Inc., Ventura County, California. Oak Ridge, TN; September 23, 1998.

Rockwell International (Rockwell). Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988.

U.S. Department of Energy (DOE). Radiation Protection of the Public and the Environment. Washington, DC: DOE Order 5400.5; February 1990.

VERIFICATION SURVEY OF BUILDINGS T019 AND T024 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T. J. VITKUS and T. L. BRIGHT

Prepared for the Office of Environmental Restoration
U.S. Department of Energy

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Group

VERIFICATION SURVEY OF BUILDINGS T019 AND T024 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by

T. J. Vitkus and T. L. Bright

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Group
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

FEBRUARY 1996

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

ACKNOWLEDGMENTS

The authors would like to acknowledge the significant contributions of the following staff members:

FIELD STAFF

T. D. Herrera
J. R. Morton

LABORATORY STAFF

R. D. Condra
J. S. Cox
M. J. Laudeman

CLERICAL STAFF

T. S. Fox
K. E. Waters

ILLUSTRATOR

T. D. Herrera

TABLE OF CONTENTS

LIST OF FIGURES

PAGE

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

μR/h	microroentgens per hour
AEC	Atomic Energy Commission
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EM	Environmental Restoration and Waste Management
EML	Environmental Measurement Laboratory
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
GM	Geiger-Mueller
ha	hectare
km	kilometer
m	meter
m^2	square meter
M&O	Management and Operation
NIST	National Institute of Standards and Technology
NaI	sodium iodide
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	Pressurized Ionization Chamber
RMDF	radioactive material disposal facility
SETF	SNAP Environmental Test Facility
SSFL	Santa Susana Field Laboratory
SNAP	Systems for Nuclear and Auxiliary Power
ZnS	zinc sulfide

VERIFICATION SURVEY
OF
BUILDINGS T019 AND T024
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

INTRODUCTION

Rockwell International's Rocketdyne Division operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), which performs testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (in natural and enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), activation products (tritium [H-3], Co-60, Eu-152, Eu-154, Ni-63, Pm-147, Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated, effective

September 30, 1995. As part of this program, Rockwell/Rocketdyne performed decommissioning and final status surveys of a number of facilities that supported the various nuclear-related ETEC operations during the latter part of the 1950's and continuing through the 1980's. Environmental Management of DOE contaminated properties continues under the termination clause of the existing M&O contract. Surplus sodium facilities have been included in the current EM (Environmental Restoration and Waste Management) Program for stabilization and eventual clean-up.

Building T024 was constructed in 1960 to house the Systems for Nuclear and Auxiliary Power (SNAP) Environmental Test Facility (SETF). The facility was used for endurance tests of SNAP-10 reactors. Four such systems were tested in the facility between the years 1960 and 1971. Decontamination was initiated in 1977 and included removal of contaminated equipment and components. Project documentation does not indicate specific contaminants (Rockwell 1978). Surveys conducted following remediation included smear sampling for removable contamination, dose rate measurements, and soil sampling from an exterior area on the east end of Building T024 where liquid and gas holdup tanks were removed. With the exception of two power vaults, Rockwell/Rocketdyne released the facility from radiological controls associated with DOE orders concerning radiation protection of workers in 1978. The power vaults have remained under a surveillance and maintenance mode since that time.

Building T019 was constructed in 1962 and served as the SNAP System Nuclear Qualification Test Facility where SNAP reactors were tested, using fully encapsulated highly enriched uranium, at zero power until termination of the SNAP program in 1970. All SNAP components were then removed and a facility survey performed. Documentation indicated that there were no releases of the uranium fuel or fission products and that neutron activation of construction materials was negligible (Rockwell 1988). Rockwell/Rocketdyne also released the building from radiological controls and redesignated it as the ETEC Construction Staging and Computer Facility.

DOE's Office of Environmental Restoration, Northwestern Area Programs is responsible for oversight of a number of remedial actions that have been or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities

conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and supplemental guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated as the organization responsible for this task at SSFL, and was requested to verify the current radiological status of each of these facilities. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (km [29 miles]) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha [2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations are conducted in Rockwell International-owned and DOE-owned facilities located within the 117 ha Area IV (Figure 2). The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

Building T019 is located on B Street in the north-central part of Area IV (Figure 2). Total area of the building is 595 m^2 divided among a high bay area that also includes a below-grade test cell, a low bay office-control center, and a vault (Figure 3). This vault was originally built for nuclear fuel element storage. Building construction is of steel framing and siding and a built-up roof.

Building T024 is located in the north-central portion of Area IV, northwest of 17th Street (Figure 2). The building consists of two levels, one at ground level containing a high bay area and support and equipment rooms. The second level is a subgrade basement, where the two power vaults are located that are currently in a surveillance and maintenance mode. Building construction is of aluminum siding, steel framing and some flooring, and concrete. Figure 4 shows the facility floor plan.

OBJECTIVE

The objective of the verification survey was to validate that cleanup procedures and survey methods used by Rockwell/Rocketdyne were adequate. Independent document reviews and measurement and sampling data provides assurance that the post-remediation data is sufficient, accurate, and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

ESSAP has reviewed Rockwell/Rocketdyne's supporting documentation concerning each building or outdoor area's final status survey procedures and results. In addition, the current levels of residual contamination remaining in the Building T024 power vaults were to be evaluated.

PROCEDURES

ESSAP personnel conducted independent measurements and sampling at SSFL on September 11 through 14, 1995. Survey activities were performed in accordance with a site-specific survey plan (ORISE 1995), using procedures and instruments described in the ESSAP Survey Procedures and Quality Assurance Manuals and summarized in Appendices A and B.

SURVEY PROCEDURES

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over 50 to 100 percent of the accessible floors and lower walls (up to 2 m) within Buildings T019 and T024. Accessible overhead surfaces where material may have settled or accumulated were also scanned. Due to access difficulties and health and safety concerns, the Building T019 test vault could not be surveyed. Surface scans of the exterior walls and grounds were performed at locations where residual contamination may have accumulated (near exhaust vents, downspouts, driplines, etc.).

Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation were marked for further investigation.

Surface Activity Measurements

Direct measurements for total alpha and total beta activity were performed at 44 (seven of which were performed within a 1 m^2 area) floor and wall locations in Building T019 and at 76 floor and wall locations in Building T024. In areas where elevated direct radiation was detected by surface scans, a set of five direct measurements were taken within a 1 m^2 area to determine the average residual activity. These measurements were performed at the center and at four points equidistant from the center and grid block corners.

Direct measurements were made using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample was collected from the location within each grid block corresponding to the highest total direct measurement and from each single-point measurement location for the determination of removable gross alpha and gross beta activity. Figures 3 and 4 show measurement and sampling locations.

Exposure Rate Measurements

Exposure rate measurements were made at two locations in Building T019 and four locations in Building T024, excluding the vaults. Exposure rate measurements were performed at 1 m above the surface using a pressurized ionization chamber (PIC). Figures 3 and 4 show exposure rate measurement locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Smears were analyzed for gross alpha and gross beta activity using a low background proportional counter. Smear results and direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates are reported in microroentgens per hour (μR/h).

FINDINGS AND RESULTS

DOCUMENT REVIEW

Based on the review of the project documents, it is ESSAP's opinion that the documentation was inadequate to satisfactorily demonstrate that each building or area meets the DOE guidelines for release to unrestricted use. Overall, the documentation for each building or area does not provide a clear description of the sequence of events necessary for demonstrating that the subject areas meet the requirements for release to unrestricted use. That is, the specification of contaminants present, selection of the appropriate guidelines, development of a sampling and analysis plan that provides adequate data for guideline interpretation, and presentation of the data in a manner that can be directly compared with the guidelines. The types of deficiencies noted in the reports included the following: all potential contaminants were not identified, final surveys were not designed to identify residual contamination of all suspected radionuclides, residual surface activity data was either absent or not reported in units of dpm/100 cm^2, radionuclide-specific sample analyses were not performed

(i.e., gross beta analysis of soil samples was performed and the data used for demonstrating compliance), appropriate guidelines were not always cited or unapproved site-specific guidelines were used. Comments on the documents were provided to DOE (ORISE 1996).

Surface Scans

Surface scans identified an area of elevated direct beta radiation in the garage portion of Building T019 and also within the fan room of Building T024. Because of the significant gamma radiation emanating from the radioactive waste materials stored at the SSFL's RMDF, surface scans of the exterior area surrounding Building T024 were inconclusive. All other surface scans for alpha, beta and gamma activity were within the range of ambient site background.

Surface Activity Levels

Surface activity levels for Buildings T019 and T024 are summarized in Table 1. For Building T019, surface activity levels were less than 55 dpm/100 cm^2 for alpha and ranged from less than 1,400 to 11,000 dpm/100 cm^2 for beta. The average surface activity level within the 1 m^2 area with the highest beta surface activity level was 5,900 dpm/100 cm^2. Surface activity levels in Building T024 (excluding the power vaults) were less than 55 dpm/100 cm^2 for alpha and ranged from less than 1,400 to 33,000 dpm/100 cm^2 for beta. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta for both buildings.

Exposure Rates

Exposure rate measurements are summarized in Table 2. Exposure rate measurements in Buildings T019 and T024 (excluding the power vaults) ranged from 10 to 13 µR/h. The Rockwell-determined average interior background exposure rate was approximately 8 µR/h.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each area were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for uranium and mixed fission and activation products. These guidelines are summarized in Appendix C. The applicable guidelines for uranium are as follows:

Total Activity

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

and the guidelines for beta-gamma emitters are:

Total Activity

5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area

15,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 β-γ dpm/100 cm^2

The average beta-gamma total surface activity guideline was exceeded within a 1 m^2 area in Building T019 (Figure 3) and the maximum beta-gamma total surface activity guideline was exceeded within the hot gas compression room in Building T024 (Figure 4). With the exception of these two areas, all other total and removable activity levels were less than the guideline values.

The DOE's exposure rate guideline is 20 μR/h above background, although Rockwell/Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. Interior exposure rates at 1 meter above the surface were within these guidelines.

SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education conducted verification activities for Buildings T019 and T024 at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period September 9 through 12, 1995, ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, and exposure rate measurements.

ESSAP's review identified a number of deficiencies in the final status documentation that was prepared for each building. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and absence of adequate figures documenting remediated areas and measurement and sampling locations.

The results of the independent verification determined that interior exposure rates were comparable to background levels and satisfied both the DOE and the more restrictive NRC exposure rate guideline. However, surface activity measurements and sampling identified residual fixed beta-gamma surface contamination in excess of the DOE guidelines in isolated locations in both Buildings T019 and T024. Because of the identification of residual contamination and documentation deficiencies, ESSAP was unable to verify Rockwell/Rocketdyne's conclusion that these areas of the buildings meet the DOE requirements for release to unrestricted use. ESSAP recommends final status documentation be revised to address deficiencies that were identified and provided to the DOE (ORISE 1996) and that additional decontamination and surveys be performed. In addition, because the Building T019 test vault could not be surveyed, ESSAP was unable to verify the radiological status of the test vault.

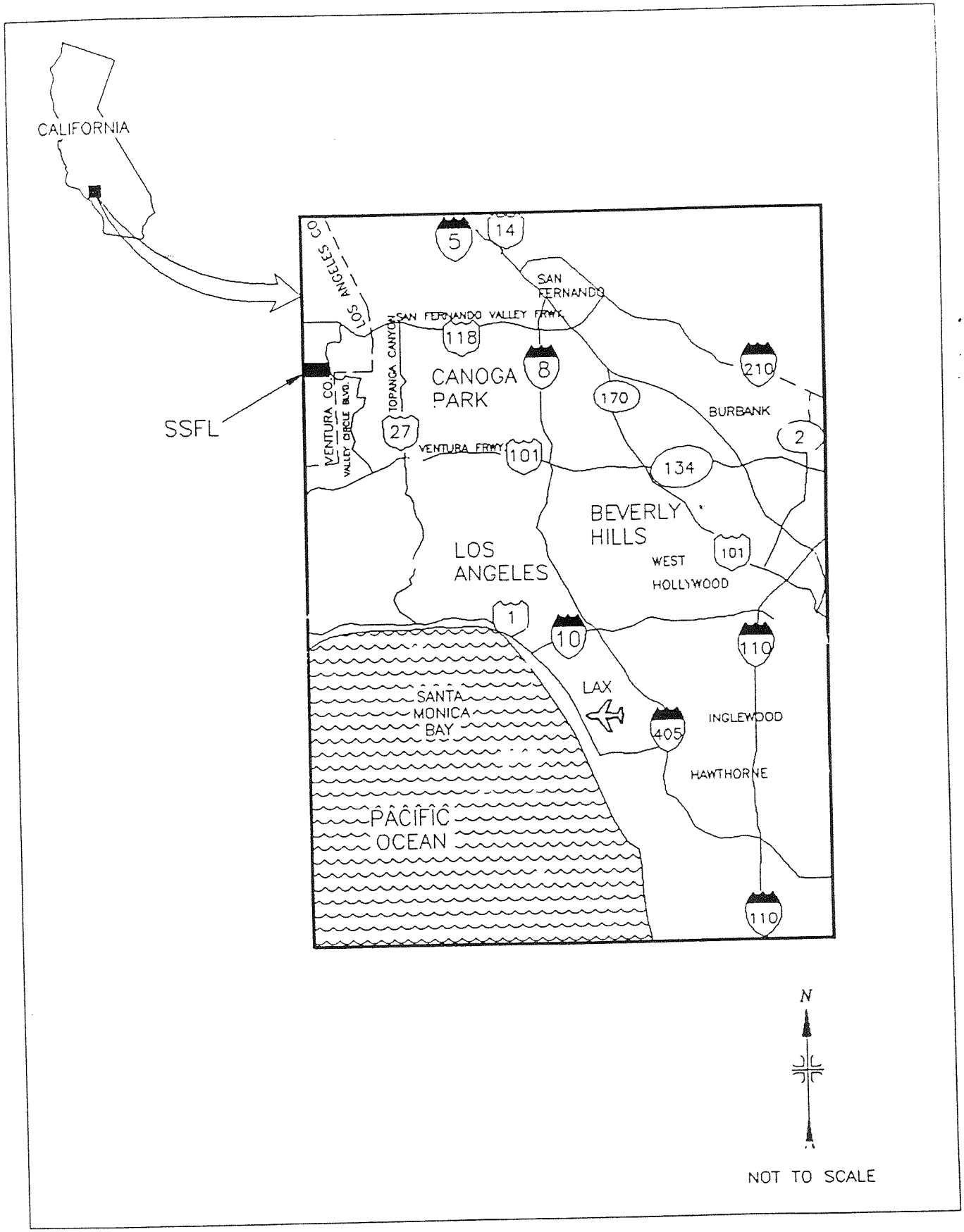


FIGURE 1: Los Angeles, California Area – Location of Santa Susana Field Laboratory Site

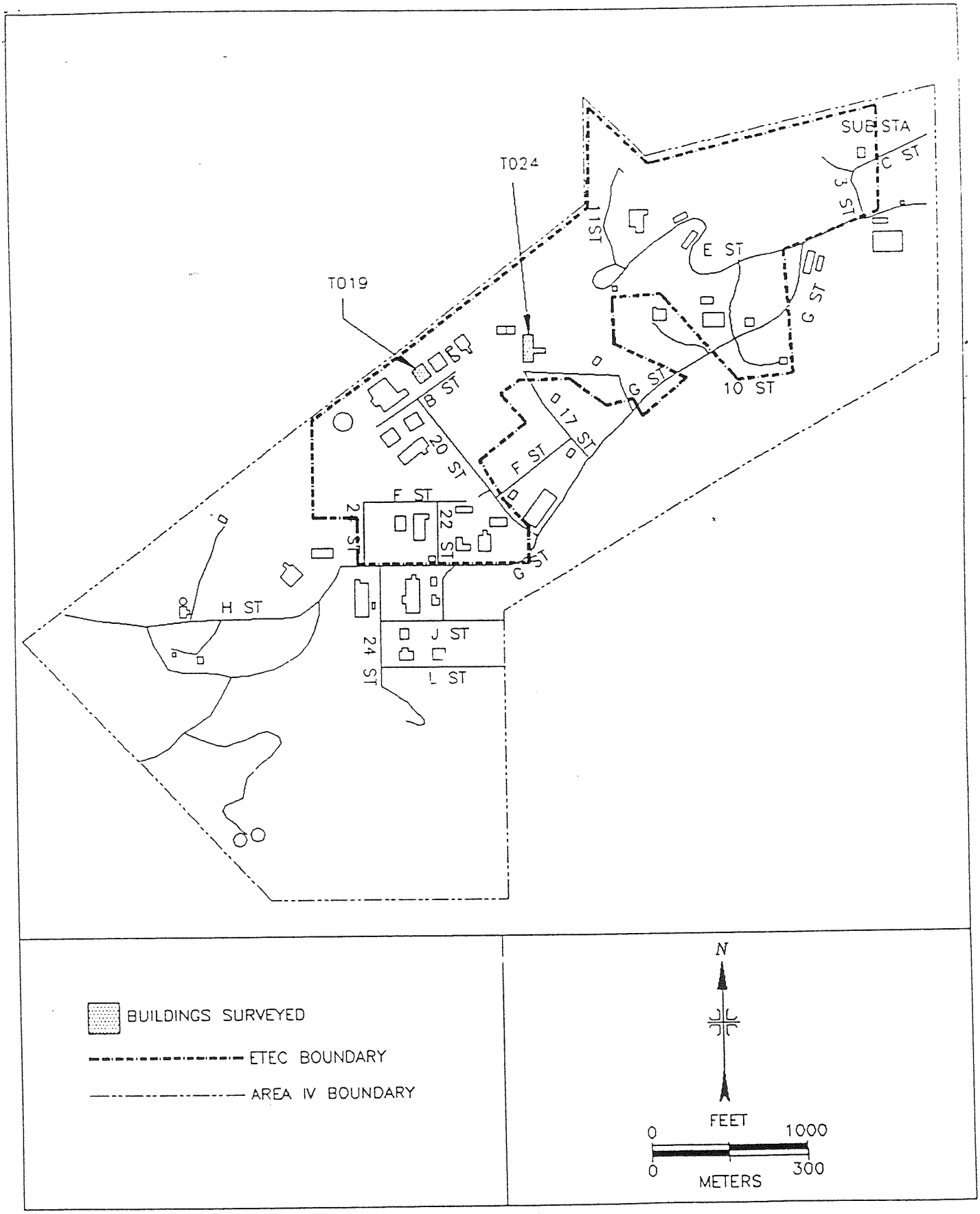


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Surveyed Areas

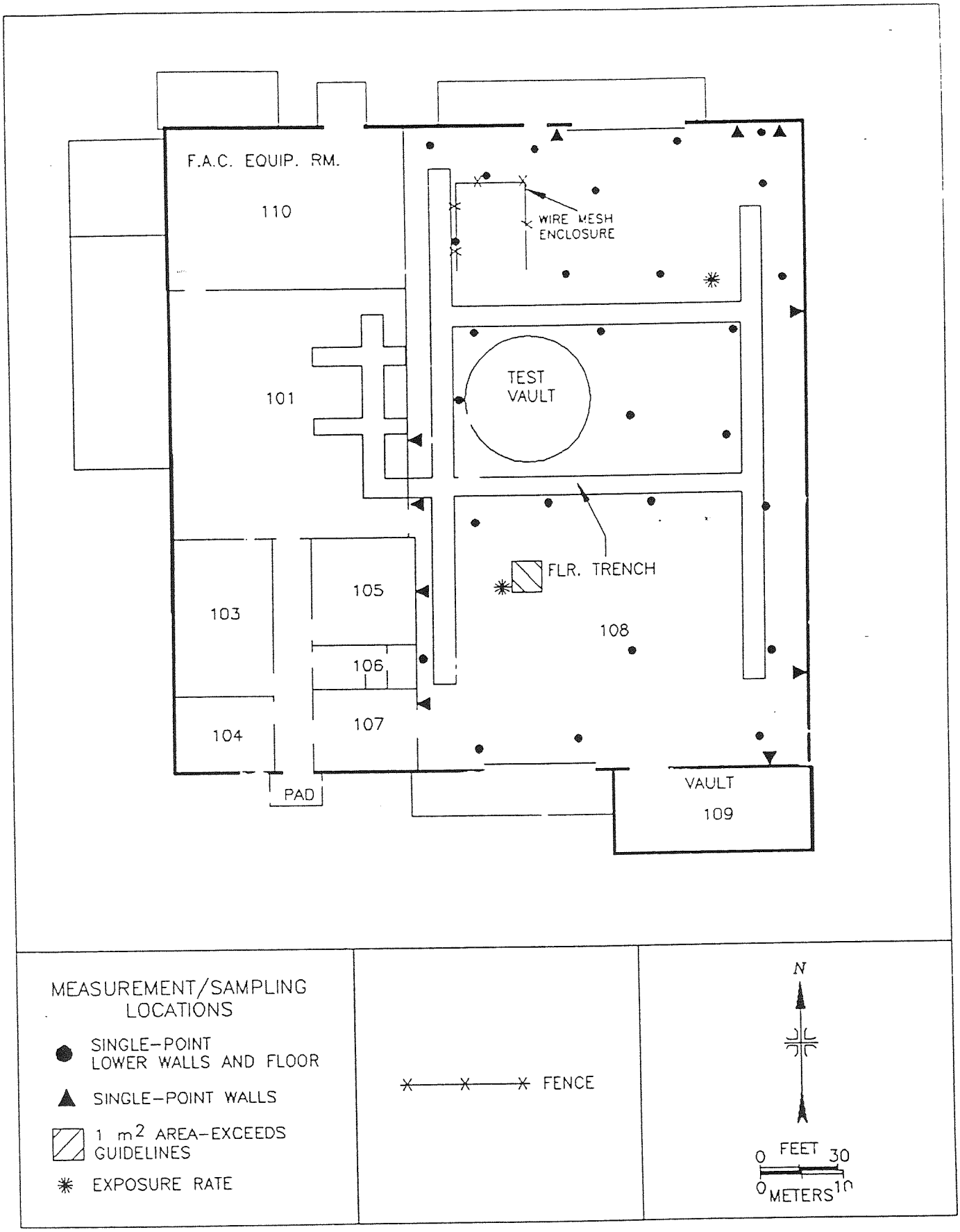
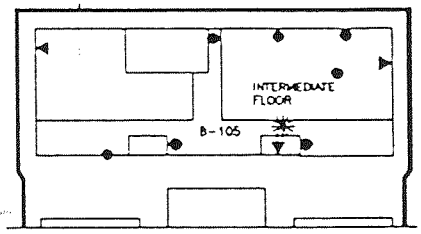
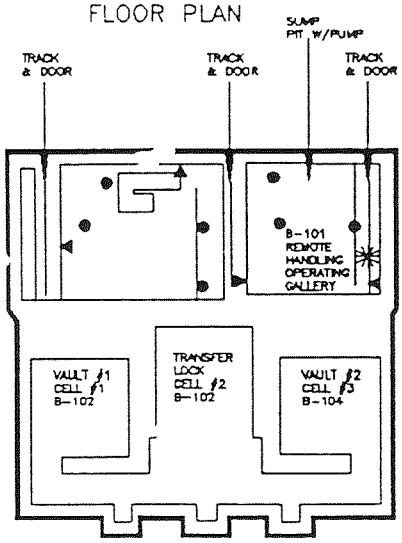


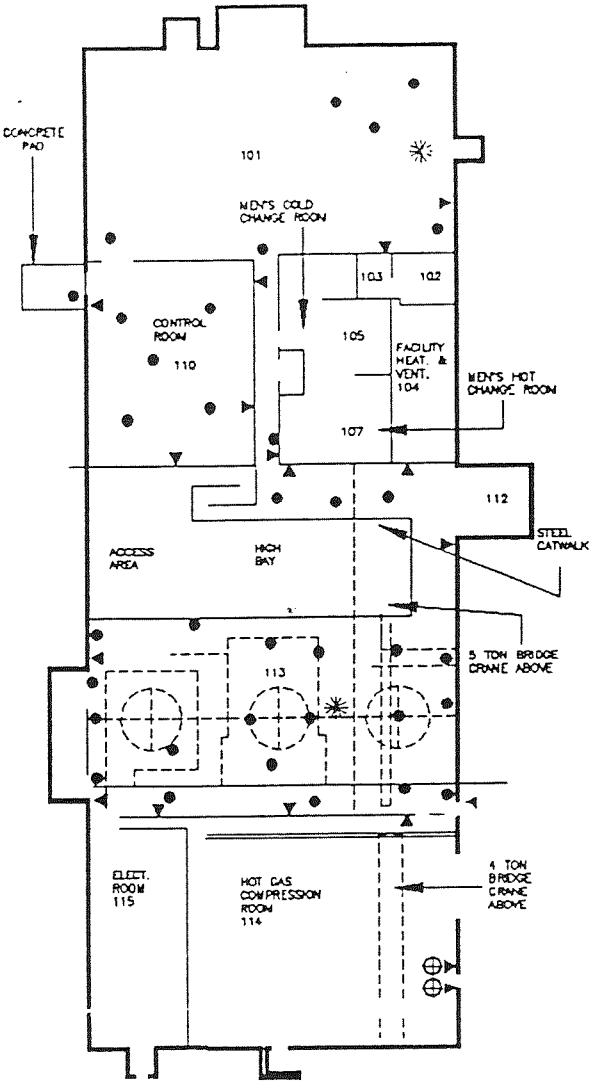
FIGURE 3: Building T019 – Floor Plan and Measurement and Sampling Locations



INTERMEDIATE FLOOR PLAN



BASEMENT PLAN



FIRST FLOOR PLAN

MEASUREMENT/SAMPLING LOCATIONS

- ● SINGLE-POINT FLOORS
- ▲ SINGLE-POINT WALLS AND EQUIPMENT
- ✳ EXPOSURE RATE
- ⊕ SINGLE-POINT FLOOR-EXCEEDS GUIDELINES

N

NOT TO SCALE

FIGURE 4: Building T024 – Floor Plan and Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDINGS T019 AND T024
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number Of Measurement Locations	Total Activity Range (dpm/100 cm²)		Removable Activity Range (dpm/100 cm²)	
		Single Measurement			
	Single-Pt.	Alpha[b]	Beta[c]	Alpha[d]	Beta[e]
T019					
Floor	34	<55	<1,400 - 11,000[f]	<12	<16
Lower Wall	10	<55	<1,000 - 1,400	<12	<16
T024					
Floor	51	<55	<1,400 - 33,000	<12	<16
Lower Wall	23	<55	<900 - <1,400	<12	<16
Equipment	2	NA	<1,000	<12	<16

[a]Refer to Figures 3 and 4.
[b]Guidelines = 5,000 α dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[c]Guidelines = 5,000 β-γ dpm/100 cm² average in a 1 m² area and 15,000 β-γ dpm/100 cm² maximum.
[d]Guidelines = 1,000 γ dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[e]Guidelines = 1,000 β-γ dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[f]Average surface activity in the surrounding 1 m² at this measurement location was 5,900 dpm/100 cm².

TABLE 2

EXPOSURE RATES
BUILDINGS T019 AND T024
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurements	Exposure Rate Ranges at 1 m Above Surface (μR/h)
T019	2	10 to 11
T024	4	11 to 13

[a]Refer to Figures 3 and 4.

REFERENCES

Oak Ridge Institute for Science and Education (ORISE). Verification Survey Plan for the Interim Storage Facility; Buildings T030, T024, T019, T013; An Area Northwest of Buildings T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International, Ventura County, CA. Oak Ridge, TN; September 6, 1995.

ORISE. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Buildings T013, T019, T024, T030, and T641; The Storage Yard West of Buildings T626 and T038; and The NW Area; Santa Susana Field Laboratory, Ventura County, CA. Oak Ridge, TN; January 11, 1996.

Rockwell International. Radiological Survey Results - Release to Unrestricted Use, Building T024, SSFL. Ventura County, CA; November 28, 1978.

Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

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

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

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

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline GM Detector
Model HP-260
Physical Area, 20 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Physical Area, 74 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-37
Physical Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Gas Proportional Detector
Model 43-68
Physical Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-112
(Reuter-Stokes, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the floors of the surveyed areas. Other surfaces were scanned using small area (20 cm^2, 74 cm^2 or 126 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	-	gas proportional detector with ratemeter-scaler
	-	ZnS scintillation detector with ratemeter-scaler
Beta	-	gas proportional detector with ratemeter-scaler
	-	GM detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using ZnS scintillation and GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for the active area of the detector. Because different building materials (poured concrete, concrete block, steel, etc.) can have very different background levels, average background counts were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the GM detectors averaged 95 cpm for concrete, 36 cpm for sheet rock, 33 cpm for structural steel, 96 cpm for cinder block, and 92 cpm for asphalt. Alpha background count rates for the ZnS detectors averaged 7 cpm for concrete, 1 cpm for sheet rock, 2 cpm for structural steel, 3 cpm for cinder block, and 2 cpm for asphalt. Net count rates were determined by subtracting the appropriate material background from the gross count rate for each measurement location. Beta efficiency factors ranged from 0.17 to 0.18 for the GM detector calibrated to Tc-99. The beta minimum detectable activities (MDA) for the GM detectors varied by material and ranged from 870 to 1,400 dpm/100 cm^2. Alpha efficiency factors ranged from 0.18 to 0.19 for the ZnS detectors calibrated to Pu-239 and MDAs ranged from 50 to 100 dpm/100 cm^2. The physical window areas for the GM and ZnS detectors were 20 cm^2 and 74 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in μR/h.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + 4.65\sqrt{BKG}$]. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standard/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revision 9 (January 1995)
- Quality Assurance Manual, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

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

[i] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

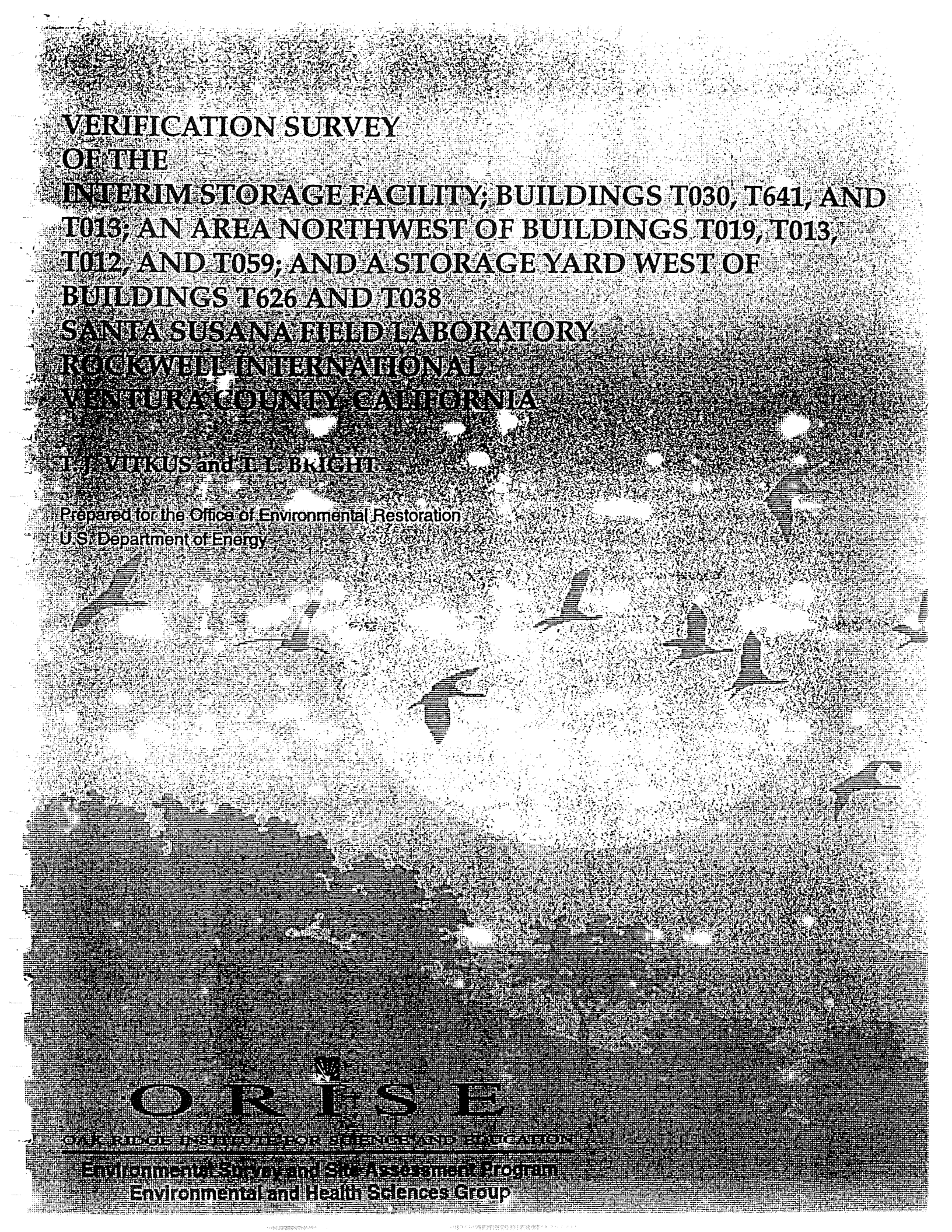
[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{1/2}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T. J. VITKUS and T. L. BRIGHT

Prepared for the Office of Environmental Restoration
U.S. Department of Energy



ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program
Environmental and Health Sciences Group

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T05°: AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by

T. J. Vitkus and T. L. Bright

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Group
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

FEBRUARY 1996

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by: Timothy J. Vitkus Date: 2/8/96

T. J. Vitkus, Project Leader
Environmental Survey and Site Assessment Program

Prepared by: Teresa J Bright Date: 2/11/96

T. L. Bright, Health Physics Technician
Environmental Survey and Site Assessment Program

Reviewed by: Mark Landeman Date: 2/13/96

M. J. Landeman, Radiochemistry Laboratory Supervisor
Environmental Survey and Site Assessment Program

Reviewed by: Ann T Payne Date: 2/16/96

A. T. Payne, Administrative Services Manager,
Quality Assurance/Health & Safety Manager
Environmental Survey and Site Assessment Program

Reviewed by: W S Beck Date: 2/16/96

W. L. Beck, Program Director
Environmental Survey and Site Assessment Program

ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

FIELD STAFF

T. D. Herrera
J. R. Morton

LABORATORY STAFF

R. D. Condra
J. S. Cox
M. J. Laudeman

CLERICAL STAFF

T. S. Fox
K. E. Waters

ILLUSTRATOR

T. D. Herrera

LIST OF FIGURES

PAGE

LIST OF TABLES

PAGE

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

INTRODUCTION AND SITE HISTORY

Rockwell International's Rocketdyne Division operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), which performs testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (in natural and enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), activation products (tritium [H-3], Co-60, Eu-152, Eu-154, Ni-63, Pm-147, Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated, effective September 30, 1995. As part of this program, Rockwell/Rocketdyne performed decommissioning and final status surveys of a number of facilities that supported the various nuclear related ETEC operations during the latter part of the 1950's and continuing through the 1980's. Environmental Management of DOE contaminated properties continues under the termination clause of the existing M&O contract. Surplus sodium facilities have been included in the current EM (Environmental Restoration and Waste Management) Program for stabilization and eventual cleanup.

The Interim Storage Facility (ISF), also referred to as DOE Facility 654, was constructed in 1958 to support the Sodium Reactor Experiment (SRE). The ISF was used to store dummy and spent fuel elements, shipping and storage casks, hot waste generated at the SRE, and items from the Organic Moderated Reactor Experiment and Systems for Nuclear and Auxiliary Power (SNAP). The ISF consisted of a concrete pad with a trench containing eight 51-centimeter diameter galvanized steel cells extending 7.6 meters into the rock strata. While the ISF was in use, a number of the items stored there deteriorated and released low-level contamination to adjacent asphalt surfaces and soil areas. Decommissioning of the ISF began in 1984 and involved removal of contaminated surfaces, soil, and the storage cells. The area was then backfilled and returned to a natural state (Rockwell 1985).

Building T030 was used from 1960 through 1964 to house a Van deGraaf accelerator facility for the performance of activation experiments. In 1965, the facility was converted for use as an office building although the accelerator remained on-site in an unused condition until at least 1966. Sometime after 1966 the facility was surveyed, and tritium contamination was identified on the accelerator. The accelerator was removed and the facility released for other uses. An asphalt area south of Building T030 was fenced and used for the storage of palletized items. It has not been verified, but items stored there may have included drums containing mixed fission products (Rockwell 1988a).

Building T641 was constructed in 1964 to serve as a shipping and receiving facility for SSFL. All radioactive and nuclear material shipments were only handled on the outdoor dock of the building. Documentation indicates that all shipments were fully packaged and never opened while on the dock. There have been no documented leaks at this facility (Rockwell 1988a).

Building T013 was constructed in 1961 for the assembly and checkout of non-nuclear SNAP reactor components. In 1970, the facility was redesignated as the ETEC Thermal Transient Facility and used for thermal testing and seismic test equipment. Rockwell/Rocketdyne classified this building as non-nuclear related.

The storage area northwest of T059, T019, T013, and T012 consists of a paved area between the buildings and the SNAP facility fence line. The property then drops sharply off to the SSFL property line. The paved portion of this Northwest Area (NW Area) was used for equipment staging and gas tanks. Site documentation identified this area as non-nuclear.

The final area was a storage yard west of Building T626 and T038 that was used for storing equipment and salvageable components. In 1978, drums containing sand contaminated with Co-60 were stored there. Rockwell/Rocketdyne performed final status surveys of each of these areas in the latter part of the 1980's and did not identify residual contamination (Rockwell 1988b).

DOE's Office of Environmental Restoration, Northwestern Area Programs is responsible for oversight of a number of remedial actions that have been or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and supplemental guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated

as the organization responsible for this task at SSFL and was requested by the DOE to perform verification surveys of these buildings and areas. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (29 miles) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha [2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations are conducted in Rockwell International-owned and DOE-owned facilities located within the 117 ha Area IV (Figure 2). The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

The ISF was located in the north-central portion of Area IV. The ISF was paved with a concrete berm containing the eight storage cells. The pavement, berms, and storage cells were removed during the decommissioning and the area was backfilled and graded. Total area of the ISF is not provided in the project documentation, but is estimated to be approximately 150 m^2 based on survey maps. Figures 2 and 3 show the location and plot plan of the ISF.

Building T030 is located north of G Street on 10th Street which is north of G Street in the eastern portion of Area IV (Figure 2). The building is constructed with steel framing, siding, and roofs and consists of an east office section and a west section where the particle accelerator was located. Total floor area of the building is 215 m^2; the west section occupies 125 m^2 of the total. There is an exterior concrete wall at the northern end of the west section that provided shielding for the accelerator beam. Building T641 is located immediately to the south of T030. Total building area is 713 m^2. The loading dock area where radioactive materials were received is located on the east end of the building and occupies approximately 200 m^2. The floor plans of Buildings T030 and T641 are shown on Figures 4 and 5.

Building T013 is located on B Street and is constructed of steel framing and siding (Figure 2). The north half of the building contains office and storage areas while the south half contains the seismic test equipment. Total floor area is approximately 780 m^2. Figure 6 shows the floor plan.

Buildings T626 and T038 are located west of 20th Street in Area IV (Figure 2). The storage area where the contaminated sands were stored is located to the western side of these buildings (Figure 7). The entire area is paved with asphalt. The area northwest of Buildings T059, T019, T013, and T012 (the NW Area) is paved with asphalt for approximately 30 meters north of the buildings, where the asphalt ends and the area drops-off to the property line (Figures 7, 8 and 9). This portion of the NW Area is covered with brush with interspersed boulders and sandstone outcroppings.

OBJECTIVE

The objective of the verification survey was to validate that cleanup procedures and survey methods utilized by Rockwell/Rocketdyne were adequate. Perfomance of independent document reviews and evaluation of measurement and sampling data provides assurance that the post-remediation data is sufficient, accurate, and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

ESSAP has reviewed Rockwell/Rocketdyne's supporting documentation concerning each building or outdoor areas final status survey procedures and results (Rockwell 1985, 1988a, and1988b).

PROCEDURES

ESSAP personnel conducted independent measurement and sampling activities at the SSFL facility during the period September 11 through 14, 1995. Survey activities were performed in

accordance with a site-specific survey plan (ORISE 1995), using procedures and instruments described in the ESSAP Survey Procedures and Quality Assurance Manuals and summarized in Appendices A and B.

For this survey, ESSAP classified buildings or outdoor areas that did not have a history of radiological use or storage as unaffected (referred to as "non-nuclear use" in Rockwell/Rocketdyne documentation). Buildings and outdoor areas with a history of radiological use, or where radioactive materials were known to or suspected of having been stored, were classified as affected areas. Survey coverage was determined based on whether an area was designated as unaffected or affected in accordance with the following procedures.

SURVEY PROCEDURES: UNAFFECTED AREAS

The following survey procedures applied to Building T013 and the NW Area.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed in Building T013 and the paved portions of the NW Area. Only gamma scans were performed in the soil portions of the NW Area. Scan area coverage was approximately 10 to 50 percent of the floors and lower walls (up to 2 meters) of Building T013 and the paved and soil areas of the NW Area. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Direct measurements for total alpha and total beta activity were performed at 31 randomly selected locations within Building T013 and at 25 locations on the paved portion of the NW Area. Direct measurements were made using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each of the Building T013 direct measurement locations. Figures 6 and 8 show measurement and sampling locations in unaffected areas.

Exposure Rate Measurements

ESSAP performed exterior background exposure rate measurements at six locations within 0.5 to 10 km of the site (Figure 10) and used Rockwell's previously determined building interior background exposure rate measurements for data comparisons. Exposure rate measurements were performed at four locations in Building T013 and a total of seven locations within the NW Area. Exposure rate measurements were performed at 1 meter above the surface using a pressurized ionization chamber (PIC). Figures 5, 7, and 8 show measurement locations.

Soil Sampling

Background soil samples were collected from the six background exposure measurement locations (Figure 10). Surface (0 to 15 cm) soil samples were collected from five locations in the NW area (Figure 9).

SURVEY PROCEDURES: AFFECTED AREAS

The following survey procedures were applicable to Building T030, the Building T641 loading dock, the ISF, and the storage yard west of Buildings T626 and T038.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over 50 to 100 percent of the accessible floors and lower walls (up to 2 m) within Building T030, the Building T641 loading dock, and the paved portions of the storage yard. Accessible overhead surfaces where material may have settled or accumulated were also scanned. Gamma scans only were performed in the ISF and the soil area that is located west of the storage yard. The ISF was excavated to a depth of 7.5 to 9 meters when the storage cells were removed and then backfilled to grade. As a result of back-filling, the original soil was inaccessible; therefore, scans of the ISF were concentrated in the peripheral areas where contamination may have migrated. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Single-point direct measurements for total alpha and total beta activity were performed on floors, walls, equipment, and on pavement in the designated areas. A total of 19, 50, and 25 measurements were performed in Building T030, the Storage Yard west of Buildings T626 and T038, and the Building T641 loading dock, respectively. Direct measurements were performed using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each direct measurement location. In the western portion of Building T030, a second smear was collected from each direct measurement location for determination of removable tritium activity levels. Measurement and sampling locations for total and removable activity are shown in Figures 4, 5, and 7.

Exposure Rate Measurements

Exterior background exposure rate measurements were made at six locations within 0.5 to 10 km of the site (Figure 10). Exposure rate measurements were performed at 17 locations in the affected areas. Figures 3, 4, 5, and 7 indicate measurement locations. Exposure rate measurements were performed at 1 meter above the surface using a PIC.

Soil Sampling

Individual soil samples were collected from four locations in the ISF area. One composite surface (0-15 cm) soil sample was collected from the T626 storage area over a 100 m^2 area. Figures 3 and 7 indicate sampling locations.

Miscellaneous Sampling

Because available field instrumentation cannot detect tritium surface activity at the guideline levels, a limited number of miscellaneous samples were collected in order to provide a quantitative indication of total tritium surface activity. Paint samples were collected from five randomly selected 100 cm^2 area on the walls of the western portion of Building T030, where the accelerator was formerly located. Sampling locations are shown in Figure 4.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. Spectra were reviewed for U-238, U-235, Th-232, Cs-137, Co-60 and any other identifiable photopeaks, particularly additional activation and fission products. Gamma spectrometry data were reported in picocuries per gram (pCi/g). Smears were analyzed for gross alpha and gross beta activity using a low background proportional counter, and for tritium by liquid scintillation. Miscellaneous samples were analyzed for tritium by liquid scintillation counting. Smear results,

miscellaneous sample results, and direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates are reported in microroentgens per hour (μR/h).

FINDINGS AND RESULTS

DOCUMENT REVIEW

Based on the review of the project documents, it is ESSAP's opinion that the documentation was inadequate to satisfactorily demonstrate that each building or area meet the DOE guidelines for release to unrestricted use. Overall, the documentation for each building or area does not provide a clear description of the sequence of events necessary for demonstrating that the subject areas meet the requirements for release to unrestricted use. That is, the specification of contaminants present, selection of the appropriate guidelines, development of a sampling and analysis plan that provides adequate data for guideline interpretation, and presentation of the data in a manner that can be directly compared with the guidelines. The types of deficiencies noted in the reports included the following: all potential contaminants were not identified, final surveys were not designed to identify residual contamination of all suspected radionuclides, residual surface activity data was either absent or not reported in units of dpm/100 cm^2, radionuclide-specific sample analyses were not performed (i.e., gross beta analysis of soil samples was performed and the data used for demonstrating compliance), and appropriate guidelines were not always cited or unapproved site-specific guidelines were used. Comments on the documentation were provided to the DOE (ORISE 1996).

UNAFFECTED AREAS

The results of the verification surveys for unaffected buildings and areas are discussed below.

Surface Scans

Surface scans did not identify any areas of elevated alpha, beta, or gamma direct radiation.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Total surface activity levels in Building T013 were less than 55 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. For the paved portion of the NW Area, surface activity levels were less than 100 dpm/100 cm^2 and less than 1,400 dpm/100 cm^2 for alpha and beta, respectively. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta.

Exposure Rates

Exposure rate measurement data is provided in Tables 3 and 4. Background exterior exposure rates ranged from 12 to 16 μR/h and averaged 14 μR/h. Exposure rates in the NW Area ranged from 14 to 16 μR/h. Exposure rates inside of Building T013 ranged from 8 to 11 μR/h.

Radionuclide Concentration In Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Ra-226 less than 0.2 to 1.2 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Th-232, 0.6 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the NW Area were: Cs-137, less than 0.1 to 0.5 pCi/g; Ra-226, 0.8 to 1.0 pCi/g; Th-228, 1.2 to 1.5 pCi/g; Th-232, 1.5 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 1.5 to 1.9 pCi/g.

AFFECTED AREAS

The survey results for Buildings T030, T641 loading dock, the storage yard west of T626 and T038, and the ISF are discussed below.

Surface Scans

Surface scans for alpha, beta and gamma activity did not identify any locations of elevated direct radiation indicative of residual contamination.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Surface activity levels for Building T030 were less than 55 dpm/100 cm^2 for total alpha and less than 1,400 dpm/100 cm^2 for total beta. Of the five miscellaneous samples collected from Building T030, four were less than the minimum detectable activities of the tritium procedure which ranged from 132 to 209 dpm/100 cm^2 (Table 2). One sample, location #2 on Figure 4, had a total tritium activity level of 6,600 dpm/100 cm^2. Activity levels for the Building T641 loading dock were less than 100 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. Total surface activity for the storage yard west of Building T626 and T038 was less than 55 dpm/100 cm^2 for alpha and ranged from less than 1,000 to 1,800 dpm/100 cm^2 for beta. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta. Removable tritium activity in Building T030 was less than 221 dpm/100 cm^2.

Exposure Rates

Exposure rates are summarized in Tables 3 and 4. Exposure rates ranged from 10 to 12 μR/h for the interior of Building T030 and the loading dock of Building T641. Rockwell determined that the average interior background exposure rate was approximately 8 μR/h. Exterior exposure rates for the ISF, ranged from 10 to 15 μR/h. Exterior background exposure rates ranged from 12 to 16 μR/h, and averaged 14 μR/h.

Radionuclide Concentrations in Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Th-232, 0.6 to

1.7 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Ra-226, less than 0.2 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the ISF and the area adjacent to the storage yard west of Buildings T626 and T038 were: Cs-137, less than 0.1 to 0.4 pCi/g; Th-232, 1.5 to 1.7 pCi/g; Th-228, 1.2 to 1.6 pCi/g; Ra-226, 0.7 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.0 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each area were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for uranium and mixed fission and activation products (DOE 1990). These guidelines are summarized in Appendix C. The applicable guidelines for uranium are as follows:

Total Activity

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

and the guidelines for beta-gamma emitters are:

Total Activity

5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area

15,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 β-γ dpm/100 cm^2

and the guidelines for tritium are (DOE 1995):

Removable Activity

10,000 dpm/100 cm^2

Although fixed tritium contamination was identified in Building T030, the guideline only addresses removable contamination. Removable tritium activity levels were within the guideline. All other total and removable activity levels were also within the respective guidelines.

The DOE's exposure rate guideline is 20 μR/h above background, although Rockwell/Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. Exposure rates at 1 meter above the surface were within these guidelines.

Other than the DOE's generic residual soil concentration guidelines for thorium and radium of 5 pCi/g in the first 15 cm of soil and 15 pCi/g in 15 cm thick layers of subsurface soil, guidelines for other radionuclides are developed on a site-specific basis. Currently, there are no approved site-wide guidelines at SSFL for the radionuclides of concern. As a result, radionuclide concentrations in soils were compared to the background concentration levels. There were no radionuclides identified in excess of background levels.

SUMMARY

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education conducted verification activities for Buildings T013, T030, the loading dock of Building T641, the NW Area, the ISF, and the storage area west of Buildings T626 and T038 at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period September 9 through 12, 1995 ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, exposure rate measurements, miscellaneous material sampling, and soil sampling.

ESSAP's review identified a number of deficiencies in the final status documentation that was prepared for each building or area. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documenting remediated areas and measurement and sampling locations.

ESSAP's verification survey results showed that surface activity levels, exposure rates, and/or radionuclide concentration levels in soil in the surveyed areas of Building T013, Building T030, the loading dock of Building T641, the NW Area, the Storage Yard West of Buildings T626 and T038, and the ISF were less than the current DOE guidelines for release to unrestricted use, or in the case of radionuclide concentrations in soils, comparable to background concentration levels.

Because of documentation deficiencies, ESSAP is unable to verify the radiological status of all areas. It is ESSAP's recommendation that final status documentation be revised and additional surveys performed as necessary to address those deficiencies that were identified and provided to DOE (ORISE 1996).

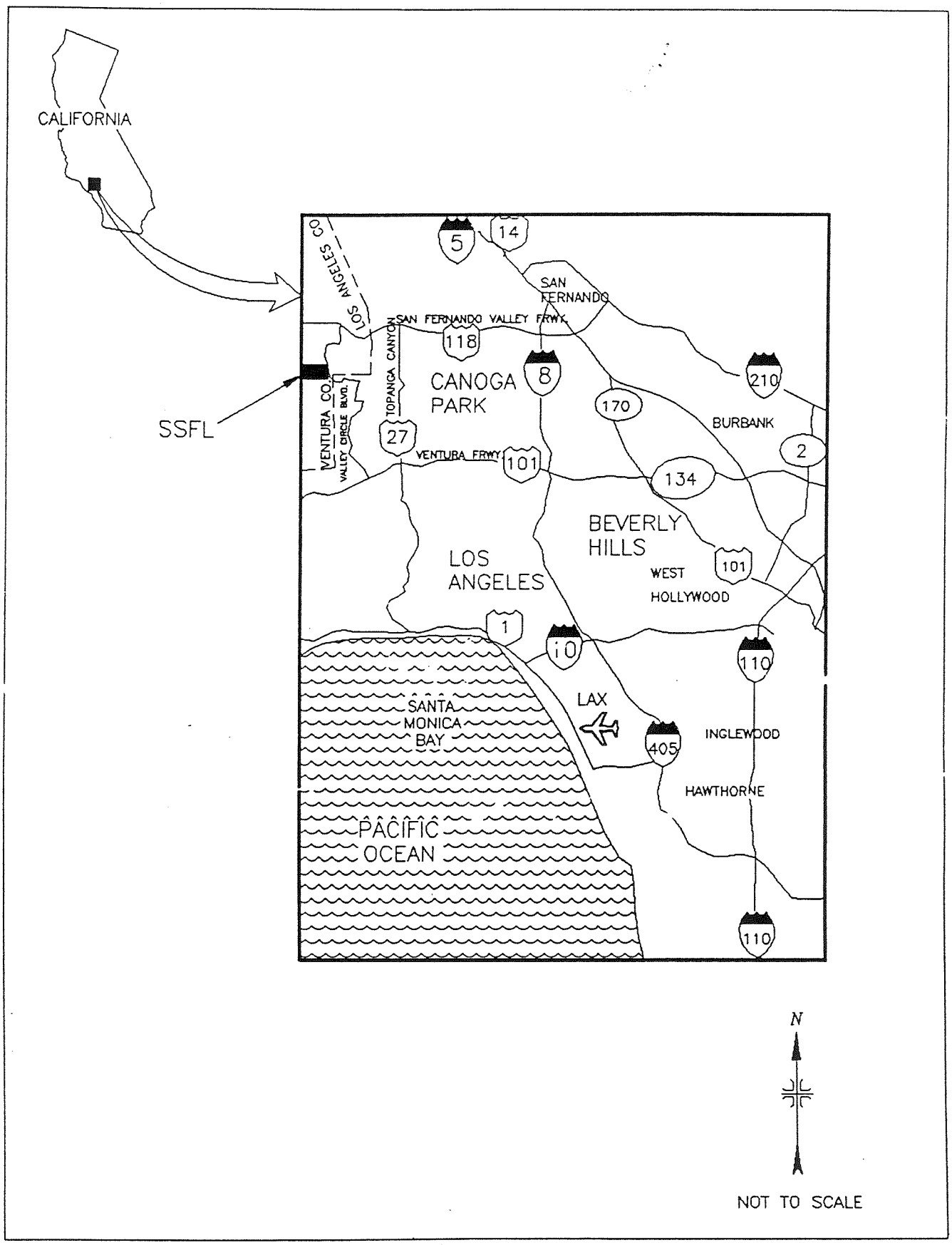


FIGURE 1: Los Angeles, California Area – Location of Santa Susana Field Laboratory Site

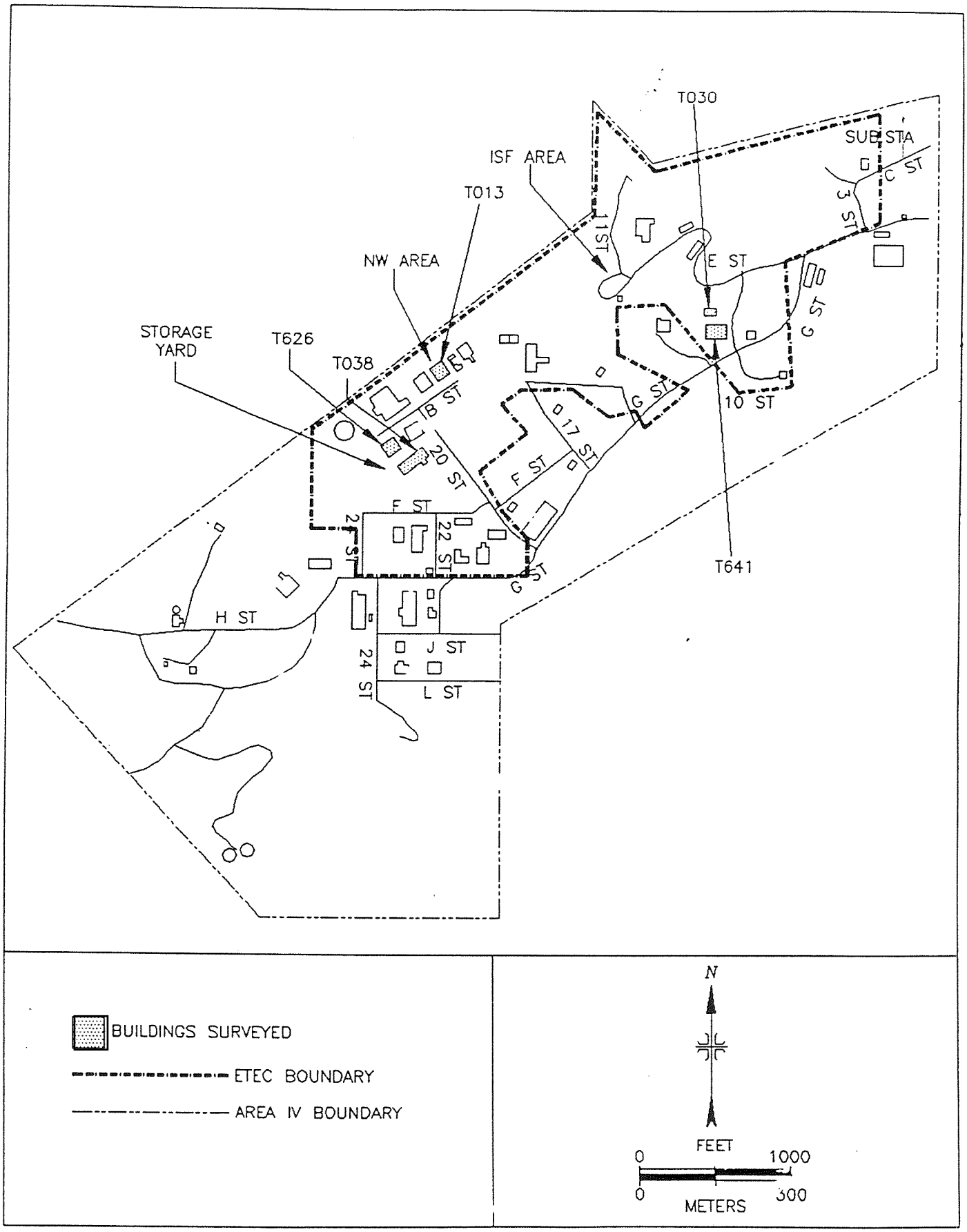


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Surveyed Areas

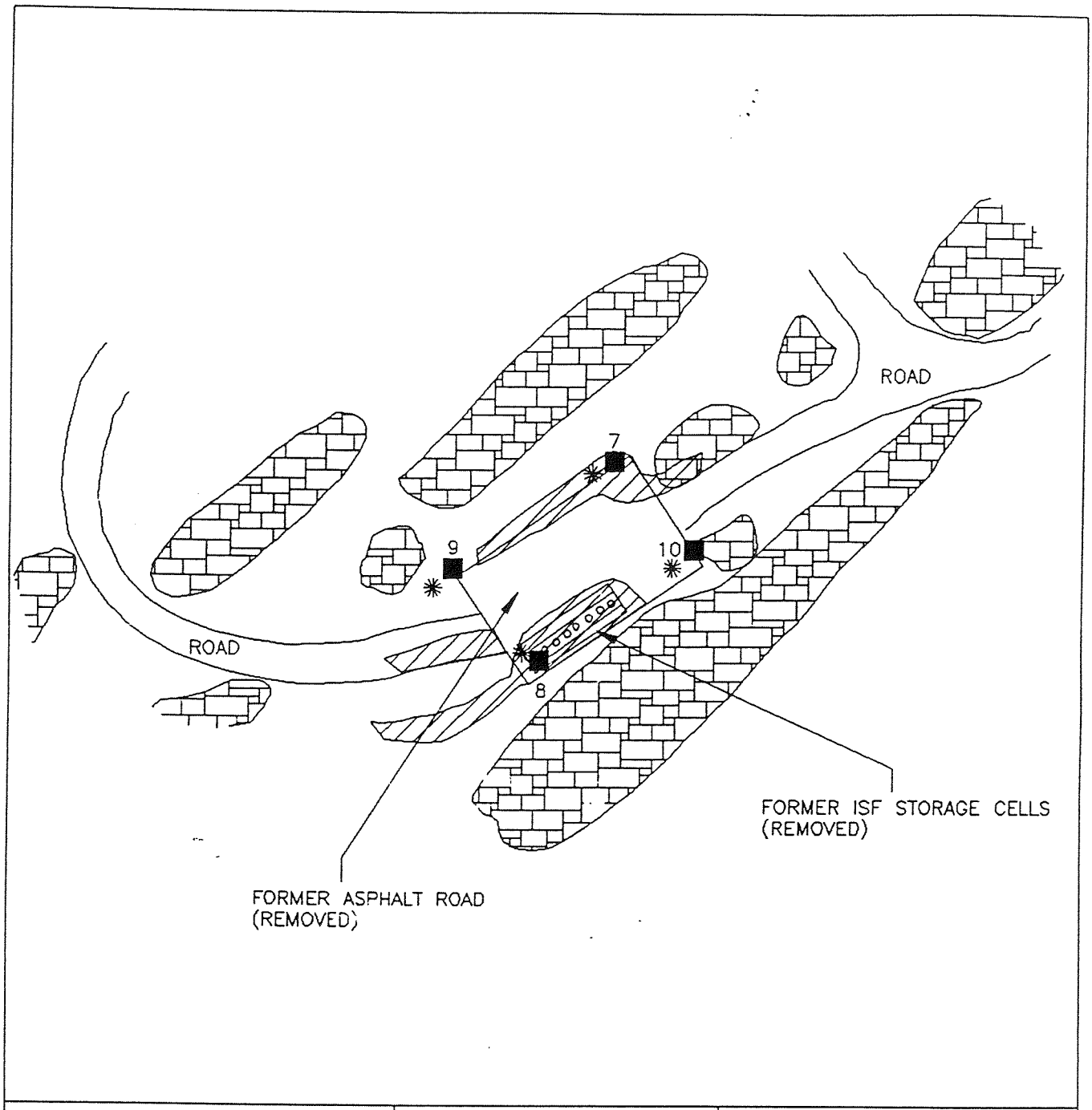
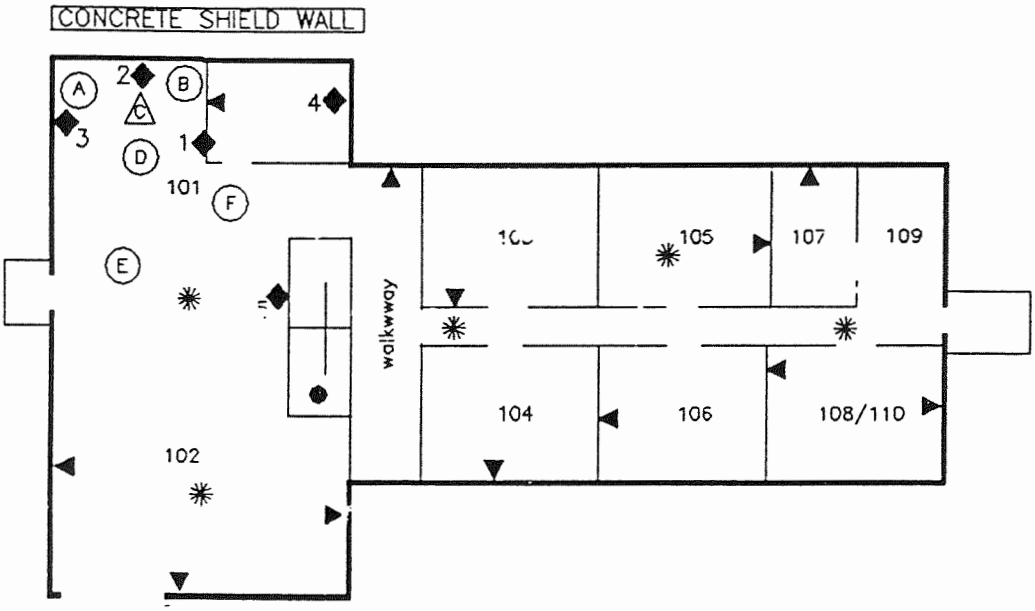


FIGURE 3: Interim Storage Facility – Plot Plan and Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT FLOOR
- SINGLE-POINT FLOOR AND TRITIUM SMEAR
- SINGLE-POINT WALLS AND CEILING
- SINGLE-POINT WALLS AND CEILING, AND TRITIUM SMEAR
- # MISCELLANEOUS SAMPLE
- EXPOSURE RATE

N

0 FEET 30

0 METERS 10

FIGURE 4: Building T030 – Floor Plan and Measurement and Sampling Locations

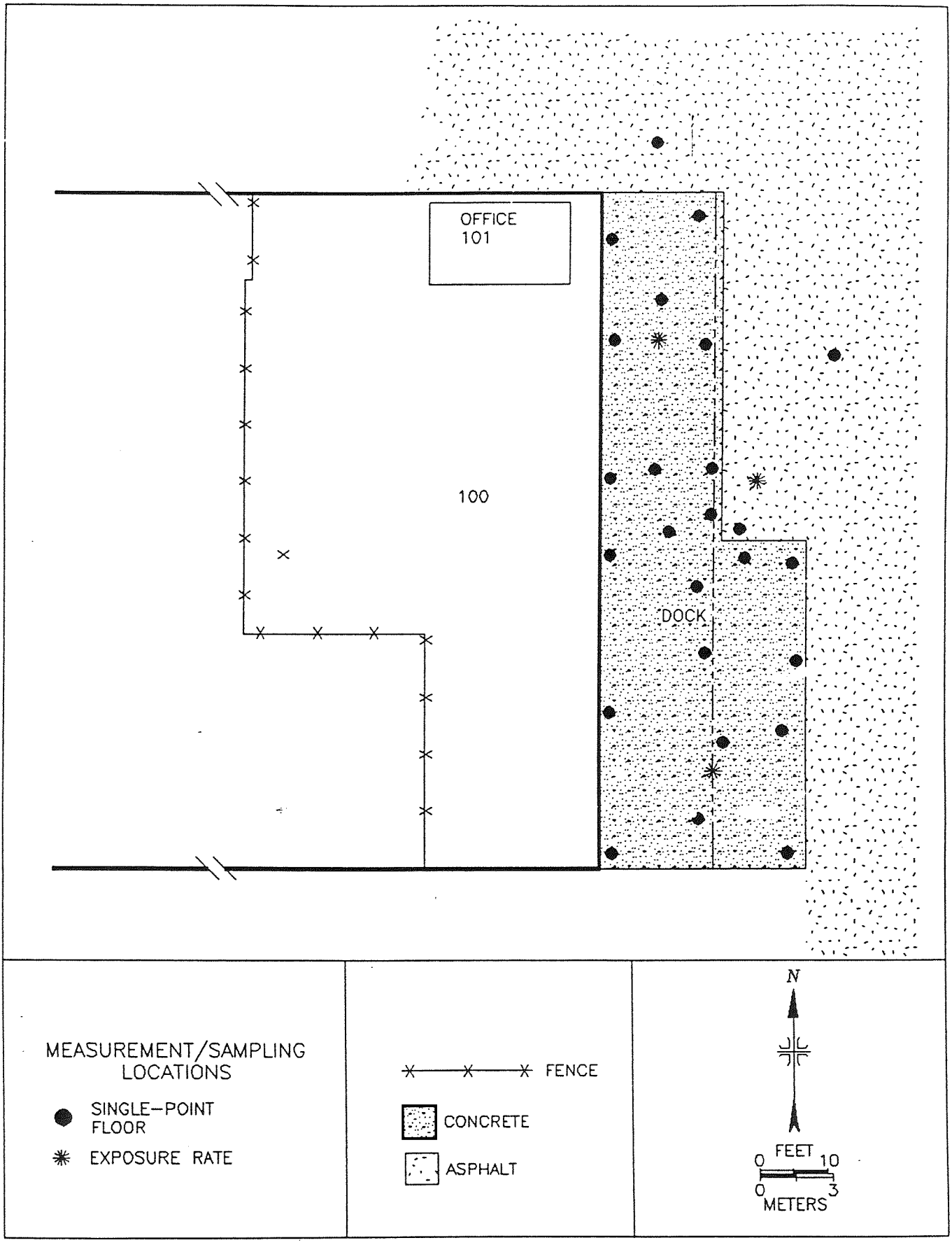
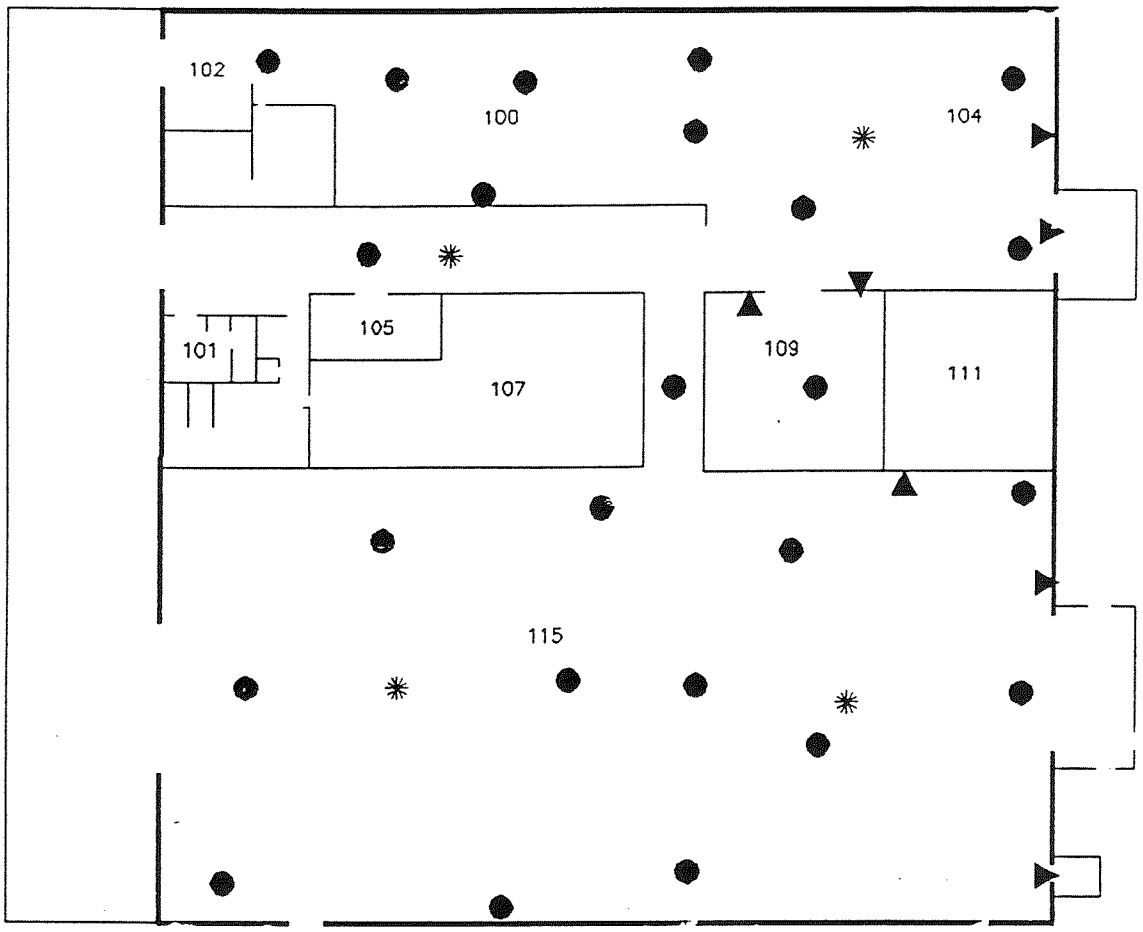


FIGURE 5: Building T641 – Floor Plan and Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- ▲ SINGLE-POINT WALLS
- ● SINGLE-POINT FLOOR
- ✳ EXPOSURE RATE

N

0 FEET 30

0 10 METERS

FIGURE 6: Building T013 – Floor Plan and Measurement and Sampling Locations

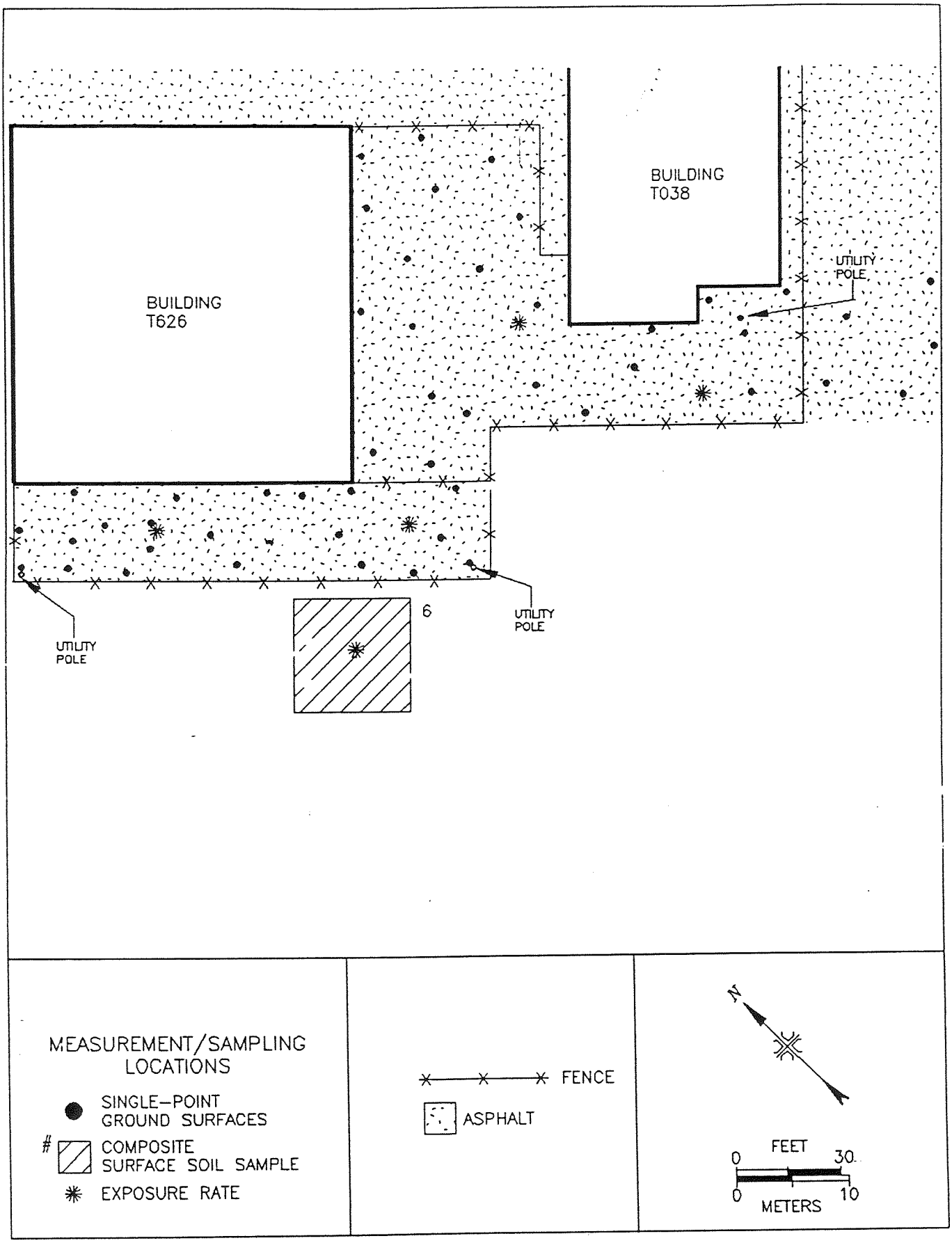


FIGURE 7: Building T626 and T038 Storage Yard – Plot Plan and Measurement and Sampling Locations

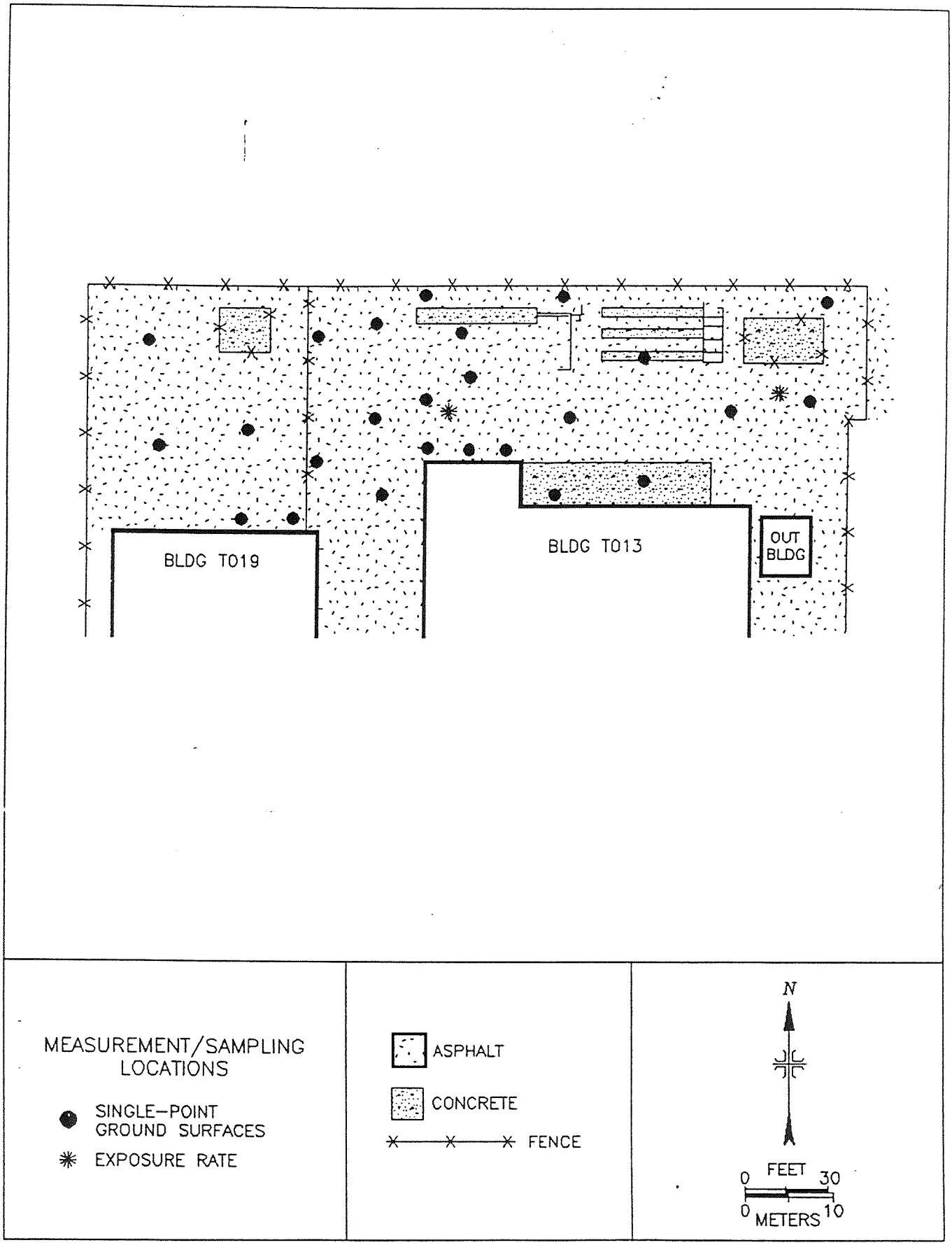


FIGURE 8: Paved Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

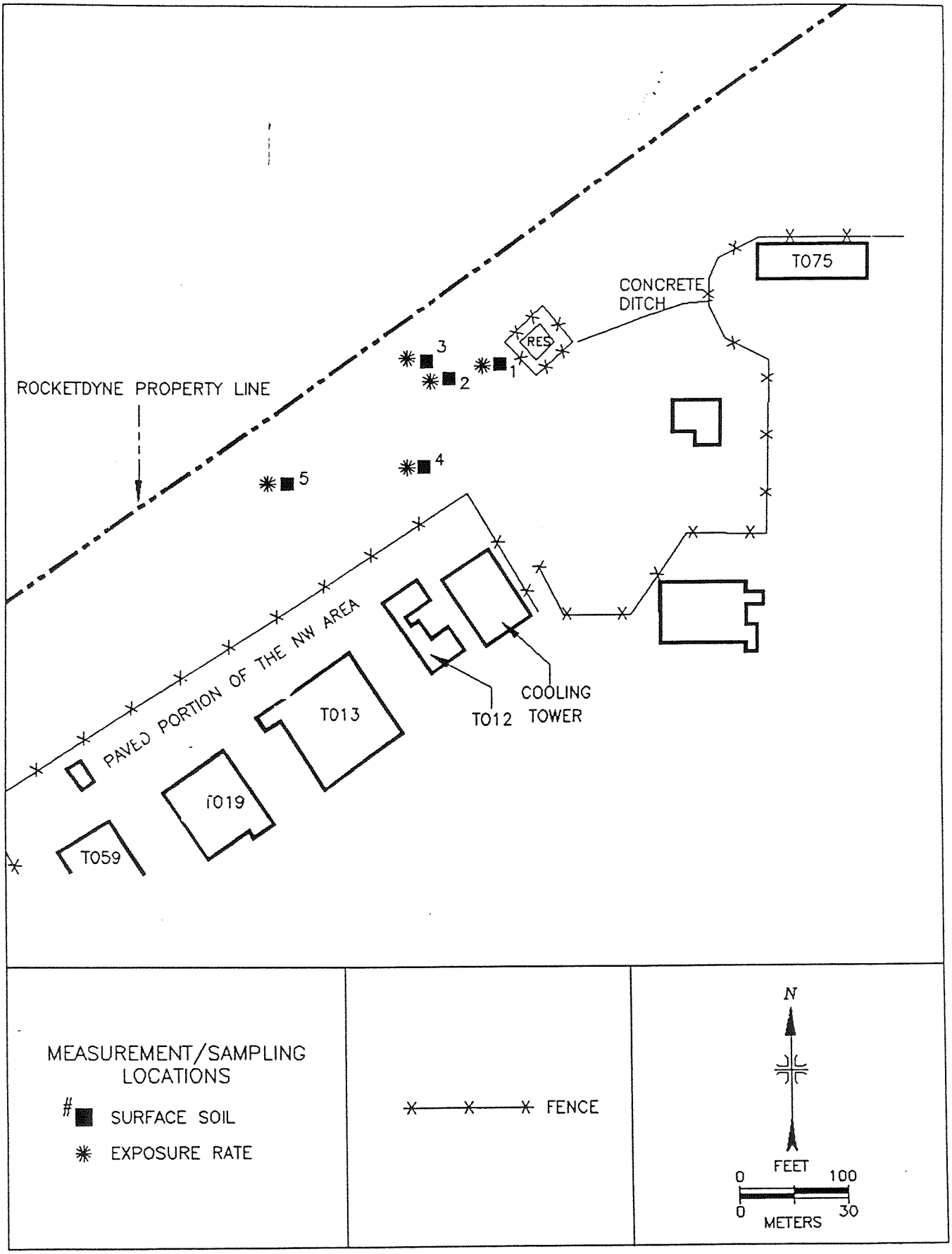


FIGURE 9: Soil Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

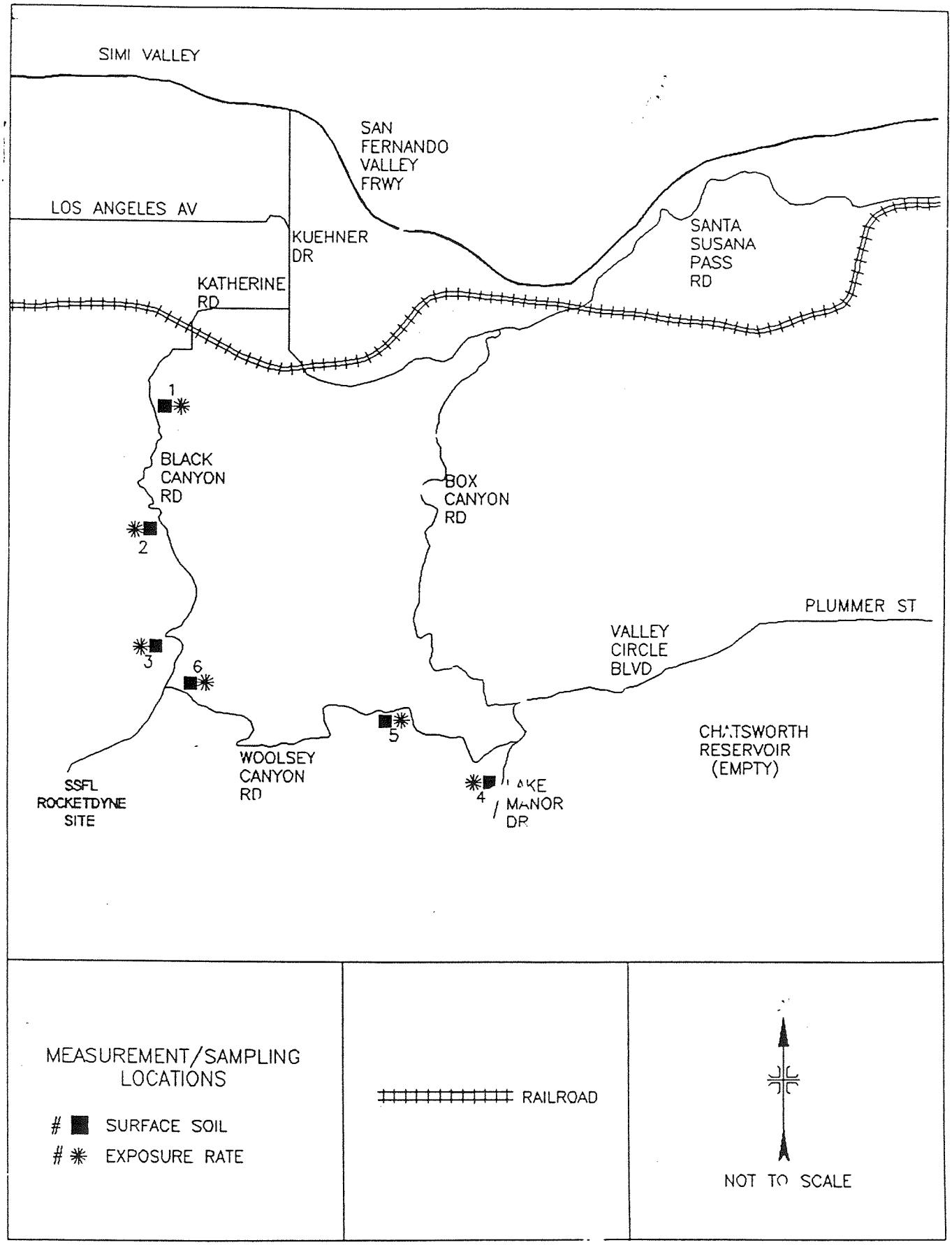


FIGURE 10: Santa Susana Field Laboratory, Ventura County, California – Background Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDINGS T013, T030, T641 LOADING DOCK, NW AREA,
AND STORAGE YARD WEST OF T626 AND T038
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations	Total Activity Range (dpm/100 cm²)		Removable Activity Range (dpm/100 cm²)	
	Single-Pt.	Alpha[b]	Beta[c]	Alpha[d]	Beta[e]
INTERIOR					
T013					
Floor	24	<55	<1,000 - <1,400	<12	<16
Lower Wall	7	<55	<900	<12	<16
T030					
Floor	6	<55	<1,000	<12	<16
Lower Wall	11	<55	<900 - <1,400	<12	<16
Upper Wall and Ceiling	2	<55	<1,000	<12	<16
EXTERIOR					
Storage Yard West of T626 and T038	50	<55	<1,000 - 1,800	<12	<16
T641 Dock	25	<100	<1,400	<12	<16
NWArea	25	<100	<1,400	<12	<16

[a]Refer to Figures 4, 5, 6, 7, and 8.
[b]Guidelines = 5,000 α dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum
[c]Guidelines = 5,000 β-γ dpm/100 cm² average in a 1 m² area and 15,000 β-γ dpm/100 cm² maximum
[d]Guideline = 1,000 α dpm/100 cm²
[e]Guideline = 1,000 β-γ dpm/100 cm²

TABLE 2

TRITIUM ACTIVITY IN MISCELLANEOUS SAMPLES
FOR BUILDING T030
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Type	Activity (dpm/100 cm^2)
Room 101, East Wall	Paint	<200[b]
Room 101, North Wall	Paint	6,600 ± 220[b]
Room 101, West Wall	Paint	<200[b]
Room 101B, East Wall	Paint	<200[b]
Room 101, W Restroom Wall	Paint	<160[b]
Location A	Smear	<30[c]
Location B	Smear	<33[c]
Location C	Smear	<56[c]
Location D	Smear	<57[c]
Location E	Smear	<44[c]
Location F	Smear	<65[c]
Location G	Smear	<220[c]

[a]Refer to Figure 4.
[b]Total Activity
[c]Removable Activity

TABLE 3

BACKGROUND EXPOSURE RATES
FOR THE
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1 m above Surface (μR/h)
#1 Gaston Road	13
#2 Black Canyon Road	16
#3 Black Canyon Road	14
#4 Valley Circle Road	15
#5 Woolsey Canyon Road	12
#6 Woolsey Canyon Road	14

[a]Refer to Figure 10.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Radionuclide Concentrations pCi/g					
	Cs-137	Ra-226	Th-228	Th-232	U-235	U-238
BACKGROUND						
#1 Gaston Rd.	<0.1	1.2 ± 0.2[b]	1.4 ± 0.1	1.6 ± 0.4	<0.1	2.5 ± 1.6
#2 Black Canyon	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.2	1.7 ± 0.3	<0.1	1.4 ± 1.5
#3 Sage Ranch Park	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.1	1.3 ± 0.3	<0.1	1.6 ± 1.1
#4 Valley Circle Road	0.2 ± 0.1	1.0 ± 0.2	1.2 ± 0.1	1.1 ± 0.4	<0.1	<2.2
#5 Woolsey Canyon 386S017	<0.1	0.9 ± 0.2	1.1 ± 0.1	1.2 ± 0.3	<0.1	2.1 ± 1.2
#6 Woolsey Canyon 386S018	<0.1	<0.2	0.6 ± 0.1	0.6 ± 0.3	<0.1	<1.0
SSFL AREAS						
NW Area #1	0.5 ± 0.1	1.0 ± 0.2	1.5 ± 0.1	1.6 ± 0.3	<0.1	0.8 ± 1.3
NW Area #2	<0.1	1.0 ± 0.2	1.4 ± 0.1	1.5 ± 0.4	<0.1	1.2 ± 1.4
NW Area #3	<0.1	1.0 ± 0.2	1.3 ± 0.1	1.7 ± 0.4	<0.1	1.9 ± 1.3
NW Area #4	<0.1	0.8 ± 0.2	1.2 ± 0.1	1.5 ± 0.3	<0.1	1.0 ± 0.9
NW Area #5	0.2 ± 0.1	1.0 ± 0.2	1.2 ± 0.1	1.6 ± 0.3	<0.1	<1.5
Storage Yard #6	0.1 ± 0.1	0.7 ± 0.2	1.2 ± 0.1	1.7 ± 0.4	<0.1	<2.0
ISF #7	<0.1	1.2 ± 0.2	1.6 ± 0.1	1.6 ± 0.3	<0.1	1.0 ± 1.5
ISF #8	0.4 ± 0.1	0.8 ± 0.2	1.4 ± 0.2	1.7 ± 0.4	<0.1	1.2 ± 1.3
ISF #9	0.1 ± 0.1	0.8 ± 0.2	1.4 ± 0.1	1.6 ± 0.4	<0.1	1.7 ± 1.4
ISF #10	0.1 ± 0.1	1.0 ± 0.2	1.3 ± 0.2	1.5 ± 0.4	<0.1	<1.5

[a]Refer to Figures 3, 7, 9, and 10.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

U.S. Department of Energy (DOE). Radiation Protection of the Public and Environment. Washington, DC; DOE order 5400.,5; February 1990.

DOE Memorandum from R. Pelletier to Distribution, "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", November 17, 1995.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey Plan for the Interim Storage Facility; Buildings T030, T024, T019, T013; An Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; September 6, 1995.

ORISE. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Building T013, T019, T024, T030, and T641; the Storage Yard West of Building T626 and T038; and the NW Area; Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; January 11, 1996.

Rockwell International. Interim Storage Facility Decommissioning Final Report. Ventura County, CA; March 15, 1985.

Rockwell International. Radiological Survey of Shipping/Receiving and Old Accelerator Area - Buildings T641 and T030. Ventura County, CA; August 19, 1988a.

Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988b.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

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

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

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

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline GM Detector
Model HP-260
Physical Area, 20 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Physical Area, 74 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-37
Physical Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Gas Proportional Detector
Model 43-68
Physical Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-112
(Reuter-Stokes, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

Tri-Carb Liquid Scintillation Analyzer
Model 1900CA
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the floors and paved portions of the surveyed areas. Other surfaces were scanned using small area (20 cm^2, 74 cm^2 or 126 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	-	gas proportional detector with ratemeter-scaler
	-	ZnS scintillation detector with ratemeter-scaler
Beta	-	gas proportional detector with ratemeter-scaler
	-	GM detector with ratemeter-scaler

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using ZnS scintillation and GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Because different building materials (poured concrete, concrete block, steel, etc.) can have very different background levels, average background counts were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the GM detectors averaged 95 cpm for concrete, 36 cpm for sheet rock, 33 cpm for structural steel, 96 cpm for cinder block, and 92 cpm for asphalt. Alpha background count rates for the ZnS detectors averaged 7 cpm for concrete, 1 cpm for sheet rock, 2 cpm for structural steel, 3 cpm for cinder block, and 2 cpm for asphalt. Net count rates were determined by subtracting the appropriate material background from the gross count rate for each measurement location. Beta efficiency factors ranged from 0.17 to 0.18 for the GM detector calibrated to Tc-99. The beta minimum detectable activities (MDA) for the GM detectors varied by material and ranged from 870 to 1,400 dpm/100cm^2. Alpha efficiency factors ranged from 0.18 to 0.19 for the ZnS detectors calibrated to Pu-239 and MDAs ranged from 50 to 100 dpm/100cm^2. The physical window area for the GM and ZnS detectors were 20 cm^2 and 74 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Tritium smears were first moistened with deionized water before the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in $\mu R/h$.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

Paint Sampling

Paint samples were obtained by chipping the paint from 100 cm^2 of surface area. The sample was then placed in a plastic specimen cup sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

Liquid Scintillation

Smears were counted in a liquid scintillation counter for low-energy beta activity to determine H-3 activity.

Gamma Spectrometry

Soil samples were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and

the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concerns were:

Co-60	1.173 MeV
Cs-137	0.662 MeV
Eu-152	0.344 MeV
Eu-154	0.723 MeV
Ra-226	0.351 MeV from Pb-214*
Th-228	0.239 MeV from Pb-212*
Th-232	0.911 MeV from Ac-228*
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Tritium

Tritium in solid samples was exchanged with water by refluxing and the resulting liquid was distilled to remove other radionuclides and organic materials. The samples were spiked with a standard tritium solution to evaluate quenching and counted in a liquid scintillation counter.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross

sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + 4.65\sqrt{BKG}$]. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standard/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revision 9 (January 1995)
- Quality Assurance Manful, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

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

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[i,j,k]
Uranium and mixed fission and activation products	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

[a] 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.

[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 measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

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

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

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

[f] The amount of removable radioactive 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 wipe 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 total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

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

[i] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{½}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

"U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Revision 2, March 1987.

"DOE Order 5400.5, Radiation Protection of the Public and the Environment," February 1990.

EXHIBIT IV

FACILITY 4019 FINAL REPORT

BOEING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	37129		35	N/C	EID-04374

Program Title CLOSURE OF ETEC (R21-RF)

Document Title FINAL REPORT DECONTAMINATION AND DISMANTLEMENT OPERATIONS AT SSFL BUILDING 4019 FOR RELEASE WITHOUT RADIOLOGICAL RESTRICTIONS

Document Type
D&D Report

Related Documents

Original Issue Date
9-11-1999

Release Date
~~RELEASE~~ 9-11-99

Prepared By/Date	Dept.	Mail/Addr
Ken Jaqday 6/1/99	344	T013

IR&D Program? Yes ☐ No ☒
If Yes, Enter Authorization No.

Approvals	Date
R. D. Meyer RD Meyer	8-19-99
~~S. E. Reeder~~ 8/19/99	
S. E. Reeder Sharon Reeder	8-26-99
P. D. Rutherford Phil Rutherford	8/25/99
M. E. Lee	8/27/99

Distribution		
*	Name	Mail Addr.
*	~~Horton, P. H.~~ Marshall, R.A.	T038
	Lefflam, S. R.	T487
*	Lee, M. E.	T038
*	Meyer, R. D.	T038
*	Reeder, S. E.	T038
*	Rutherford, P. D. (3)	T487
*	~~DOE Site Restoration (7)~~	~~T038~~
*	Ervin III, Guy	T038
*	Shah, S. (4)	T038

Abstract

This document presents information supporting release of SSFL Building 4019 without radiological restrictions.

* Complete Document
No Asterisk, Title Page/Summary
or Change Page Only.

Reserved for Proprietary/Legal Notice

CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

Building 4019, a former nuclear facility at the Santa Susana Field Laboratory (SSFL) is a 6400 ft^2 building with steel framing, siding and built-up roof on a reinforced concrete slab. The building has a 10-ft height Low Bay containing office areas, a conference room, a restroom and an equipment room. Connected to the Low Bay is a 32-ft height High Bay containing open floor space, a 10-ton bridge crane, an empty storage room with cinder block walls and a below-grade test vault with hydraulic lift.

This report documents the decontamination and dismantlement (D&D) activities conducted in the Building 4019 High Bay, test vault, storage room and equipment room supporting the eventual release of the building for unrestricted use. Section 2 provides background on the facility. Section 3 overviews the D&D activities while Section 4 provides details of the most recent activities. Section 5 and 6 provide waste generation and cost summaries, respectively. Section 7 contains the references.

2.0 BACKGROUND

2.1 LOCATION

Building 4019 is part of Rocketdyne's Santa Susana Field Laboratory (SSFL) in the Simi Hills of southeastern Ventura County, California, adjacent to the Los Angeles County Line and approximately 29 miles northwest of downtown Los Angeles. **Figure 2-1** shows the location of the SSFL relative to the surrounding communities. Building 4019 is located in Area IV, which comprises the western portion of the SSFL in an area known as Burro Flats. This is indicated in **Figure 2-2**, a portion of the 1967 edition of the U.S. Geological Survey Calabasas Quadrangle topographic map. **Figure 2-3** is an aerial photograph of Area IV, showing Building 4019 and the surrounding buildings as they appeared in the mid-1960's. Building 4019 , as were many of the Area IV buildings, was built in the early 1960's to support the Atomic Energy Commission (AEC) Systems for Nuclear Auxiliary Power (SNAP) program.

2.2 FACILITY CHARACTERISTICS

Figures 2-4 through **2-13** are various views of Building 4019 as it appears today. The Low Bay conference room, offices and restroom are currently used to support Boeing employee training courses. The High Bay is being used as an indoor storage area. The test vault has prospects for future simulated space environment tests using the vacuum chamber and equipment currently stored in the backyard. The vacuum chamber and equipment is planned to be lowered into the test vault for storage after the hydraulic lift fluid is changed out with non-PCB containing fluid.

Figures 2-14, 2-15 and **2-16** are the elevation drawing, plan drawing and section drawing, respectively, of Building 4019 as it was built.

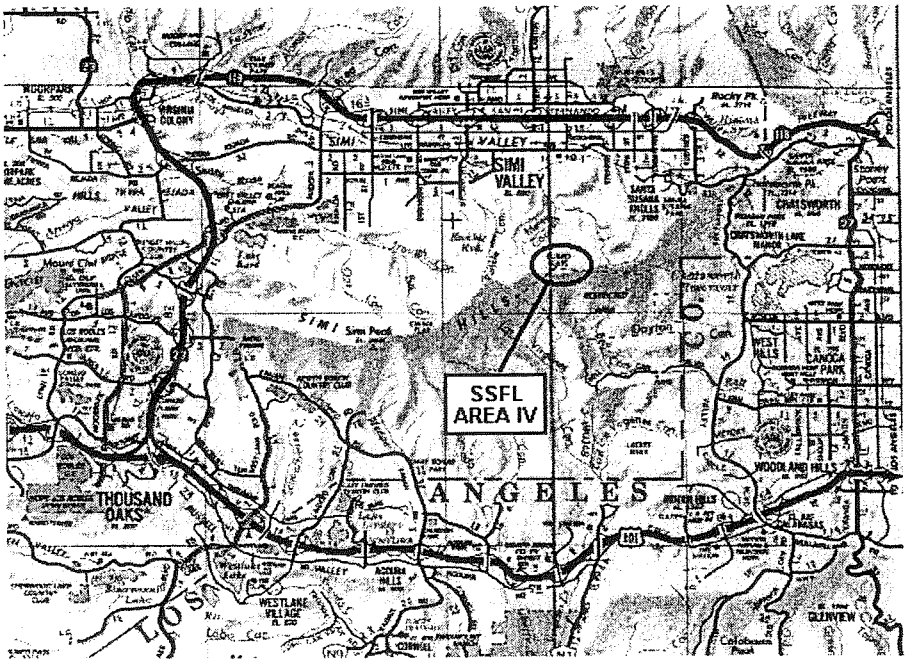


Figure 2-1. Map of Southeastern Ventura County Showing the Location of the SSFL

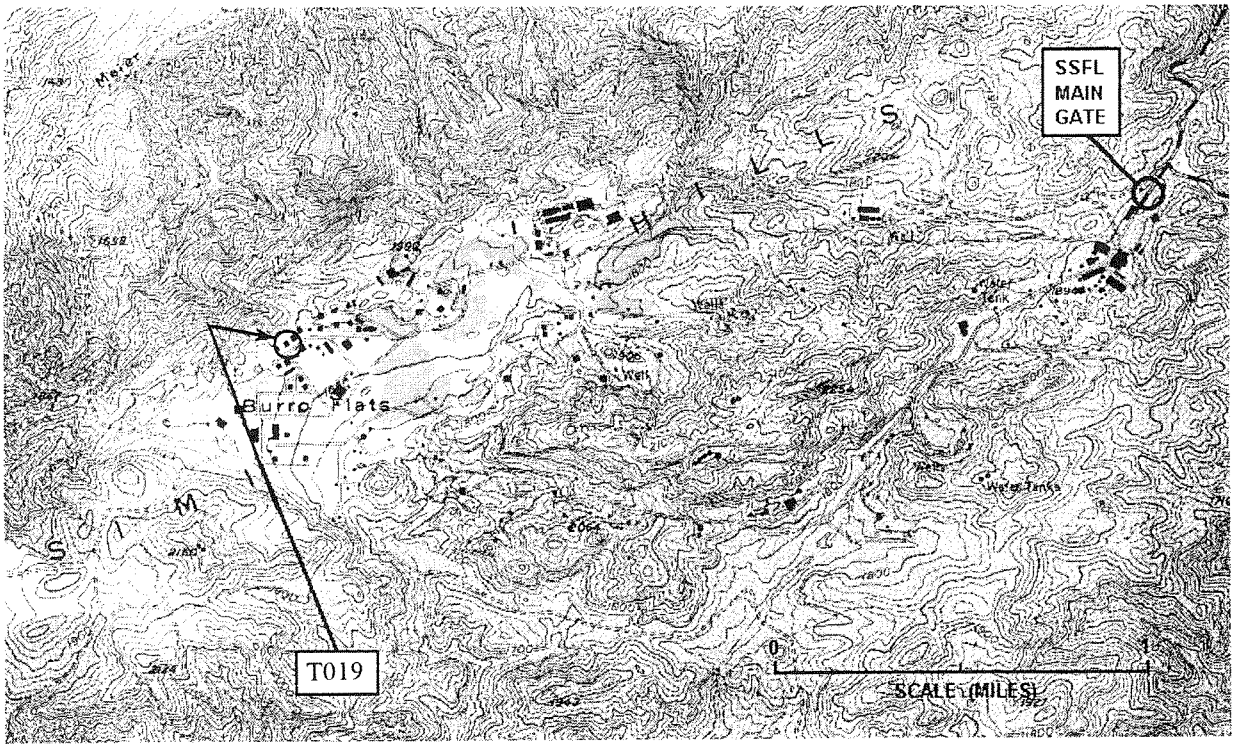


Figure 2-2. Topographic Map for the Area Encompassing the SSFL, Showing the Location of Building 4019

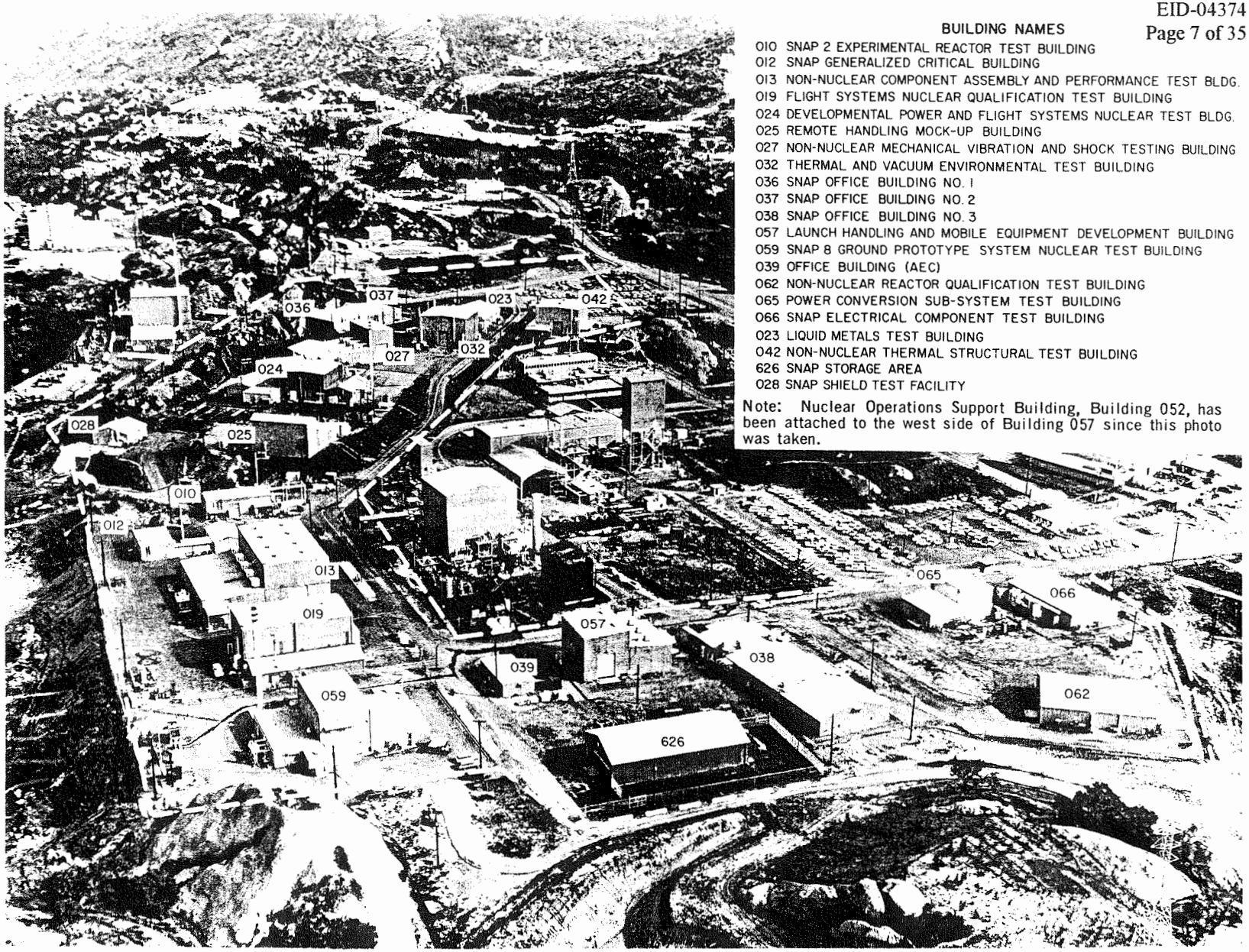


Figure 2-3. Mid-1960's SNAP Building Complex, Looking East

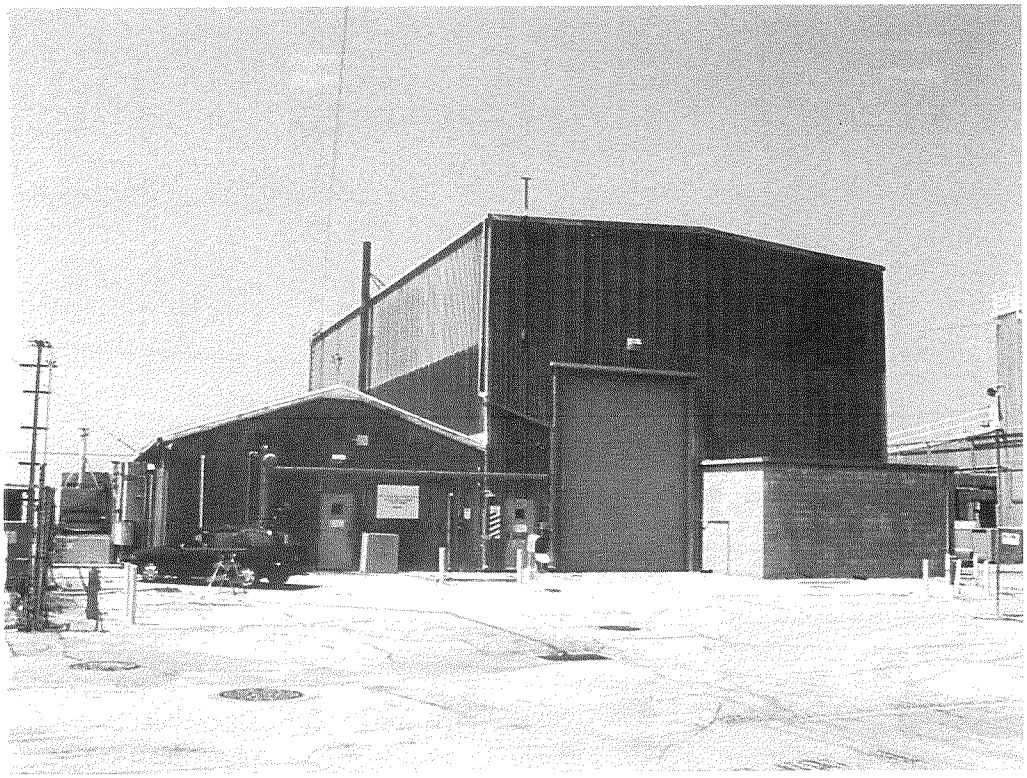


Figure 2-4. Building 4019 Exterior, Looking North

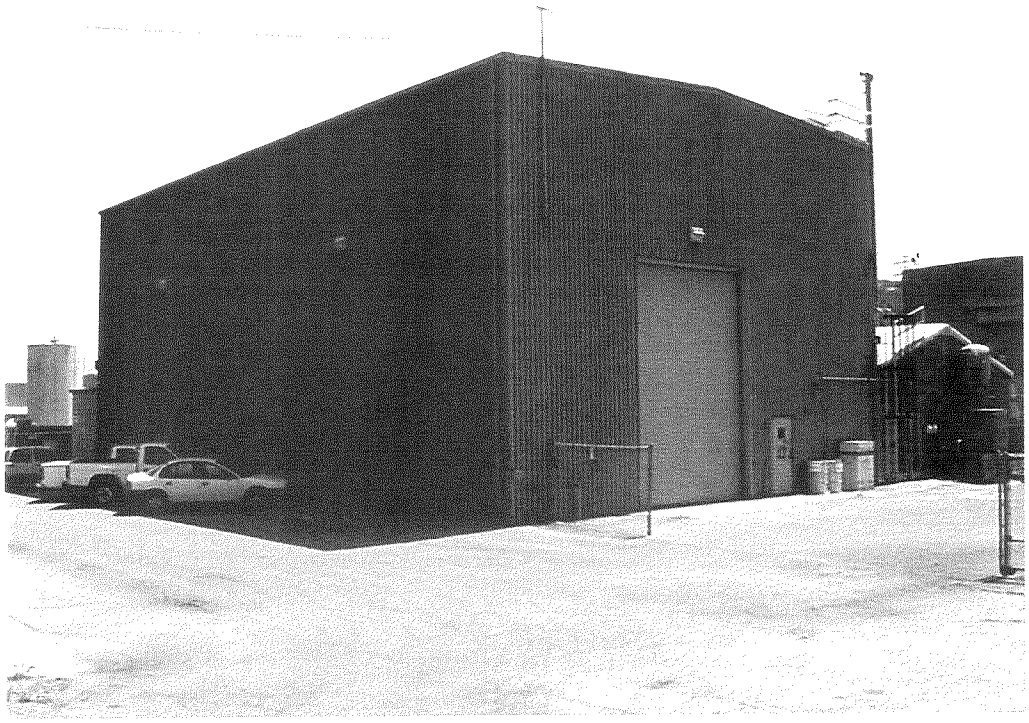


Figure 2-5. Building 4019 Exterior, Looking Southwest

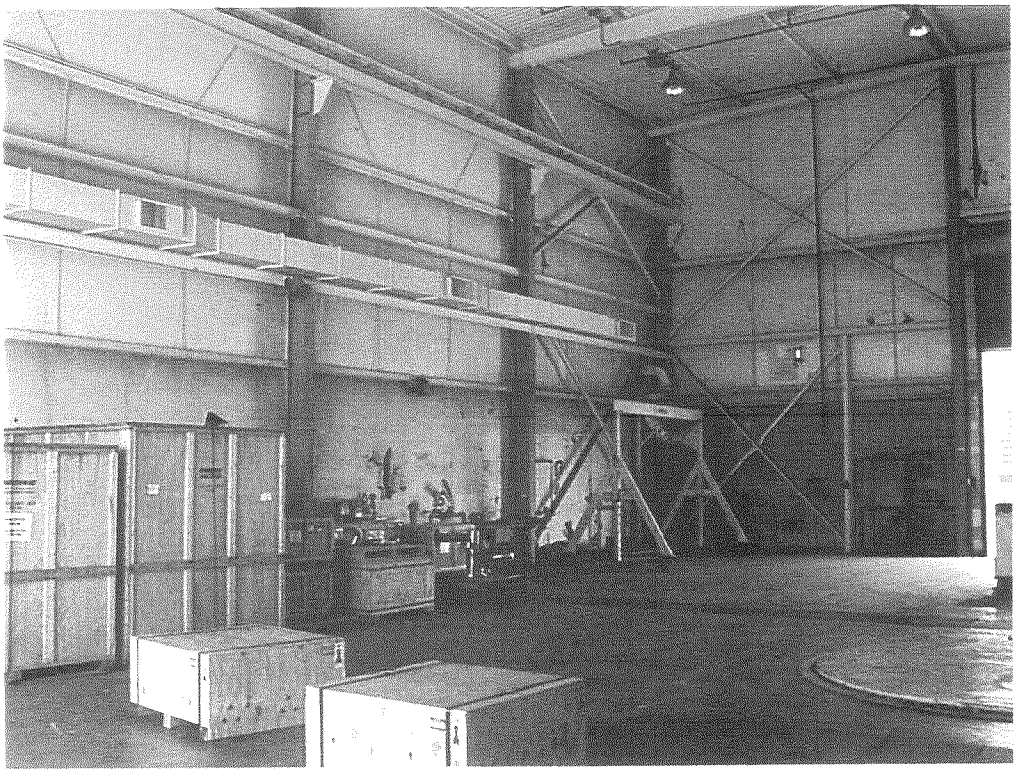


Figure 2-6. Building 4019 High Bay, Looking Southeast

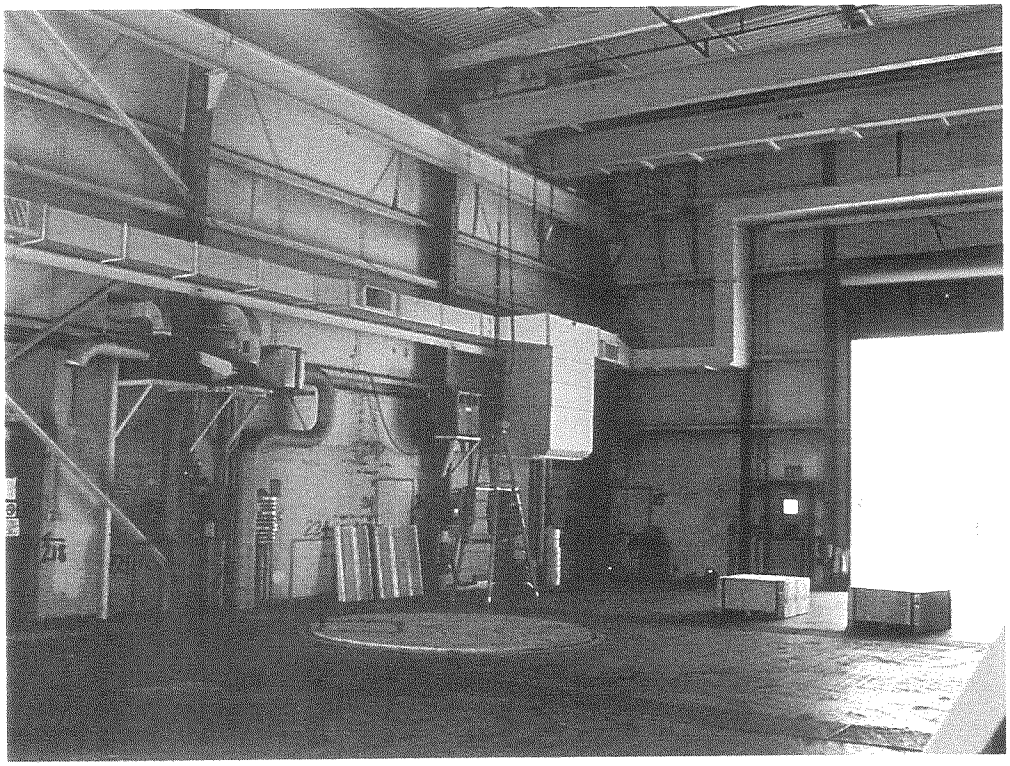


Figure 2-7. Building 4019 High Bay, Looking Northwest

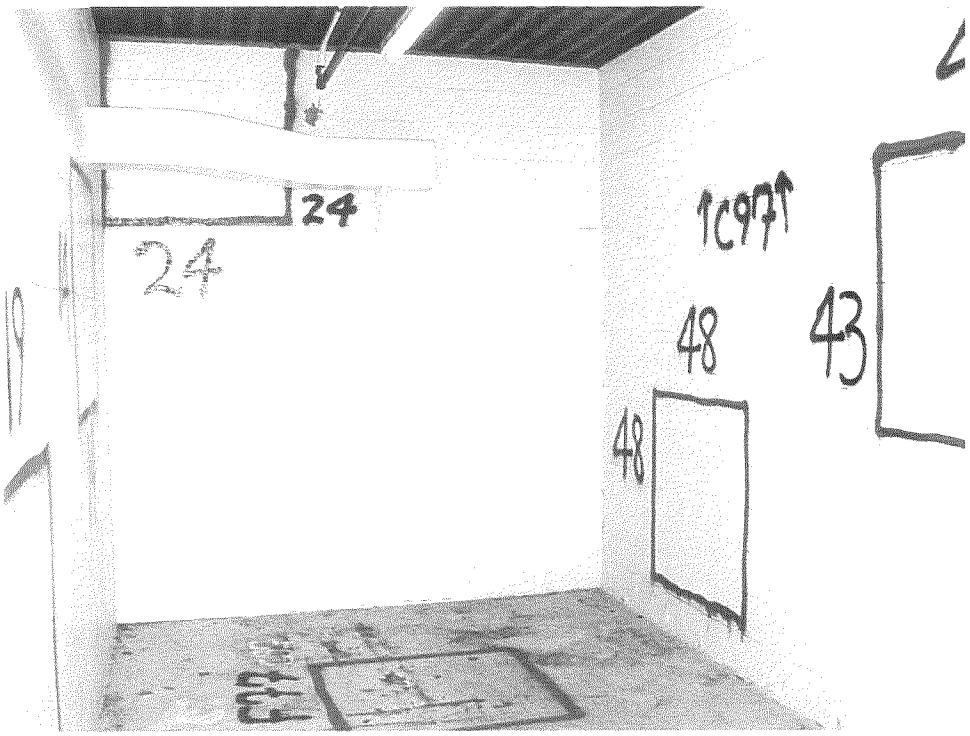


Figure 2-8. Building 4019 Storage Room

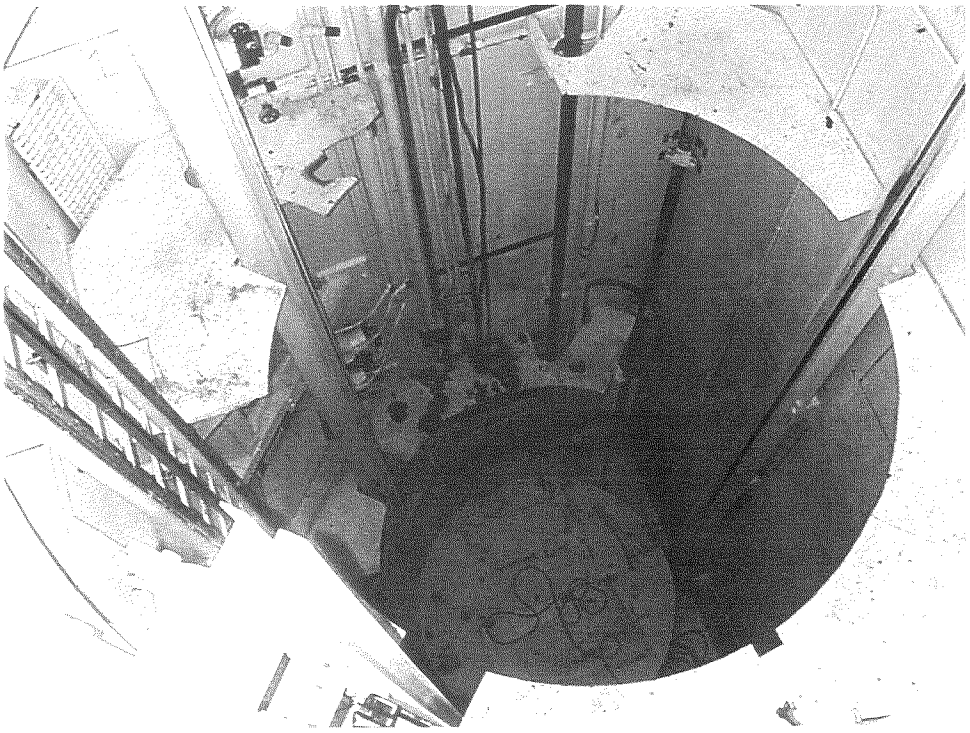


Figure 2-9. Building 4019 Test Vault

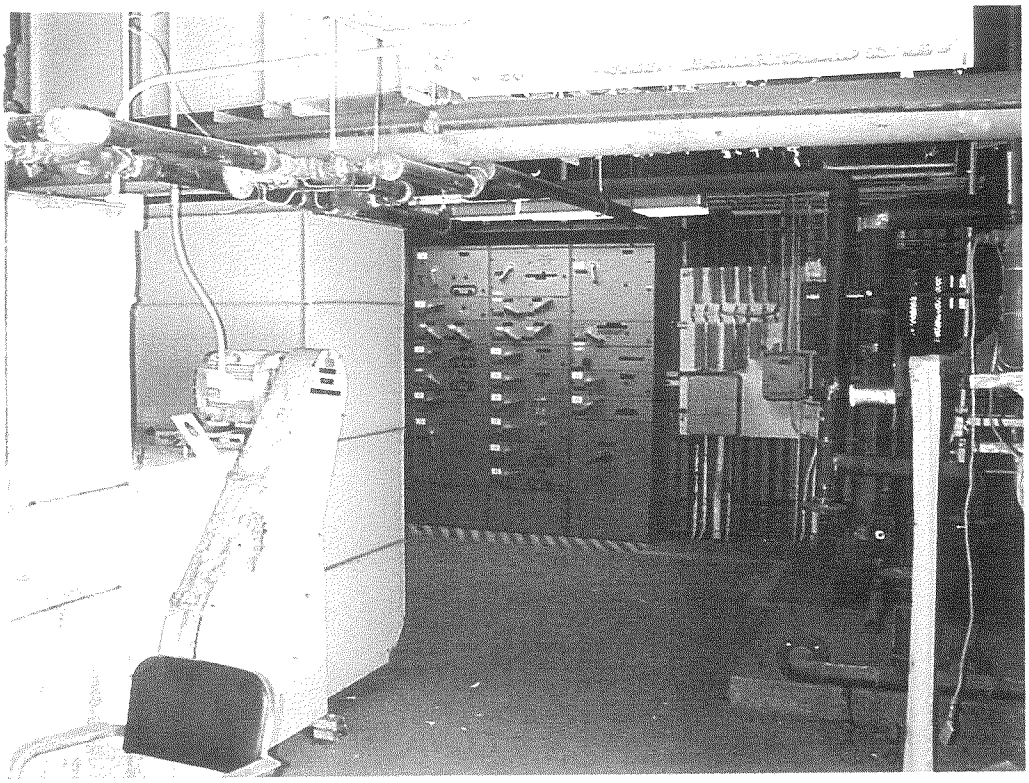


Figure 2-10. Building 4019 Equipment Room

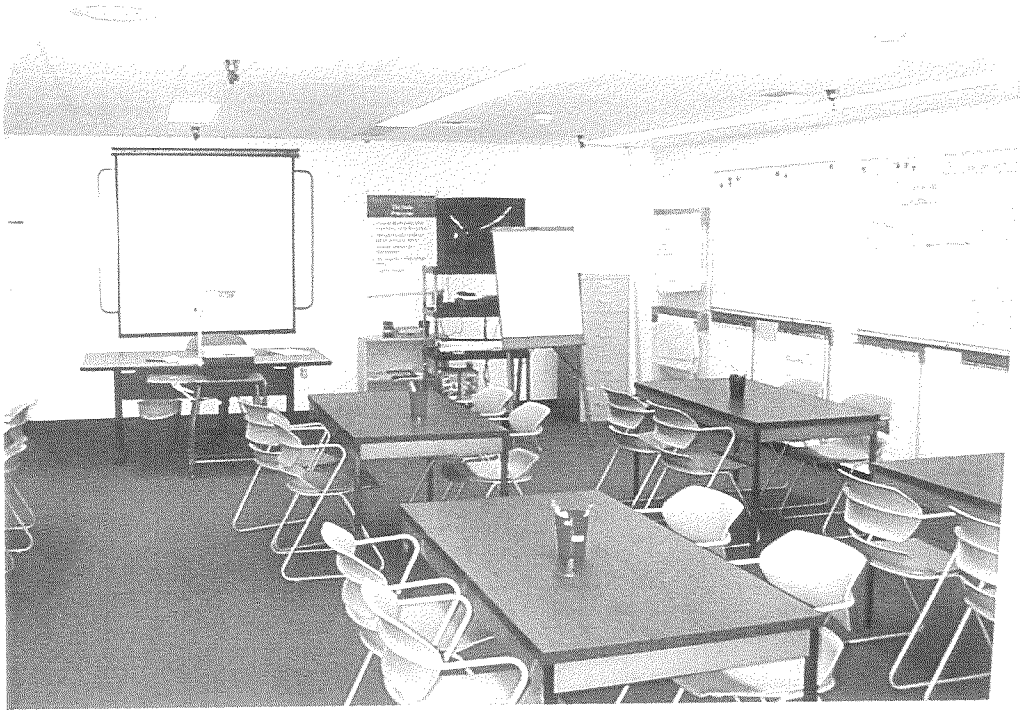


Figure 2-11. Building 4019 Conference Room

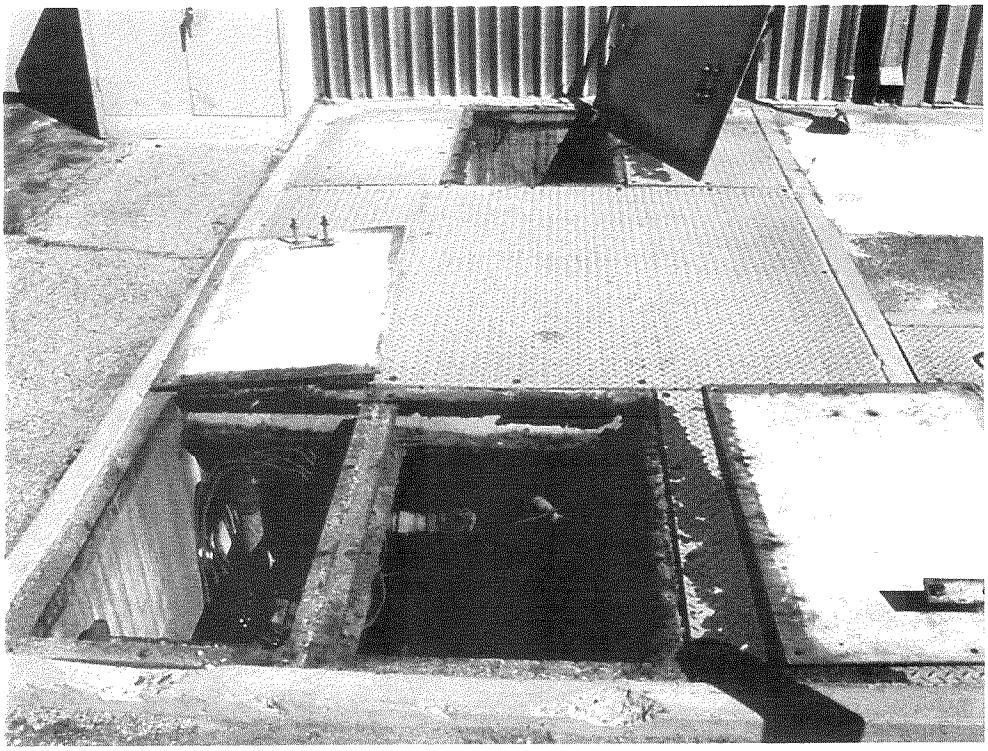


Figure 2-12. Building 4019 Waste Survey Tank

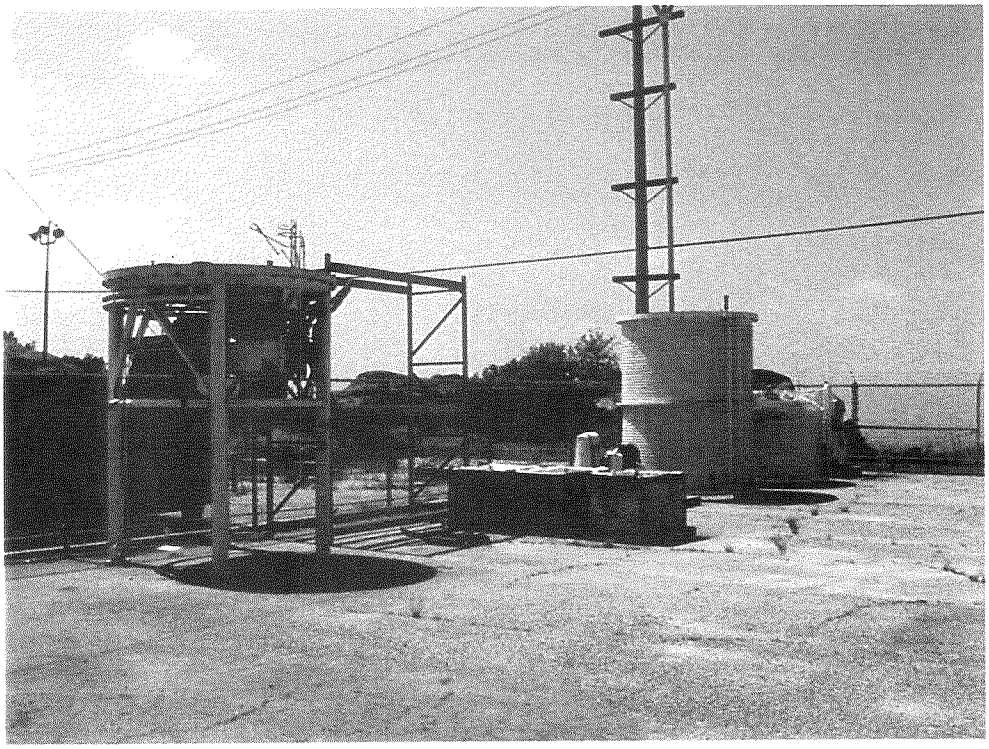
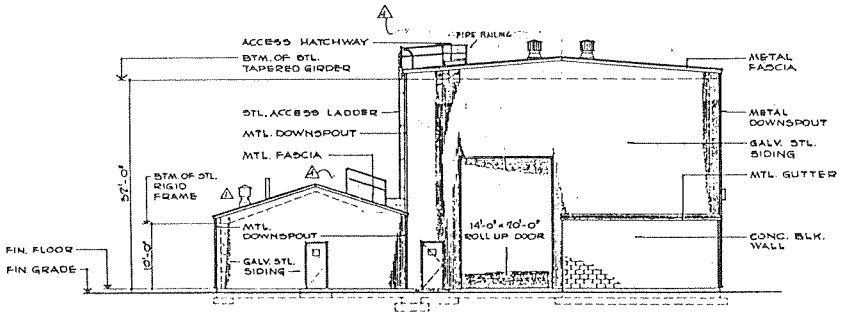
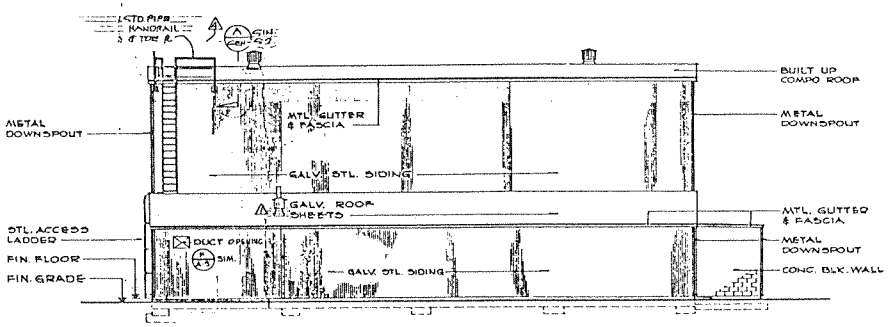


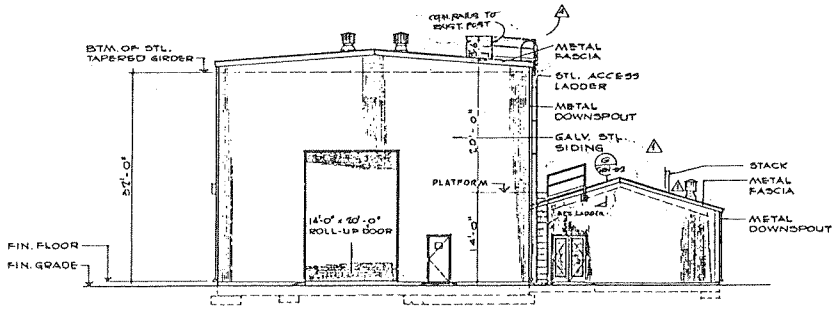
Figure 2-13. Building 4019 Test Vault Vacuum Chamber Equipment



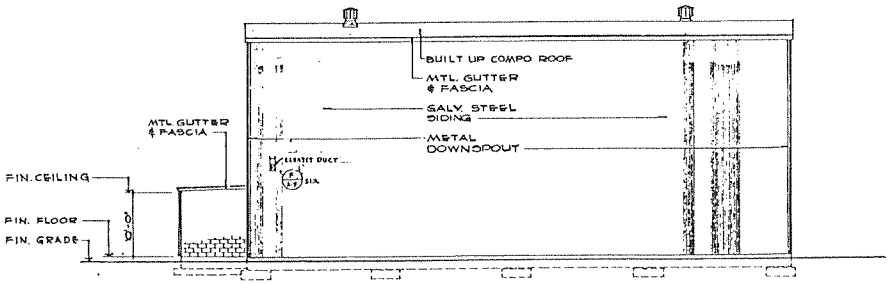
SOUTH ELEVATION



WEST ELEVATION



NORTH ELEVATION



EAST ELEVATION

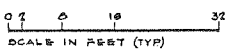


Figure 2-14. As-Built Elevation Drawings Building 4019

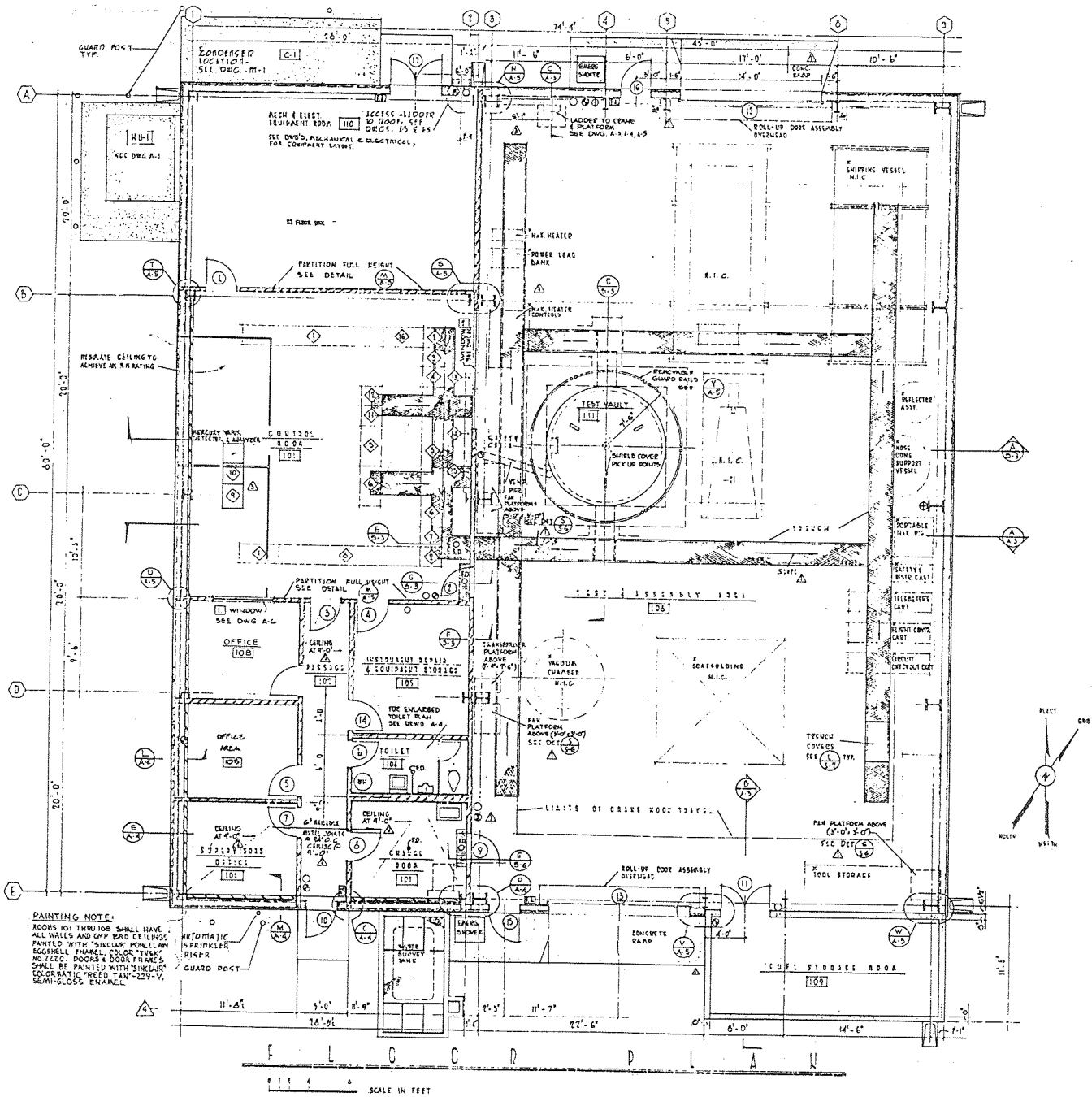


Figure 2-15. As-Built Plan Drawing Building 4019

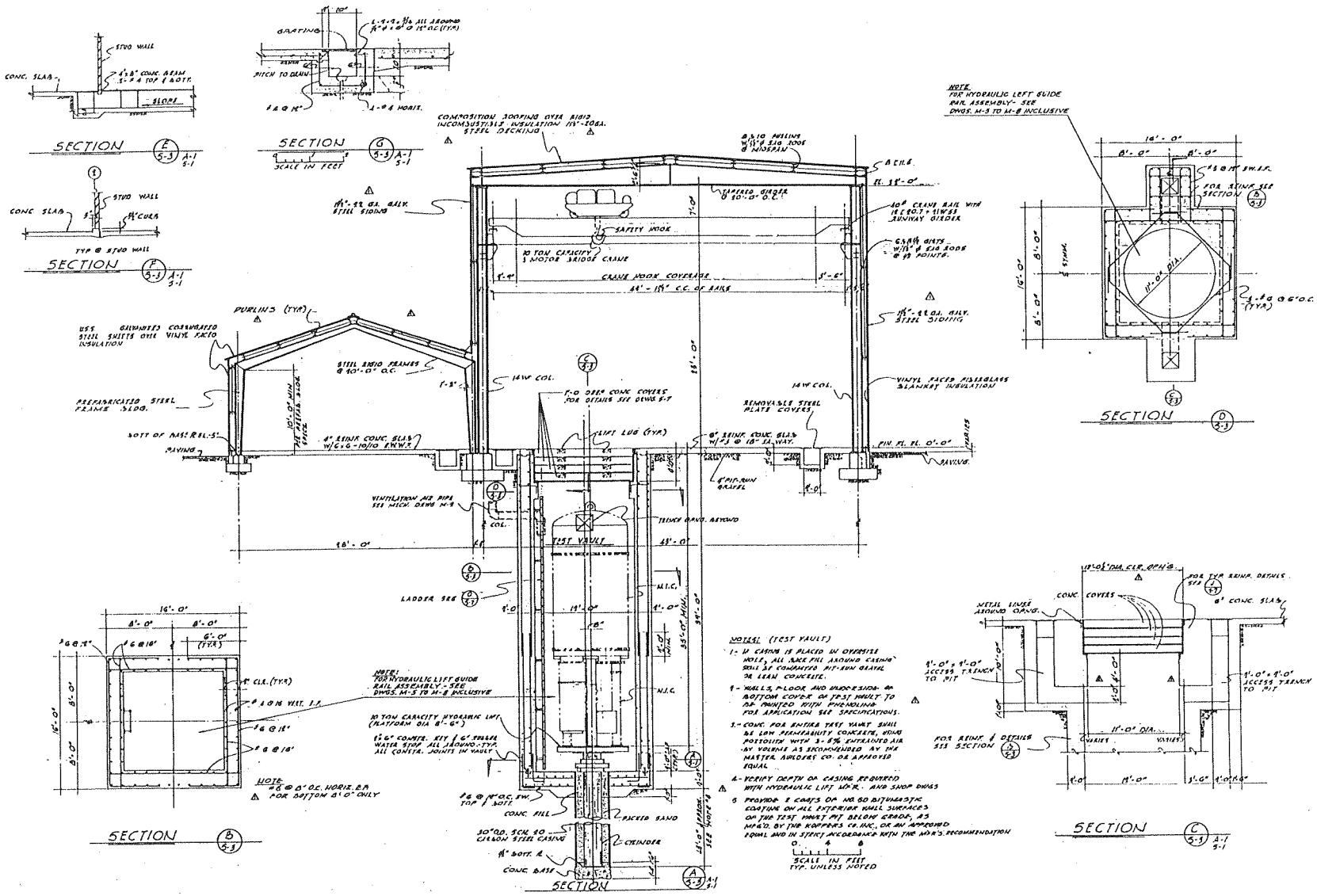


Figure 2-16. As-Built Section Drawing Building 4019

2.3 OPERATIONAL HISTORY

According to Reference 1, Building 4019 was built in 1962 to be the SNAP Flight Systems Nuclear Qualification Test Building. The Low Bay contained the control room, personnel change room, equipment room, restroom and offices. The High Bay contained the final assembly and test area used for acceptance tests in 1964 and 1965 on three SNAP 10A flight systems, FS-1, FS-4 and FS-5.

For each flight system, the Building 4019 involvement began after transferring the flight system from the pre-assembly area in Building 4013 into the 4019 High Bay.

Figure 2-17 is a schematic of a typical SNAP 10A flight system. **Figure 2-18** is a photograph of Flight System FS-4 on top of the hydraulic lift inside the test vault. FS-4 was the flight system that was eventually launched into space as a flight demonstration on April 3, 1965. The SNAP 10A flight systems were designed to be remotely started once in orbit and operate one year. They would provide 40kW-thermal / 400W- electrical power using a NaK-cooled nuclear reactor and SiGe thermoelectric conversion system.

Scaffolding was erected near the southern end of the Building 4019 High Bay that would allow workers easy access when the flight system was in its upright position. There was also a laydown location near the test vault that permitted steps of the final assembly and post-test disassembly to be conducted in the horizontal orientation.

Fuel and reflector assemblies from the Building 4019 storage room were installed into the flight system. NaK, control and instrument lines would be attached and non-nuclear systems would be checked out. The vacuum chamber, without the top cover, was then lowered over the flight system and attached to the lower flange interface. The hydraulic lift was then used to lower the partially assembled test configuration into the test vault for final test preparations. Eventually the beryllium control drums were installed and reactor core fuel loading initiated and continued until dry criticality could be achieved.

The concrete cover plugs were then put in place over the test vault and the control drums calibrated (adjusted) under dry criticality zero-load conditions. The reactor was then shutdown, the concrete plugs were removed and the reactor core fuel loading continued to completion. The reactor vessel end and thermoelectric pump were then welded into the flight system. The flight system was then filled with NaK, the NaK circulated and cleaned, and finally the expansion compensator welded on, providing a closed NaK system. Following further non-nuclear checkouts, the vacuum chamber top cover was attached and the flight system was lowered into the test vault and the vacuum pumping system activated and checked out. Eventually the concrete cover plugs were put in place and wet criticality zero-power tests conducted and the reflector control drums fine adjusted.

The flight system was then removed from the vacuum chamber and the reflector assembly replaced by a safety shutdown sleeve. The flight system was then placed in inert gas-filled containers for shipment to the launch site or storage. Reflector assemblies were shipped or stored in separate containers.

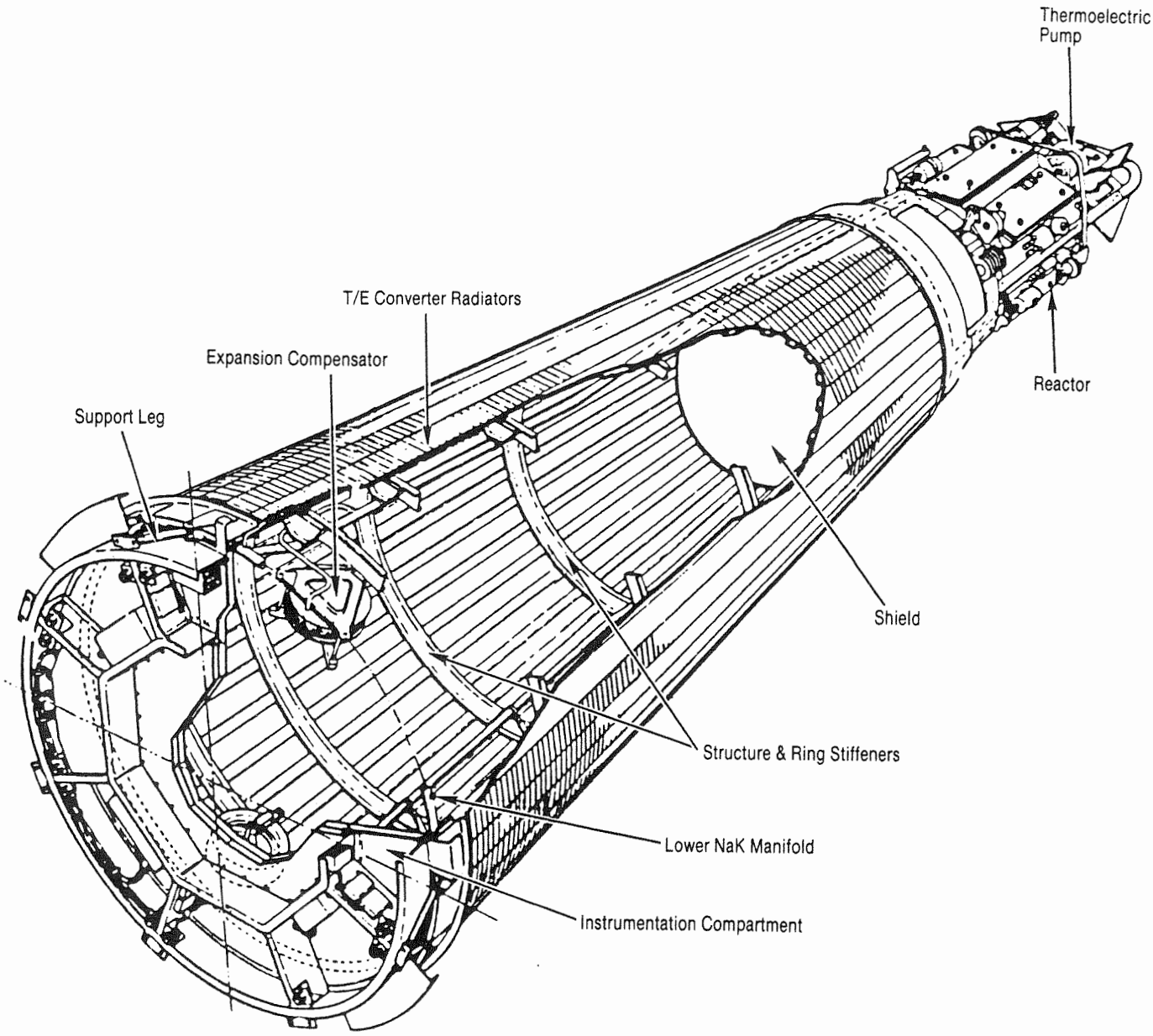


Figure 2-17. SNAP 10A Flight System

Figure 2-18. SNAP 10A FS-4 in Acceptance Testing

The total time spent by any flight system in Building 4019 was less than 4 months, and the reactor operation was less than 16 hours total for any flight system. The radiation exposure to the test facility during testing and from the fission products remaining in the flight systems after the tests and before removal from the facility was minor.

The SNAP program was terminated in 1970. There were no reported incidences involving nuclear materials or releases at or in Building 4019. Furthermore, when Building 4019 was reassigned for non-nuclear use (circa 1970), radiological surveys were performed to ensure that the area was safe for unrestricted use.

3.0 SUMMARY

Rocketdyne radiological surveys of Building 4019 were conducted in 1988 that concluded the building was uncontaminated and could be released from radiological controls (Reference 2). In 1995, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conducted a verification survey of Building 4019 and found a $1m^2$ area on the High Bay floor that had an average surface activity slightly in excess of DOE guidelines for release without radiological restrictions (Reference 4). ORISE also did not survey the test vault. In the summer of 1998, Rocketdyne/Boeing performed D&D activities in Building 4019 and a final radiological survey was conducted that concluded Building 4019 is suitable for release without radiological restrictions (Reference 11). ORISE conducted a reverification of Building 4019 in September 1998 and all measured surface activity and exposure rates met applicable guidelines for release without radiological restrictions (Reference 12).

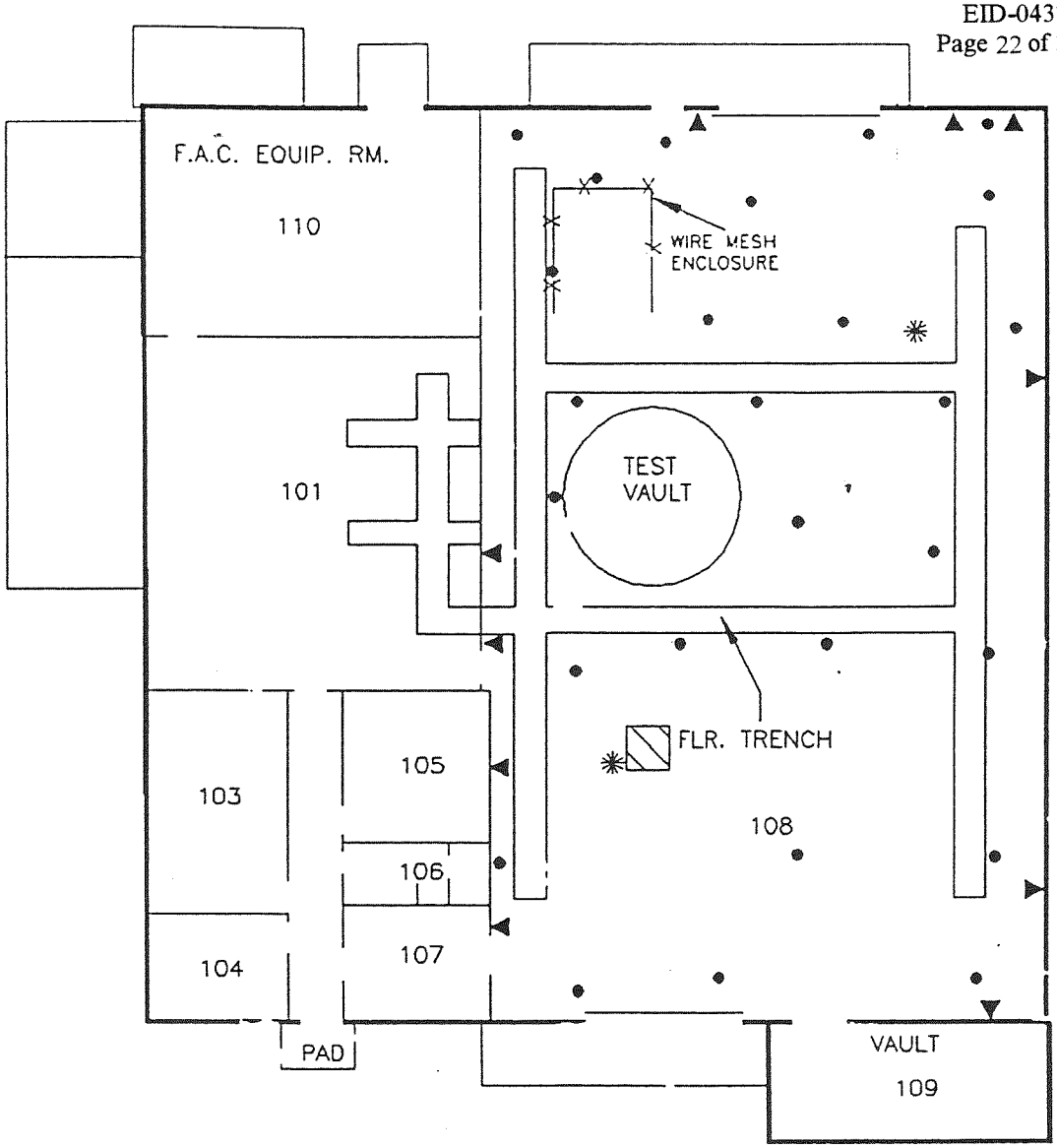
At this time, the only known hazards in Building 4019 are asbestos containing insulation in the equipment room and (Polychlorinated Biphenyl – PCB) containing fluid in the test vault's hydraulic lift system. In 1999, it is planned to propose a project to DOE to obtain funds to reduce these hazards to the acceptance levels required for unrestricted use.

4.0 PROJECT ACTIVITIES/RESULTS

4.1 RECENT D&D AND SURVEY ACTIVITIES

In 1988, Rocketdyne conducted a radiological survey of Building 4019 (Reference 2). It consisted of a walk-through survey for gamma exposure rate with planned surface smear samples and beta surface activity surveys if radioactive contamination was indicated. 67 locations were surveyed for gamma exposure rates including direct beta contamination measurements. Reference 2 concluded that Building 4019 was uncontaminated and no further investigation was required. Subsequently, Building 4019 was released by Rocketdyne from radiological controls and it was designated the ETEC Construction Staging and Computer Facility.

In 1995, ORISE conducted a verification survey of various SSFL locations including Building 4019 (Reference 4). The survey found that Building 4019 met the Rocketdyne exposure rate limit of 5 μR/hr above background levels. The survey also found that the total and removable alpha and beta activity levels at 44 single point surface locations **(see Figure 4-3)** were below DOE guidelines on maximum values, as summarized in **Table 4-1**. The closest reading to the guideline value of 15,000 dpm/100cm^2 was 11,000 dpm/100 cm^2. This location was between the test vault and South door. However, the average surface activity in the surrounding 1 m^2 at this measurement location was 5900 dpm/100cm^2 which exceeded the DOE guideline of 5000 dpm/100cm^2.



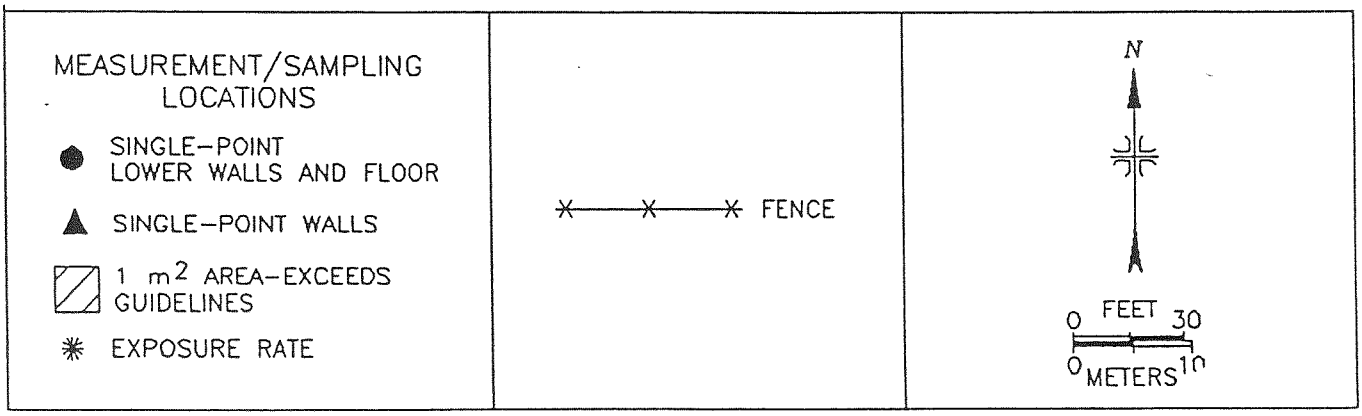


Figure 4-1. 1996 ORISE Building 4019 Verification Survey Map

Table 4-1. Summary of Surface Activity Levels Building 4019 (1996 ORISE, Reference 4)

Location[a]	Number Of Measurement Locations	Total Activity Range (dpm/100 cm²)		Removable Activity Range (dpm/100 cm²)	
		Single Measurement			
	Single-Pt.	Alpha[b]	Beta[c]	Alpha[d]	Beta[e]
T019					
Floor	34	<55	<1,400 - 11,000[f]	<12	<16
Lower Wall	10	<55	<1,000 - 1,400	<12	<16

[a]Refer to Figures 3 and 4.
[b]Guidelines = 5,000 α dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[c]Guidelines = 5,000 β-γ dpm/100 cm² average in a 1 m² area and 15,000 β-γ dpm/100 cm² maximum.
[d]Guidelines = 1,000 γ dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[e]Guidelines = 1,000 β-γ dpm/100 cm² average in a 1 m² area and 15,000 α dpm/100 cm² maximum.
[f]Average surface activity in the surrounding 1 m² at this measurement location was 5,900 dpm/100 cm².

There were also a number of deficiencies identified by ORISE in Rocketdyne's prior 1988 documentation (Reference 5). As a result, ORISE was unable to verify Rocketdyne's conclusion that Building 4019 meets the DOE requirements for unrestricted use and recommended that additional D&D and surveys be performed. In addition, due to access difficulties and health and safety concerns, the test vault could not be surveyed by ORISE and therefore the radiological status of the test vault could not be verified.

In June 1997, the test vault cover plugs were removed and a confined space entry was conducted to perform a radiation survey. This survey by Rocketdyne Radiation Safety consisted of taking activity readings, smear samples and material samples at the 16 locations identified in **Figure 4-4**. The activity levels were between 12 and 14 μR/hr at all locations. The smear and material samples had no detectable activity above background levels.

The vacuum chamber and vacuum pump inside the test vault had been removed earlier and in June 1997 a radiation survey of this equipment by Rocketdyne Radiation Safety indicated no unnatural activity.

In 1997, as part of company site wide abatement programs, the asbestos containing roofing materials were replaced by an outside roofing contractor and the peeling leaded paint on the High Bay doors, AC/heating ducts and structural steel was removed by a licensed lead abatement subcontractor.

The latest D&D activities were started in June, 1998. These were the operations required to support final release radiation surveys and ORISE re-verifications.

The operational mission was to remove equipment from the High Bay, storage room and test vault that was obstructive to radiation surveys and to clean oil and dirt films from potentially activated surfaces that could obscure radiation measurements.

The operations were interrupted when it was discovered that the test vault's hydraulic lift fluid contained PCB's. The 40 CFR 761 acceptable level of PCBs is 50 ppm while the hydraulic lift fluid contained 160 ppm. Chemical sampling of free standing liquids and films on the test vault walls and floor indicated a PCB hazard existed inside the test vault. The test vault D&D plan was then modified to first remove free standing liquids and films from the test vault. This would reduce the PCB airborne hazard and segregate the higher concentrations of PCBs from the wastewater planned to be generated from the eventual spray washing of the test vault. Workers were required to wear protective clothing and organic filtered face masks while performing the cleaning operations.

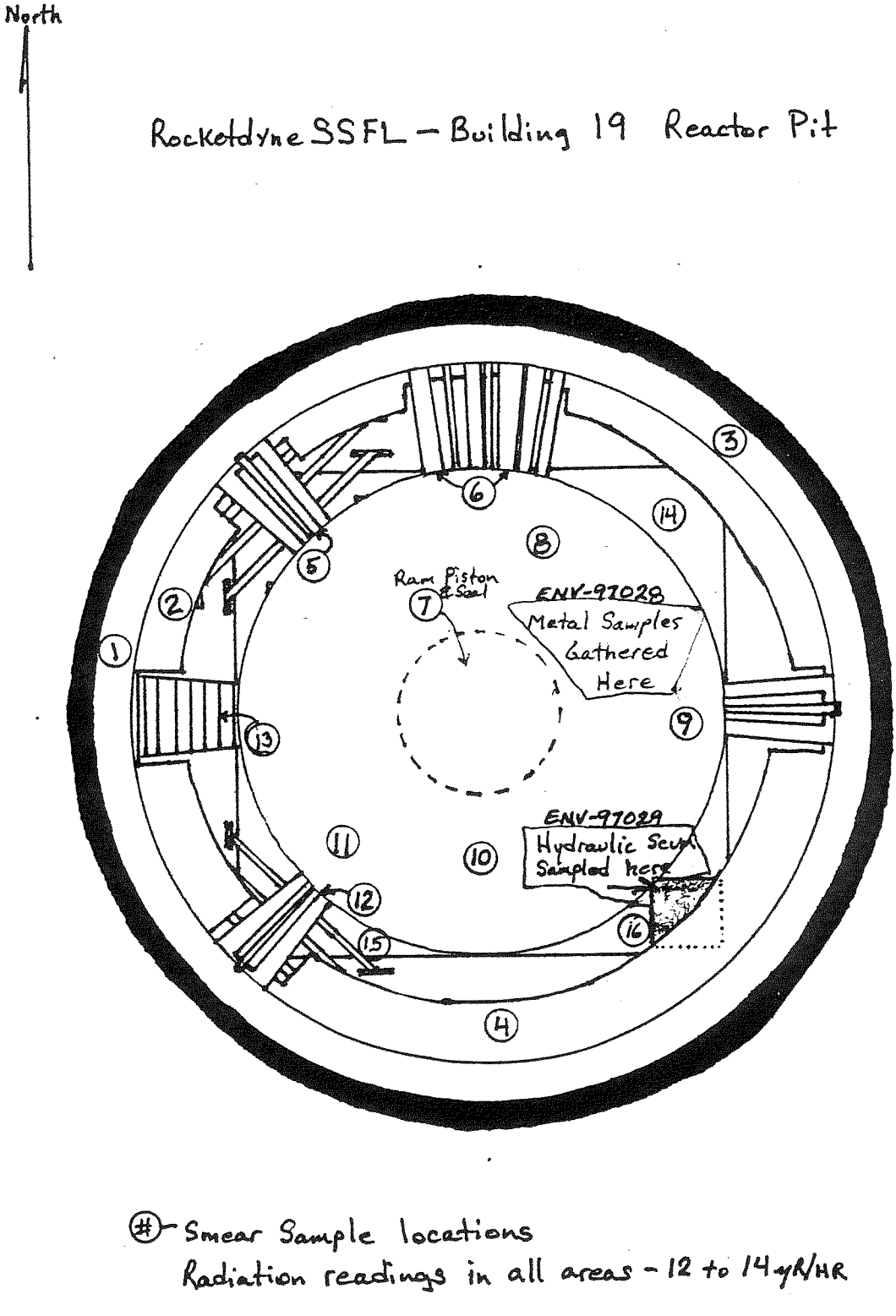


Figure 4-2. 1997 Rocketdyne Survey Map of Building 4019 Test Vault

In July, 1998, Plant Services electricians deactivated all electrical sources to the test vault except for the lighting inside the test vault and the test vault exhaust fan on the west wall of the High Bay. A ground fault interrupt circuit(GFCI) box was established for portable lighting and power tool usage inside the test vault.

An outside asbestos abatement contractor entered the test vault and obtained samples for determination of asbestos content. Analyses indicated that the only asbestos containing materials were small pieces of floor tile that had been in the crack between the cover plugs and High Bay floor slab and had fallen into the test vault when the cover plugs were removed. These were removed by the licensed subcontractor using a HEPA-filtered vacuum.

An extension ladder was welded to the top of the existing test vault entry ladder and outfitted with a center rail system that provided a movable tie-off location the length of the ladder for fall protection equipment.

Seventy one Confined Space Entries into the Building 4019 test vault were conducted per the Reference 6 Confined Space Safe Operating Plan (CSSOP) between July 15, 1998 and October 9, 1998. The initial Confined Space Entries were conducted to clean up a hydraulic lift fluid spill into the pit. An unlabeled small diameter copper tubing bleed line was mistakenly severed during movement of wire bundles in preparation for removal of the deactivated electrical lines. About one gallon of hydraulic lift fluid spilled before the line could be crimped shut. The spilled hydraulic lift fluid outside the test vault was immediately mopped up and a sample of the hydraulic lift fluid sent to Columbia Analytical Services (Reference 7) for analysis. After analysis determined that the hydraulic lift fluid contained PCB's, the spilled hydraulic lift fluid inside the test vault was cleaned up using a double wipe technique and Alchonox cleaning agent. Wipe samples for chemical analysis (per Title 4O CFR 761, Iso-octane solvent used) were then collected at the cleaned areas and throughout the test vault. Chemical analyses by Columbia Analytical Services (Reference 8) indicated that some of the sampled areas remote from the recent spill had PCB levels as high as 620 μg per wipe sample which is well above the Title 40 non-restricted access area cleanup requirement of 10 μg. A representative cleaned area had a wipe sample with PCB level of 7 μg.

The next series of Confined Space Entries rerouted the bleed line and added a double valve system that allowed the hydraulic lift fluid to be removed from the lift cylinder into 55 gallon waste drums on the high bay floor. 6000 pounds of weight was lifted using the facility overhead crane onto the top of the hydraulic lift platform to force the hydraulic lift fluid out of the lift cylinder and into the waste drums. 255 gallons of hydraulic lift fluid were collected and disposed of as hazardous waste. Samples were taken from the hydraulic lift fluid and radionuclide concentrations analysis conducted by Rocketdyne Radiation Safety found no contamination of Cs-137, Co-60, or any other man-made isotope of fuel.

Confined Space Entry was conducted as part of a verification survey by the State of California.

On September 12, 1998, during a Confined Space Entry for the Rocketdyne Radiation Safety survey, a burning odor was noticed and the entry was aborted. It was suspected to be overheating of one of the interior light ballasts. An investigation commenced to establish whether there was an airborne hazard from the burnout of a PCB containing light ballast. Confined Space Entries on September 15, 1998 and September 16, 1998 disassembled the lights and investigated the ballasts. All were non-PCB type. The Rocketdyne Radiation Safety Test Vault survey was completed without further incidents.

In parallel with the Building 4019 test vault entries, other D&D operations were conducted. The hydraulic lift fluid reservoirs and pump equipment in the Equipment Room were drained of 85 gallons of hydraulic lift fluid and removed. The hydraulic lift fluid was put into two 55 gallon waste drums and disposed of as hazardous waste.

Holes were drilled into the reservoirs to prevent their reuse as containers and they were moved out of Building 4019 to a holding area where they will be recycled as scrap metal.

A hydraulic lift fluid sample was taken from a low spot in the line that had been attached to the reservoirs. The sample was sent out for chemical analysis using a second column method to clearly confirm the presence of PCBs by eliminating possible interference, which may cause a false positive result. The analysis conducted by Columbia Analytical Services, Inc. (Reference 9) indicated a PCB level of 73 ppm, lower than the earlier sample (Reference 7) but still above the 40 CFR 761 acceptable level of 50 ppm.

The High Bay and storage room were cleared of storage racks containing surplus equipment. The test vault's vacuum chamber and pumps that were being stored in the High Bay were surveyed for radiation, satisfied release criteria and were moved out of the building to the rear storage yard.

The comprehensive Final Status Survey was performed per the procedures provided in Reference 10. This included 100% qualitative survey of all surfaces for surface contamination, 165 quantitative measurements of total alpha & beta surface contamination, 665 smear measurements for removable alpha & beta contamination, and 43 ambient radiation exposure measurements. The results of the survey are provided in Reference 11. All measurements were below the DOE and Department of Health Services (DHS) approved cleanup standards.

On September 29, 1998, ORISE performed a re-verification of Building 4019. The survey (Reference 12) was conducted in accordance with a DOE approved site-specific survey plan (Reference 13). The ORISE survey verified that Building 4019 is suitable for release for unrestricted use.

Confined Space Entry was conducted as part of a verification survey by the State of California.

On September 12, 1998, during a Confined Space Entry for the Rocketdyne Radiation Safety survey, a burning odor was noticed and the entry was aborted. It was suspected to be overheating of one of the interior light ballasts. An investigation commenced to establish whether there was an airborne hazard from the burnout of a PCB containing light ballast. Confined Space Entries on September 15, 1998 and September 16, 1998 disassembled the lights and investigated the ballasts. All were non-PCB type. The Rocketdyne Radiation Safety Test Vault survey was completed without further incidents.

In parallel with the Building 4019 test vault entries, other D&D operations were conducted. The hydraulic lift fluid reservoirs and pump equipment in the Equipment Room were drained of 85 gallons of hydraulic lift fluid and removed. The hydraulic lift fluid was put into two 55 gallon waste drums and disposed of as hazardous waste.

Holes were drilled into the reservoirs to prevent their reuse as containers and they were moved out of Building 4019 to a holding area where they will be recycled as scrap metal.

A hydraulic lift fluid sample was taken from a low spot in the line that had been attached to the reservoirs. The sample was sent out for chemical analysis using a second column method to clearly confirm the presence of PCBs by eliminating possible interference, which may cause a false positive result. The analysis conducted by Columbia Analytical Services, Inc. (Reference 9) indicated a PCB level of 73 ppm, lower than the earlier sample (Reference 7) but still above the 40 CFR 761 acceptable level of 50 ppm.

The High Bay and storage room were cleared of storage racks containing surplus equipment. The test vault's vacuum chamber and pumps that were being stored in the High Bay were surveyed for radiation, satisfied release criteria and were moved out of the building to the rear storage yard.

The comprehensive Final Status Survey was performed per the procedures provided in Reference 10. This included 100% qualitative survey of all surfaces for surface contamination, 165 quantitative measurements of total alpha & beta surface contamination, 665 smear measurements for removable alpha & beta contamination, and 43 ambient radiation exposure measurements. The results of the survey are provided in Reference 11. All measurements were below the DOE and Department of Health Services (DHS) approved cleanup standards.

On September 29, 1998, ORISE performed a re-verification of Building 4019. The survey (Reference 12) was conducted in accordance with a DOE approved site-specific survey plan (Reference 13). The ORISE survey verified that Building 4019 is suitable for release for unrestricted use.

In October 1999, the DHS Radiologic Health Branch performed a verification survey of Building 4019 and confirmed that the building is suitable for release for unrestricted use.

5.0 WASTE GENERATED AND DISPOSAL

Most of the wastes generated during the later Rocketdyne D&D activities were disposed of as hazardous materials. The liquid wastes generated were the lift fluid with PCBs, the glycol in the water lines and the oily effluent with PCBs from hot water cleaning the test vault. The solid wastes generated were absorbent wipes, PPE, sump pumps, hoses, and miscellaneous equipment contaminated by the PCB containing lift fluid. Table 5-1 lists the hazardous waste disposal log for the Building 4019 D&D activity. Missing from this list are the wastes generated during the asbestos and leaded paint abatements conducted by outside contractors. Also, a small quantity of uncontaminated equipment and parts being stored on High Bay and storage room shelving was removed along with the shelving and either divested, scrapped or disposed of as non-hazardous waste. There was also a small quantity of radioactive scabbled concrete debris generated from the decontamination of the High Bay floor that was transferred to the Radioactive Materials Handling Facility (RMHF) for disposal as radioactive low level waste. There was no mixed waste generated.

Table 5-1. Building 4019 Hazardous Waste Disposal Log, 8/98 through 12/98

LOG	ISSUED	DRUM TYPE	DRUM SIZE	RCVD	WASTE	WT
liquid waste						
6782	18-Aug-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Lift Fluid w/ PCB'S	419
6655	10-Jul-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Lift Fluid w/ PCB'S	452
6656	10-Jul-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Lift Fluid w/ PCB'S	418
6779	18-Aug-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Lift Fluid w/ PCB'S	393
6780	18-Aug-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Lift Fluid w/ PCB'S	439
6781	18-Aug-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	10-Sep-98	Glycol	435
6783	18-Aug-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	11-Sep-98	Glycol	446
6863	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	18-Sep-98	Oily Effluent w/ PCB'S	336
6862	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	18-Sep-98	Oily Effluent w/ PCB'S	440
6865	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	18-Sep-98	Oily Effluent w/ PCB'S	172
6864	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	29-Sep-98	Lift Fluid w/ PCB'S	222
6866	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	29-Sep-98	Lift Fluid w/ PCB'S	486
solid waste					sum	4658
6513	15-May-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	20-Aug-98	Oily Debris PCB's	63
6748	10-Aug-98	TRIWALL	2 Cubic Yard	20-Aug-98	Oily Debris PCB's	330
6834	10-Sep-98	CF – Container Fiber (Yard Box)	1 Cubic Yard	10-Sep-98	Oily Debris PCB's	206
6814	01-Sep-98	CF – Container Fiber (Yard Box)	1 Cubic Yard	11-Sep-98	Oily Debris PCB's	182
6833	10-Sep-98	CF – Container Fiber (Yard Box)	1 Cubic Yard	18-Sep-98	Oily Debris PCB's	288
6839	11-Sep-98	CF – Container Fiber (Yard Box)	1 Cubic Yard	18-Sep-98	Oily Debris PCB's	826
6840	11-Sep-98	CF – Container Fiber (Yard Box)	1 Cubic Yard	18-Sep-98	Oily Debris PCB's	629
7047	04-Dec-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	08-Dec-98	Oily Debris PCB's	225
7052	04-Dec-98	DF OT – Open Top Drum Fiber (Cardboard/Poly)	55 Gallons	08-Dec-98	Oily Debris PCB's	60
6867	18-Sep-98	DF CT – Close Top Drum Fiber (Cardboard/Poly)	55 Gallons	14-Dec-98	Oily Debris PCB's	499
					sum	3308

6.0 PERSONNEL RADIATION EXPOSURE

No measurable radioactive exposure was expected or observed during final remedial operations and final survey activities.

7.0 PROJECT COST SUMMARY

Costs associated with the D&D of Building 4019 were reviewed, categorized and summarized. The summary is presented below.

D&D Planning and Supervision	35K
D&D Operations Labor	86K
Radiation Safety Operations Support	21K
Final Radiological Release Survey and Report	52K
Hazardous Waste Disposal	9K
Final Report and Docket	21K
	224K

8.0 REFERENCES

1. SNAP 10A Test Program, ETEC Report SP-100-XT-0002, G. L. Schmidt, SSFL, Ventura County CA., September 1988

2. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; And a Storage Yard West of Buildings T626 and T038, ETEC Report GEN-ZR-0010, J. A. Chapman, SSFL, Ventura County CA, August 26, 1988

3. Verification Survey Plan for the Interim Storage Facility; Buildings T030, T024, T019, T013; An Area Northwest of Buildings T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038, ORISE Document, Oak Ridge TN., September 6, 1995

4. Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rocketdyne International, Ventura County, California, ESSAP Final Report, ORISE 96/C-5, T. J. Vitkus and T. L. Bright, Oak ridge TN., February 1996

5. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Buildings T013, T019, T024, T030, and T641; The Storage Yard West of Buildings T626 and T038; and The NW Area; Santa Susana Field Laboratory, Ventura County CA., ORISE Document, Oak Ridge TN., January 11, 1996

6. CS #24 Bldg. T019 High Bay Test Pit Confined Space Safe Operating Plan, Revision 1, Rocketdyne RSOP C-312 Compliant Document, D. Trippeda and K. Jaquay, SSFL, Ventura County CA, July 31, 1998

7. Process Oil Line Fluids – Bldg 19/Tas No. F-073/Log #98060296, Columbia Analytical Services Letter Report, E. Schwartz to N. Garrard (Rocketdyne), Canoga Park CA, July 10, 1998

8. Analytical Report, PCB Samples/TAS# F-075 for Rocketdyne Div. Of Boeing, Service Request L9802393, Polychlorinated Biphenyls (PCBs), Columbia Analytical Services Faxed Results, E. Schwartz to N. Garrard (Rocketdyne), Canoga Park CA., July 27 1998

9. Analytical Report, Hydraulic Oil/TAS# F-076 for Rocketdyne Div. Of Boeing, Service Request L9803415, Polychlorinated Biphenyls (PCBs), Columbia Analytical Services Faxed Results, E. Schwartz to N. Garrard (Rocketdyne), Canoga Park CA., October 16, 1998

10. SNAP Test Chamber, Building 4019, Final Survey Procedure, ETEC Document 019-SP-0001, P. Liddy, SSFL, Ventura County CA, August 24, 1998

11. Building 4019 Final Status Survey Report –(R21-RF) RS-00002, Pat Liddy, July 21, 1999

12. Addendum to the Verification Survey Report for Buildings T019 and T024, Santa Susana Field Laboratory, Ventura County, California (Ref. 4), ORISE Letter Report , T. Vitkus to A. Gupta (DOE EM-43), Oak Ridge TN, February 16, 1999

13. Proposed Verification Survey Plan for the DeSoto Mass Spectrometry Laboratory (104), the Building 4019 Test Vault, and the T064 Side Yard, Santa Susana Field Laboratory, Boeing North America, Inc., Ventura County, California, ORISE Document, Oak Ridge TN, September 23, 1998

EXHIBIT V

FINAL DOCUMENTATION AND RADIOLOGICAL SURVEY OF FACILITY 4019 AFTER DECONTAMINATION AND DECOMMISSIONING

BOEING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	37629	81	81	NEW	RS-00002

Program Title
Closure of ETEC (R21-RF)

Document Title
Building 4019 Final Status Survey Report

Document Type
Procedure

Related Documents

Original Issue Date
6/10/99

Release Date 7-21-99
RELEASE E.M.

Approvals — Date
P. Rutherford — 6/17/99
S. Reeder — 6/18/99
M. Lee — 7/12/99

Prepared By/Date	Dept.	Mail/Addr
P. Liddy 6/5/99	641	T487

IR&D Program? Yes ☐ No ☒
If Yes, Enter Authorization No.

Distribution

*	Name	Mail Addr.
*	J. Barnes	T487
*	P. Horton	T038
*	P. Rutherford (5)	T487
*	M. Lee	T038
*	P. Waite	T038
*	P. Liddy	T487
*	F. Dahl	T100
*	R. McGinnis	T487
*	R. Garrett (2)	T487
*	D. Trippeda	T038
*	Rad Safety Files	T487
*	Engineering Data Mgmt	AB18
*	Facility Release Files	T487
*	R. Meyer	T038

Abstract

This document provides the results of the Final Status Survey of building 4019 at the Santa Susana Field Laboratory. All measurements confirm that the facility meets the release limits approved by the Department of Energy and the State of California Department of Health Services. Accordingly, the facility is suitable for release for unrestricted use.

* Complete Document
No Asterisk, Title Page/Summary
or Change Page Only.

Reserved for Proprietary/Legal Notice

TABLE OF CONTENTS

Tables

Figures

Graphs

EXECUTIVE SUMMARY

On September 1998, a Final Status Survey was completed in Building 4019 confirming that the facility meets release limits approved by the Department of Energy, and the Department of Health Services. Accordingly, the facility is suitable for release for unrestricted use.

During 1998, a comprehensive decontamination and decommissioning effort was conducted in the former SNAP Testing Facility, Building 4019. After D&D efforts, a comprehensive Final Status Survey of the facility concluded in September 1998. The Final Status Survey classified the building into two types of areas: "affected areas" which either had a potential for contamination or may have required previous decontamination, and "unaffected areas" where no previous decontamination effort was ever required. Sample Lot surveys were obtained from these areas.

Sample Lot 1, affected areas, comprised of the High Bay Floor, 3 meters up the walls, and Vault Room 109. Sample Lot 2, unaffected areas, comprised of the walls of the High Bay from 3 meters off the floor to the ceiling, overhead crane, piping, and ventilation ducting. Sample Lot 3, affected area, comprised of the Reactor Test Chamber itself. Sample Lot 4, unaffected areas, comprised of the office area and Room 110 that was already accepted as areas found below guideline limits in 1996 and remained so. All measurements were tested statistically for compliance within the regulatory acceptable derived concentration guideline limits (DCGLs), and ambient exposure rates.

In all Sample Lots for affected and unaffected areas, the highest quantitative total alpha measurement found was 13 dpm/100cm^2, and the highest quantitative total beta measurement found was 961 dpm/100cm^2 which were well below the 5,000 dpm/100cm^2 limit for fixed contamination. The highest removable alpha contamination found was 6 dpm/100cm^2, and the highest removable beta found was 12 dpm/100cm^2, again significantly below the 1,000 dpm/100cm^2 removable contamination limit. The highest level for Cs-137 was 1.8 pCi/gm, and no Co-60 was detected in any of the areas. The Cs-137 activity was scabbled, and the concrete debris was removed as contaminated waste. A 100% direct qualitative frisk of all floors, walls and ceilings revealed all areas had no significant detectable activity.

Graphs of the surface contamination results were evenly distributed, and the results were less than the release limits. All tests for surface contamination confirmed the entire Building 4019 is suitable for release without radiological restrictions.

2.0 BACKGROUND

2.1 Location and Structure

Building 4019 is located at the Rocketdyne-Santa Susana Field Laboratory, along the northwest boundary line. The facility is constructed of steel framing with steel siding, and contains a 10,800 square feet High Bay, a 10-ton overhead bridge crane, and an adjoining office control center. A 12-foot diameter vacuum test chamber with a hydraulic lift platform is located inside the northwest area of the High Bay. A vault room (109) with cinder block walls is located in the southeast corner. Building 4019 office areas include the equipment Room along the northwest quadrant of the building. A plan view of Building 4019 is shown in Figure 1 below.

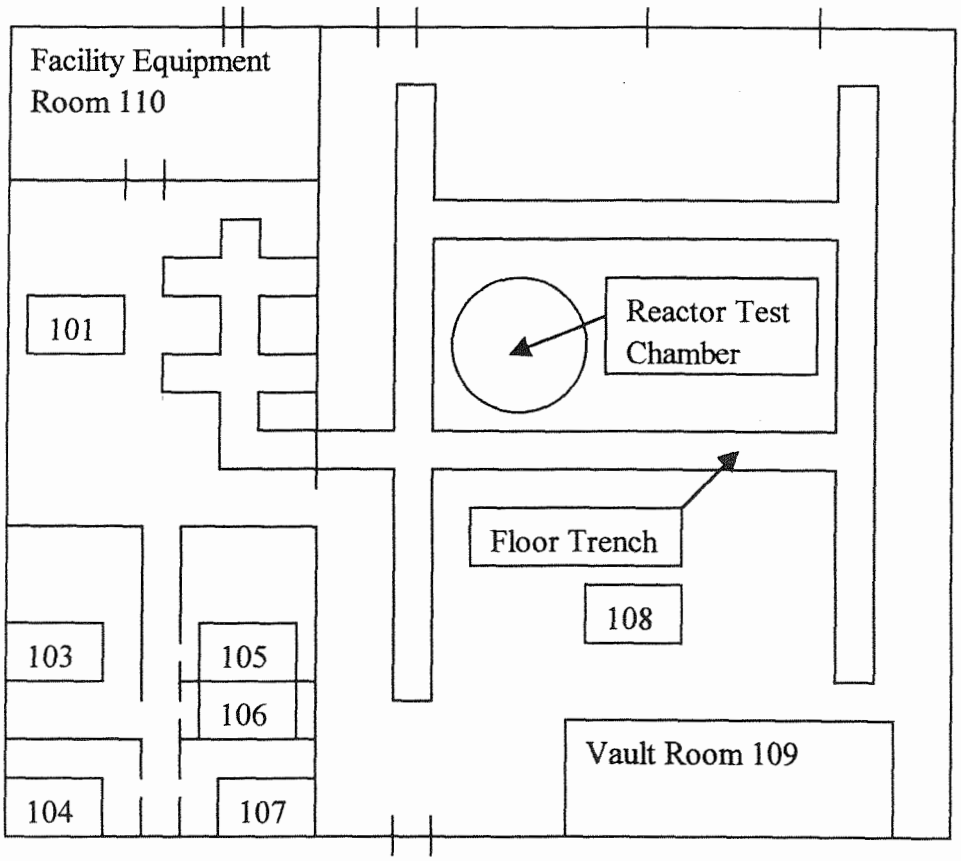


FIGURE 1: TOPOGRAPHY MAP OF BUILDING 4019

The dimensions of the High Bay are 60-ft long by 45-ft wide by 36-ft high. The former (Fuel Storage) Vault Room 109, is 12-ft by 10-ft by 10-ft and is located inside the High Bay. The Reactor Test Chamber in the High Bay floor, is cylinder shape for a quarter of the area down; square shape for the remaining three quarters to the bottom, and contains approximately 2448 ft^2 of surface area. It is 12-ft diameter, and 40-ft deep. The office areas, located next to the High Bay, are 60-ft long by 28-ft wide by 10-ft high. Former Equipment Room 110, which is also 12-ft by 10-ft by 10-ft, is located on the northwest end of the office areas. Sheet-rock walls separate the offices from the High Bay. There is one double and one single door access into the High Bay from the office area, and two roll-up doors and two single door access into the High Bay from the outside area.

2.2 Operating History

In support the Atomic International's *Systems for Nuclear Auxiliary Power* or SNAP program, Building 4019 was built for testing SNAP reactors at zero power. Several reactor designs were developed and tested in the Reactor Test Chamber for the SNAP program. Encapsulated, enriched uranium was used in the testing, with no resulting neutron activation or release of nuclear material. All nuclear or radioactive material handled was fully encapsulated. No contamination incidents or fission product releases occurred at Building 4019. Upon termination of the SNAP program in 1970, all SNAP components were removed. A radiation survey was later performed in 1988 to ensure no radioactivity existed (See Reference 1). Building 4019 was later designated as the ETEC Construction Staging and Computer Facility, and has been used for this purpose since.

2.3 Radiological Assessment

Building 4019 was not expected to contain residual activity for several reasons:

- Nuclear materials, such as uranium carbide, handled in the High Bay were fully encapsulated in Hastelloy@ and no releases occurred.
- Activation of building materials was negligible as the test reactors were operated for short periods at low power.
- When Building 4019 was reassigned, a thorough radiation survey was performed to ensure no residual activity remained undetected.

In 1988, surveys conducted for Building 4019 were based on limits prescribed in the DOE guidelines for enriched uranium used for the SNAP. The scope and detail of this radiological survey was based on the likelihood residual activity occurred in those areas where nuclear operations were performed despite the reasons listed above. Maximum total surface activity levels in the High Bay were 55 dpm/100cm^2 for alpha, and 1400 dpm/100cm^2 for beta. Removable activity levels in the High Bay were less than 12 dpm/100cm^2 for gross alpha and less than 16 dpm/100cm^2 for gross beta (see Reference 1). Offices adjacent to the High Bay were surveyed for radiological contamination and found clean, confirming that contaminated materials were not worked on or transported outside of the High Bay.

3.0 SURVEY PREPARATION

3.1 Identifying Survey Units

The Building 4019 High Bay area, test chamber, adjoining rooms and offices were divided into two survey classes: "affected" and "unaffected" areas based on past surveys where contamination was known or suspected.. The survey units were then evaluated to determine if surface contamination was below the derived concentration guidelines (DCGLs). A reference coordinate system was established and marked in the High Bay, test vault, and office areas. Random sampling points were identified in the survey pattern. (Refer to Figure 2). Coordinates that did not fall within the survey unit area or could not be surveyed because of site conditions were replaced with other sample locations.

Scanning was performed to locate small areas of elevated concentrations of residual radioactivity to determine if they met the release criteria. Direct, qualitative scans were conducted for alpha and beta-gamma contamination followed by a cumulative counts and smear surveys of interior surfaces. The percentage of survey conducted for each area is shown in Table 1.

			QUALITATIVE		QUANTITATIVE[1]		REMOVABLE		AMBIENT
LOT	CLASS	LOCATION	α	β	α	β	α	β	γ
1	AFFECTED	**Hibay Floor, Lower Walls**	100% SCAN TOTAL	100% SCAN TOTAL	11% SCAN	11% SCAN	11%	11%	11%
2	UNAFFECTED	**Hibay upper walls, ceiling, crane**	100% SCAN TOTAL	100% SCAN TOTAL	6% SCAN	6% SCAN	6%	6%	NONE
3	AFFECTED	**Test Chamber**	100% SCAN TOTAL	100% SCAN TOTAL	21% SCAN	21% SCAN	21%	21%	NONE
4	AFFECTED	**Rm 109**	100% SCAN TOTAL	100% SCAN TOTAL	11% SCAN	11% SCAN	11%	11%	NONE
5	UNAFFECTED	**Room 110, Offices**	100% SCAN TOTAL	100% SCAN TOTAL	NONE	NONE	500 Smears	500 Smears	NONE

% indicates measurements taken in grid squares within the 9 square meter grid areas.
[1] Obtained with 5-minute counts.

TABLE 1: SURVEYS DETERMINED FOR BUILDING 4019.

3.2 Sampling Locations

In the affected areas, direct, qualitative alpha and beta-gamma scans of the floors and walls, (100% surface area) were conducted. After the scans, the entire area was divided into 9 square meter grids and portrayed on a scaled survey map (see Figure 3). Within each grid, a one square meter area (1m x 1m) was selected for a cumulative count survey. For surfaces having less than a square meter area (remnant areas), a minimum area of one square meter was surveyed by combining other adjacent remnant areas. In affected areas, structural surfaces consisting of beams, pipes, conduits, and other surfaces that were not easily assessable were surveyed over twenty percent (20%) of the surface area.

For unaffected areas, a direct, qualitative scan (100 % of all surface area) on the floors, walls, and ceilings was conducted. Areas of concern included floor baseboards, windowsills, areas behind file cabinets or furniture, door thresholds, and any other areas where contamination potentially accumulated over time. Portions of the High Bay unaffected area, were selected for a cumulative count survey. Surfaces selected for surveying were based on those expected to have the highest contamination levels (e.g. ledges, tops of conduit, etc.). After the survey of the accessible areas of the ventilation ducting was conducted, no contamination was detected. Figure 2 shows the areas in Building 4019 designated as the affected and unaffected areas.

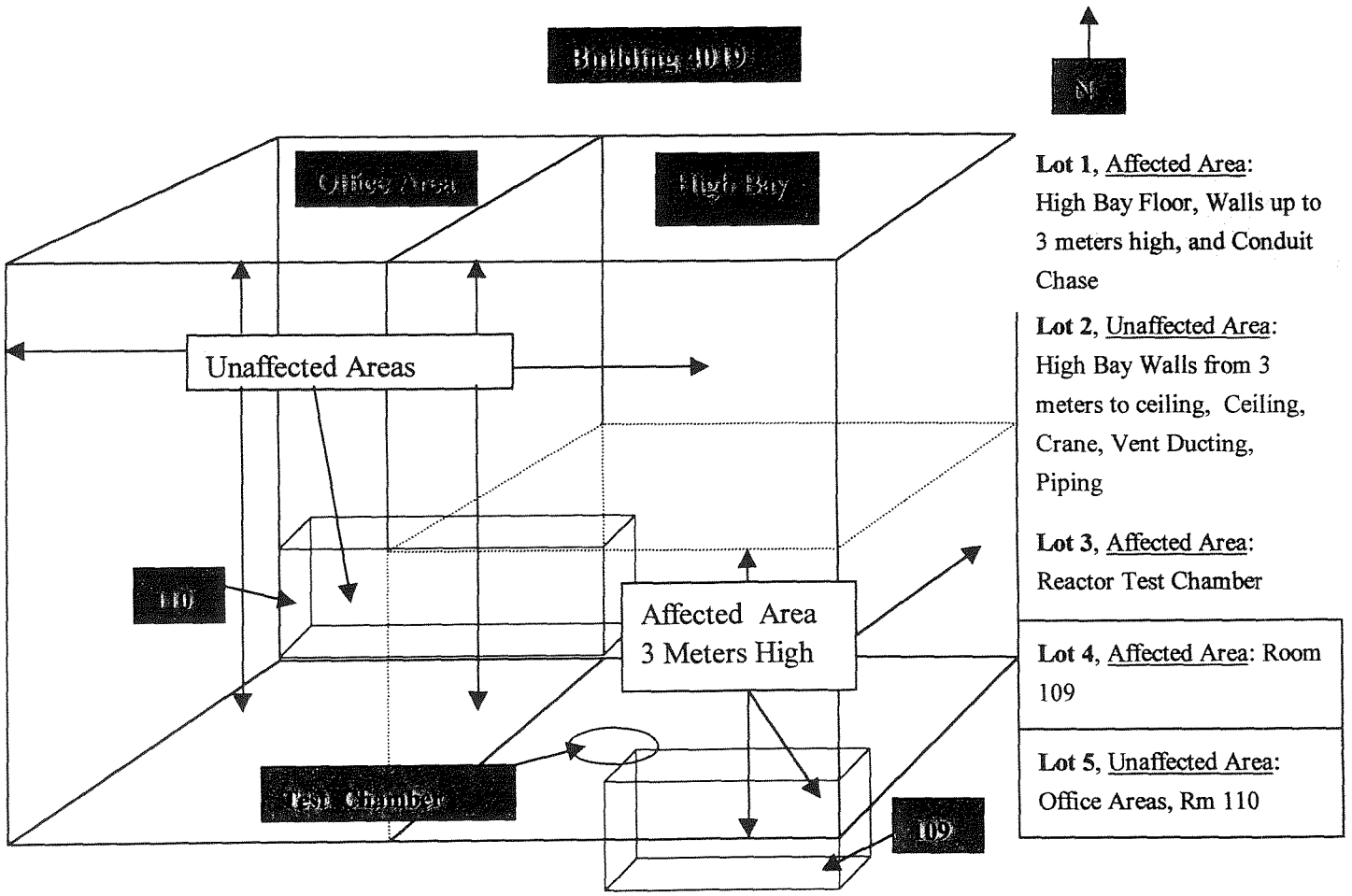


FIGURE 2: AFFECTED AND UNAFFECTED AREAS

3.3 Sample Collection

Sample Lot 1 (Affected Areas)

Sample Lot 1 was composed of measurements taken from the High Bay floor (including the conduit trenches) and walls up to 3 meters high. Figure 3 shows the High Bay grid map used for the survey.

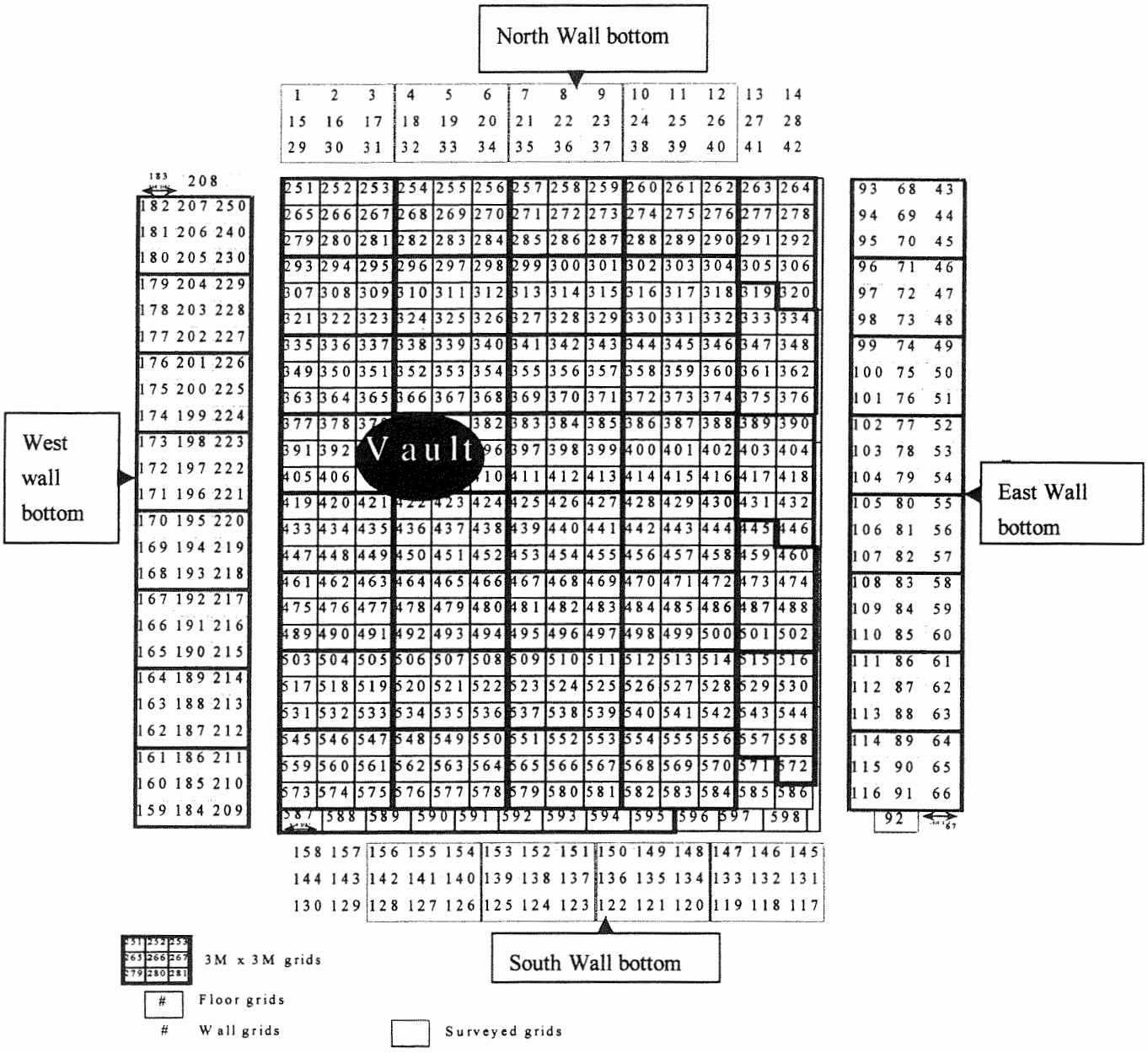


FIGURE 3: SAMPLE LOT 1 HIGH BAY

Measurements were taken for quantitative total alpha and beta, removable alpha and beta, and ambient gamma levels. Qualitative measurements were taken for all one hundred percent (100%) of the survey grid, and quantitative measurements for eleven percent (11%) of all the survey grids (See Table 1). This method satisfies the State of California guidelines in DECON-1 (see Reference 5) that a minimum of 10% of an area shall be surveyed.

Sample Lot 2 (Unaffected Area)

Sample Lot 2 was composed of measurements taken on the upper wall areas of the High Bay, from the 3 meter high mark where the affected area ended, up to and including the ceiling. A direct qualitative frisk (100%) was performed using an alpha scintillation probe and a G-M pancake probe. Six percent (6%) of all surfaces were surveyed for total alpha and beta activity, and six percent (6%) for removable activity (see Table 1). The overhead crane, ventilation ducting,beams and horizontal surfaces were scanned 100% for direct qualitative frisk. Figure 4 shows the High Bay unaffected area grid survey.

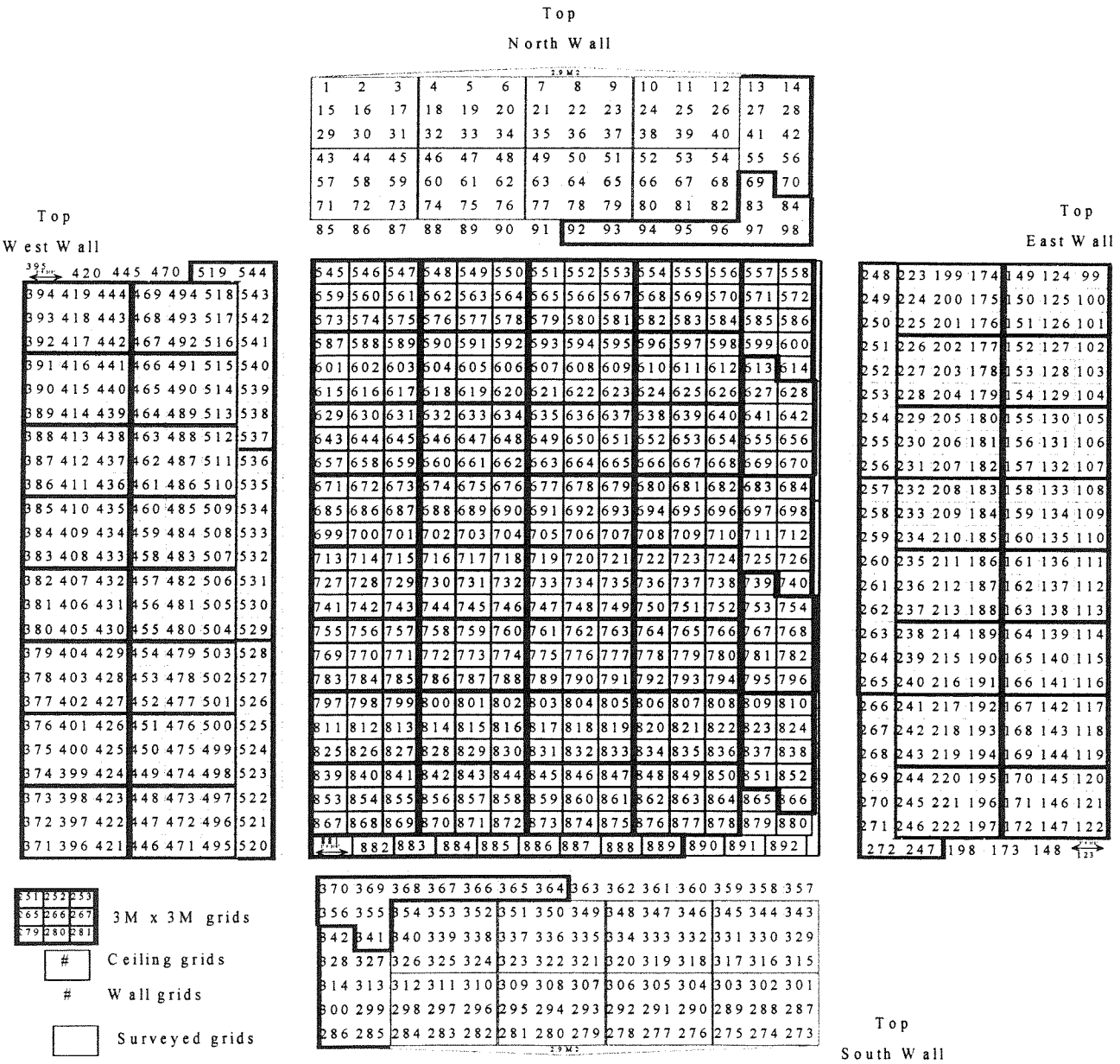


FIGURE 4: SAMPLE LOT 2 HIGH BAY

Sample Lot 3 (Affected Area)

The Sample Lot 3 survey consisted of the Reactor Test Chamber, shown in Figure 5. The entire chamber was grided and surveyed in the same manner as Sample Lot 1 except twenty one percent (21%) of the area was surveyed for quantitative alpha and beta measurements, and twenty-one percent (21%) for removable activity. Samples of glycol and oil from the bottom of the pit were obtained and sent to the laboratory for a gamma spectral analysis with the Canberra Series 100 MCA System with High-Purity Germanium Detector and a "Chain of Custody" tracking form.

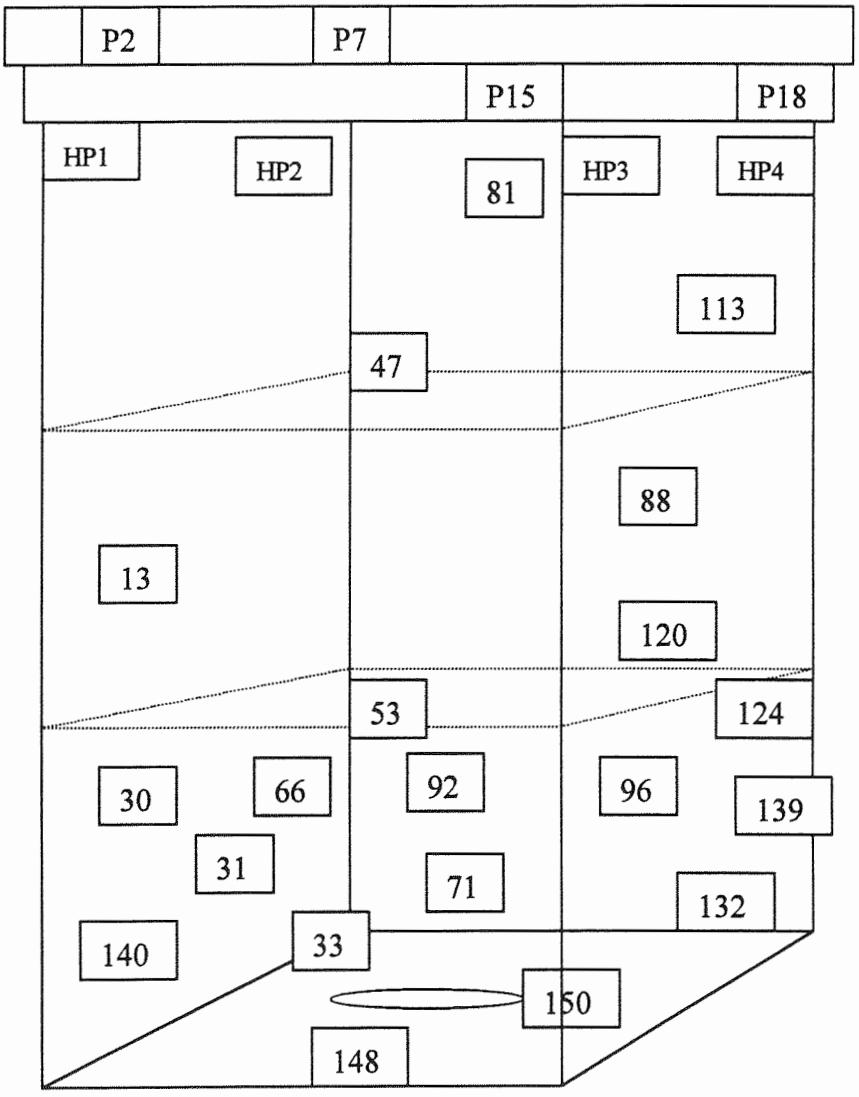


FIGURE 5: SAMPLE LOT 3 REACTOR TEST CHAMBER

Sample Lot 4 (Affected Area)

In addition to the High Bay area itself, Room 109, the former [New Fuel Storage] Vault, was located within the High Bay. The same level of survey conducted for the affected area of the High Bay described above for Sample Lot 1, was performed for Sample Lot 4, Room 109. Figure 6 shows the grid map for Room 109.

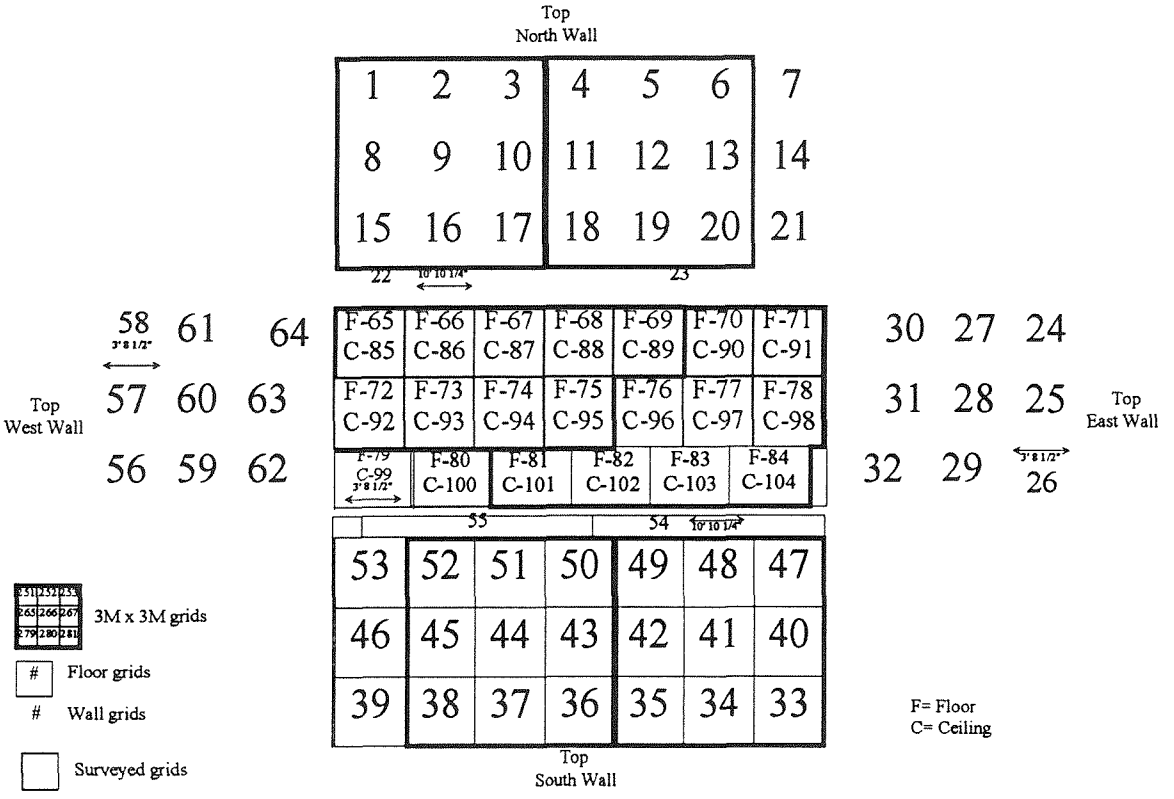


FIGURE 6: [NEW FUEL STORAGE] VAULT, ROOM 109 GRID MAP

Sample Lot 5 (Unaffected Area)

Sample Lot 5 comprised of the office areas and [Component Equipment] Room 110. A one hundred percent (100%) direct qualitative frisk of the walls, floors, and ceilings was performed using an alpha scintillation probe and a G-M pancake probe (see Table 1). Three hundred (300) random smears were taken in the office areas, and two hundred (200) smears in Room 110 for removable contamination.

3.4 Survey Instrumentation and Techniques

A count rate meter with an audible indication was used for both qualitative and quantitative scans. Audible indication during the scan required a detector to be more sensitive than the scalar read-out. For scanning, the detector was moved slowly, at a scan rate of less than 5 cm/sec, over the surface being surveyed. The face of the detector was located near the surface and not more than ½-inch distance away.

Standard 1.75 inch disk smears (1 3/4 NPO, cloth) were used to obtain measurements of removable surface alpha and beta activity by wiping approximately 100 cm^2 of the surface area. The activity was measured on the disks using a low background, gas-flow, Tennelec proportional counter calibrated using Th-230 and Tc-99 standard sources.

The ambient exposure rates were measured at 1-meter from all surfaces using a 1-inch by 1", NaI probe, NaI scintillation detector calibrated quarterly, and daily checks made using a Cs-137 source. A standard conversion factor of 215 cpm per μR/hr, based on comparisons with a Reuter-Stokes High Pressure Ion Chamber (HPIC), was used for conversion of counts per minute to μR/hr measurements. All survey data was recorded on Final Status Survey Data Sheets (FSDS).

3.5 Calibrations and Checks

Measurements of total and maximum alpha surface activity were made using an alpha scintillation detector, sensitive only to alpha particles with energies exceeding about 1.5 MeV. The detector was calibrated with a Th-230 alpha source standard traceable to the National Institute of Standards and Technology (NIST). Measurements of the average and maximum beta surface activities were made with a thin-window pancake Geiger-Mueller (G-M) tube. The G-M detector was calibrated with a Tc-99 beta source standard, traceable to NIST.

All portable survey instruments were serviced and calibrated with NIST traceable standards on a quarterly basis. In addition, daily source, background, and performance checks were done on all instrumentation, when in use, to determine acceptable performance and establish a background value for the instrument on that day. Calibration records for the survey instruments used are maintained in the Radiation Safety Department files.

The gas-flow proportional counters, used to measure removable contamination, were calibrated using Th-230 and Tc-99 standard sources, traceable to NIST.

The ambient exposure rates at 1m from surfaces were measured using a one-inch by one-inch (1-in x 1-in) probe NaI scintillation detector. These instruments were calibrated against a Reuter-Stokes high-pressure ionization chamber, and daily checks were made using a Cs-137 source.

Daily checks and calibrations were performed on all instrumentation to determine acceptable performance. Daily checks and calibration data were entered on the appropriate Instrument Qualification Sheet (IQS).

3.6 Detection

The detection limits for the instruments and methods used are shown in Table 2. They are well below the DOE limit criteria (Reference 7). Disintegration per minute (dpm) means the rate of emission by radioactive material derived by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation. Where surface contamination by both alpha and beta-gamma emitting radionuclides existed, the limits established for alpha and beta radionuclides applied independently.

	Alpha (dpm/100cm^2)		Beta (dpm/100cm^2)		Ambient Gamma (μR/hr)
	Total	Removable	Total	Removable	
Limit Criteria	5,000	1,000	5,000	1,000	<5μR/hr above background
Theoretical Detection Limit (SAA)	5.25	4.59	367	11.0	0.25
Derived Detection Limit Range	3.5-7.0	4.1-5.08	161-484	9.8-12.2	0.24-0.26
Detection Limit (% of limit criteria)	0.1%	0.45%	6.8%	1.1%	5.0%

TABLE 2: DETECTION LIMITS AND ESTABLISHED LIMIT CRITERIA

3.7 Survey Evaluations

Acceptable contamination limits and gamma exposure rates for releasing a facility for unrestricted use are described in Table 3 below. The lowest (most conservative) applicable limits were chosen from these guidelines and incorporated into the Final Status Survey criteria for the Building 4019.

Radionuclides	Average	Maximum	Removable
Separated or enriched Sr-90, Th-natural, Th-232	<1,000	<3,000	<200
U-natural, U-235, U-238, and associated decay products	<5,000α	<15,000α	<1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission), including Sr-90 intrinsic to the mixture. [This category of radionuclides includes mixed fission products, including Cs-137 and Sr-90. It does not apply to Sr-90, which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.]	<5,000β-γ	<15,000β-γ	<1,000β-γ
Gamma Exposure Rate	≤ 5 μR/hr above background at one meter		
Note: Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides apply independently. Measurements of average contamination should not be averaged over an area of more than one square meter. For objects of less surface area, dose rate averages should be derived for each such object. The maximum and removable contamination level applies to an area of not more than 100 cm^2.			

From DOE Order 5400.5, Figure IV-1 (see Reference 7).

TABLE 3: ALLOWABLE RESIDUAL SURFACE CONTAMINATION (DPM/100CM2)

Table 4 provides guidelines for alpha and beta-gamma emitters whose specific isotopic content had not been determined.

Radionuclides	Average (dpm/100 cm2)	Removable (dpm/100 cm2)	Maximum (dpm/100 cm2)	Max Count Rate Meter Response
Unidentified Alpha emitters	< 100	< 20	< 300	No detectable activity when measured on a ZnS portable survey meter. (< 2 cpm on "slow" response)
Unidentified Beta-Gamma emitters	< 5,000	< 100	< 15,000	< 100 net counts per minute above ambient background on a pancake frisker

(see Reference 7)

TABLE 4: CONTAMINATION LIMITS FOR UNIDENTIFIED ISOTOPES

The average surface levels of contamination were taken over an area of one square meter. For objects of less surface area, the average was derived for each surface. The maximum contamination level applied to an area of not more than 100 cm^2. The amount of removable material per 100 cm^2 of surface area was determined by wiping an area 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 was determined, the activity per unit area was based on the actual area and the entire surface was wiped.

4.0 DATA ANALYSES

The Final Status Survey had to confirm that Building 4019 High Bay, Reactor Test Chamber, overhead crane, and rooms 109 and 110 and adjoining offices were acceptable for unrestricted use. Therefore, the results of the survey must be validated using statistical analysis. A distribution analysis was performed in which the activity was plotted against the cumulative probability using Cumplot 2.20 (see Reference 3).

A statistical procedure was used to validate the applicability of the raw survey data for selected sample lot areas. The statistical method known as "sampling inspection by variables" was used. This method is widely applied in the industry and military.

In sampling inspection by variables, the data is assumed to be *normally* (i.e., Gaussian) distributed. The mean of the distribution $\bar{x}$, and its standard deviation ***s***, are then related to a "test statistic," TS, as follows:

$$\mathbf{TS} = \bar{x} + k \cdot s$$

where $\bar{x}$ = average (arithmetic mean of measured values)

s = observed sample standard deviation

k = tolerance factor calculated from the number of samples to achieve the desired sensitivity for the test

TS and $\bar{x}$ are then compared with an acceptance limit, U, to determine acceptance or other plans of action, including rejection of the area as contaminated and requiring further remediation.

The sample mean and standard deviation are easily calculable quantities; the value of **k**, the tolerance factor, is examined. Of the various criteria for selecting plans for acceptance sampling by variables (see Reference 8), the most appropriate is the method of *Lot Tolerance Percent Defective* (LTPD, also referred to as the *Rejectable Quality Level* (RQL). The LTPD is defined as the poorest quality that should be accepted in an individual lot. Associated with the LTPD is a parameter referred to as "consumer's risk" (β), the risk of accepting a lot of quality equal to or poorer than the LTPD.

Assigning values for LTPD and β, and given the sample size ***n***, a value for ***k*** can be calculated as follows:

$$k = \frac{K_2 + \sqrt{K_2^2 - ab}}{a};\quad a = 1 - \frac{K_\beta}{2(n-1)};\quad b = K_2^2 - \frac{K_\beta^2}{n}$$

where k = tolerance factor,

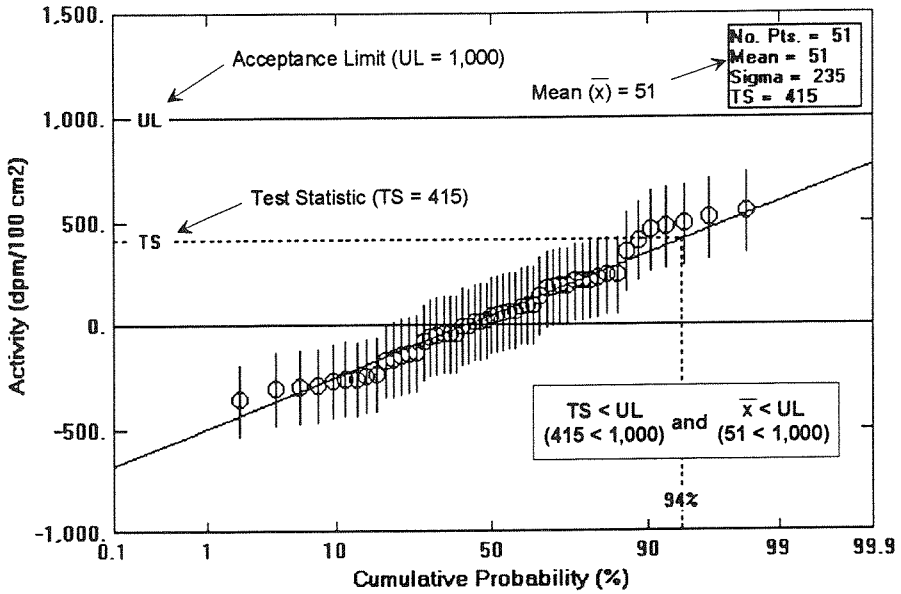
K_2 = the normal deviate exceeded with probability equal to the LTPD,

K_β = the normal deviate exceeded with probability of β,

n = number of samples.

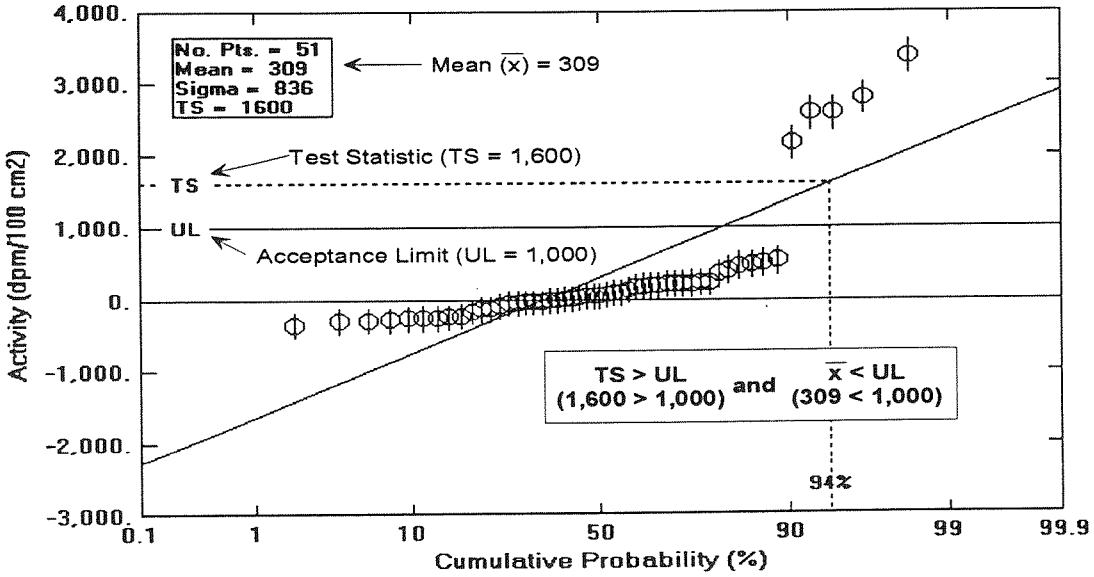
Depending on the data collected, the statistical test may result in one of three conclusions illustrated on the next two pages.

1. **Acceptance**: If the test statistic ($\bar{x} + k \cdot s$) is less than or equal to the limit (U); accept the region as clean. If any single measured value exceeds 80% of the limit; decontaminate that location to as near background as is possible, but do not change the value in the analysis. Graph A is an example of the sample lot acceptance by the test.



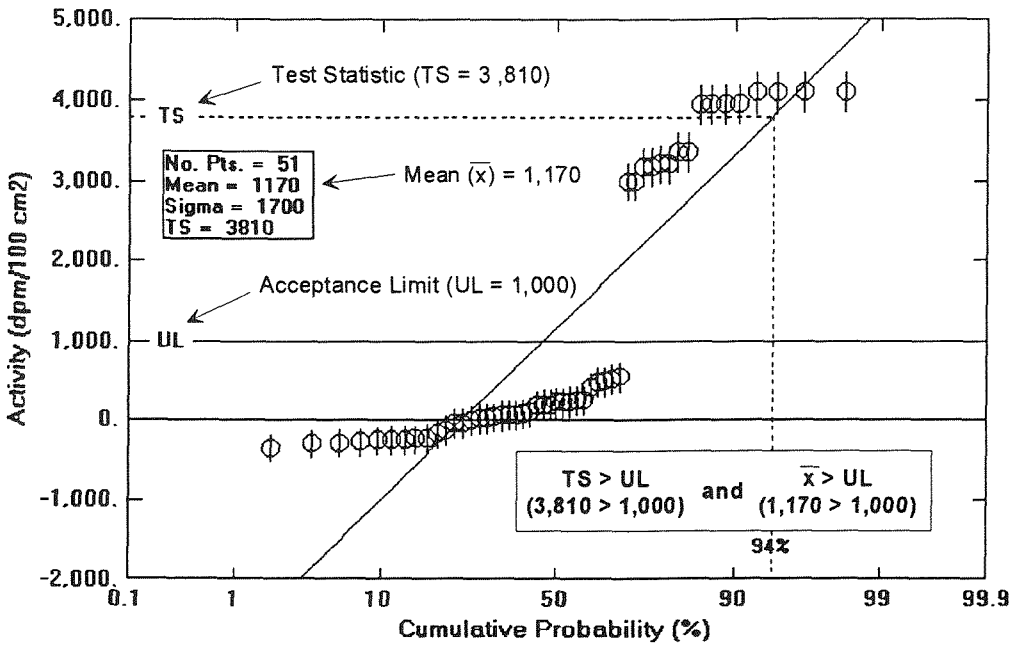
GRAPH A. EXAMPLE OF SAMPLE LOT ACCEPTANCE, WHERE TS ($=\bar{x} + K \cdot S$) ≤ UL AND $\bar{x} \leq$ UL

2. **Collect additional measurements**: If the test statistic ($\bar{x} + k \cdot s$) is greater that the limit (U), but $\bar{x}$ itself is less than U, and if independently re-sampling and combining all measured values to determine if $\bar{x} + k \cdot s \leq$ U for the combined set occurs; then accept the region as clean. If not, the region is contaminated and must be remediated. Graph B gives an example of additional measurements that must be taken in the sample lot to accept or reject it.



GRAPH B. EXAMPLE OF SAMPLE LOT REQUIRING ADDITIONAL MEASUREMENTS, WHERE TS ($= \bar{x} + K \cdot S$) > UL AND $\bar{x}$ < UL

3. **Rejection:** If the test statistic ($\bar{x} + k \cdot s$) is greater than the limit (U) and $\bar{x} \geq$ U; the region is contaminated and must be remediated. **Graph** C gives an example of sample lot rejection by the test.



GRAPH C. EXAMPLE OF SAMPLE LOT REJECTION, WHERE TS (= $\bar{x} + K \cdot S$) > UL AND $\bar{x}$ > UL

The Final Status Survey was analyzed using a Lot Tolerance Percent Defect of β = LTPD = 5%, for the choices $K_\beta = K_2 = 1.645$ for a region of rejection, one-tailed test. The 5% value used was more conservative than the 10% LTPD Consumer Risk Value used by the USNRC [Regulatory Guide 6.6], and State of California (see Reference 9). If the statistical tests met the acceptance criteria above, we were willing to accept the hypothesis that the probability of accepting a Sample Lot as not being contaminated, (which is in fact 5% or more contaminated) is 5%. In other words, if the test statistic is less than the release criteria, we are 95% confident that over 95% of the Sample Lot has residual contamination below 100% of the release criteria of Section 3.6. This is referred to as the (95/95/100) test.

5.0 SAMPLE LOT ANALYSES AND RESULTS

Survey measurements were tested against the acceptance criteria for each particular type of radiation. All Sample Lots were tested for removable contamination, and Lots 1 through 3 for the total contamination and ambient gamma measurements.

Measurements for the Final Status Survey were taken over the period from 9/5/98 through 9/30/98. Raw data measurements were adjusted for daily instrument background and statistically tested using the "Cumplot" method (see Reference 3). Data was plotted on cumulative probability graphs shown in Appendix B. The more linear the data, the closer it approached a normal distribution. When applicable, plots were shown in two scales; a condensed scale to show detailed data distribution and an expanded view when there is a wide separation between the data and the acceptance limit.

The test statistic ($TS = \bar{x} + k \cdot s$) for all sample lots combined were calculated and applicable contamination acceptance limits were compared. Individual calculated sample results data, used to generate the graphs, are also provided in the following Appendices B through E.

5.1 Test Statistic Results

The test statistic results shown in Table 5, demonstrate for each applicable acceptance limit (UL), the corresponding test statistic (TS) value is less than U, ($TS < U$). Therefore, the Sample Lots pass the "sampling inspection by variables" test and are "Accepted" as radiologically clean. The Building 4019 surveys correspond to assuring with a 95% confidence that 95% of the Sample Lots have residual contamination below 100% (a 95/95/100 test) of the applicable DOE and State of California limits (see Reference 6).

	Total (dpm/100 cm^2)		Removable (dpm/100 cm^2)	
Criteria	**Alpha**	**Beta**	**Alpha**	**Beta**
Acceptance Limit (UL)	**5,000**	**5,000**	**1,000**	**1,000**
Actual Results (TS) Lot 1 High Bay	7	473	3	13
Lot 2 (TS)	4	-633*	3	18
Lot 3 (TS)	10	91	4	13
Lot 4 (TS)	12	1300	3	3

*Refer to Section 5.2, Lot 2 for details

TABLE 5: TEST STATISTIC RESULTS COMPARISON

5.2 Sample Lot Survey Results

Lot 1

For the High Bay, the survey data results demonstrated the highest quantitative total alpha measurement was 13 dpm/100cm^2 and highest removable alpha contamination was 5.5 dpm/100cm^2 The highest quantitative total beta measurement was 797.5 dpm/100cm^2 and the highest removable beta contamination was 23 dpm/100cm^2.

The highest [gross] gamma level was 10 μR/hr inside the building. Background outside of Building 4019 was higher than inside Building 4019 itself. The acceptance limit of 18.3 μR/hr was derived from the reference background of 14,256 cpm outside of Building 4019, divided by the 215cpm/μR/hr conversion factor, plus 5μR/hr correction factor over that background level. The highest corrected [net] gamma level was <5μR/hr above background.

Qualitative measurements taken for all one hundred percent (100%) of the survey grids in the affected area indicated no detectable activity.

Refer to Appendix B for Lot 1 detailed results.

Lot 2

The survey data results for the High Bay, unaffected area showed the highest total alpha measurement was 3 dpm/100cm^2 and highest removable alpha contamination was 5 dpm/100cm^2. The High Bay area where the survey took place, three meters up from the floor to the ceiling, and the fact that the background is lower the further the distance from the ground; resulted in the corrected beta activity to be lower than background levels. The highest total quantitative beta measurement was below background levels. The highest total beta measurement with no background levels subtracted out [gross] was 286 dpm/100cm^2. The highest removable beta contamination was 25 dpm/100cm^2. This data includes the overhead crane and ventilation ducting (see Appendix C).

Qualitative measurements were taken for all one hundred percent (100%) of the survey grid indicated no detectable activity.

Lot 3

The highest total alpha measurement was 5.5 dpm/100cm^2 and highest removable alpha contamination was 3 dpm/100cm^2. The highest total beta was 357 dpm/100cm^2 and the highest removable beta contamination was 12.5 dpm/100cm^2 (see Appendix D). Qualitative measurements were taken for all one hundred percent (100%) of the survey grid indicated no detectable activity. The radionuclide concentrations analysis on the glycol and oil from the Reactor Test Chamber found no contamination of Cs-137, Co-60, or any other man-made isotope or fuel.

Lot 4

The survey data results for Room 109 demonstrated a highest total alpha measurement of 11.5 dpm/100cm^2 and highest removable alpha contamination was 5 dpm/100cm^2. The highest total beta was 961 dpm/100cm^2 and the highest removable beta contamination was 10 dpm/100cm^2 (see Appendix E). The highest gamma level was 2.5 μR/hr.

Lot 5

The survey data results for the office areas and Room 110 indicated that removable surface contamination results were evenly distributed, and the results were less than the release limits. Qualitative measurements taken for all one hundred percent (100%) of the survey grids in the affected area indicated no detectable activity.

Table 6 summarizes the Sample Lot results for all areas of Building 4019.

Location	Quantitative Total (dpm/100 cm^2)		Removable (dpm/100 cm^2)		Gross Gamma	Qualitative	
	Alpha	Beta	Alpha	Beta	Exposure Rate (μR/h)	Alpha	Beta
Lot 1	11	797	5	23	10[E]	NDA[B]	NDA
Lot 2	3	-548[A]	5	25	NM	NDA	NDA
Lot 3	5	357	3	12.5	NM	NDA	NDA
Lot 4	11	961	5	10	15.7	NDA	NDA
Lot 5	NM[D]	NM	<MDA[C]	<MDA	NM	NDA	NDA

(A)Gross counts, refer to Lot 2, Page 23 (B)NDA= no detectable activity (C) MDA: Minimum Detectable Activity
(D) NM = not measured (E) Refer to Lot 1, page 23

TABLE 6: MAXIMUM SURVEY RESULTS

5.3 Scabbled Floor Section

When a small, 2-ft by 2-ft floor section near the southwest corner of the High Bay was identified in the 1996 ORISE Survey Report, the highest total beta measurements ranged from 1400 to 11,000 dpm/100cm^2. The floor section was scabbled and samples were taken during the procedure. The sample results revealed 1.8 pCi/gm of Cs-137 at approximately 20% of the clean-up standard of 9.2 pCi/gm (the location of the highest counts/minute). No Co-60 was detected. The scabbled residue was disposed of as radioactive waste.

Post remediation, the highest quantitative total alpha measurement to that floor section was 8 dpm/100cm2 and no removable alpha measurements were detected on that specific floor surface area. The highest quantitative total beta measurement was 364 dpm/100cm2 and the highest removable beta contamination was 20 dpm/100cm^2. Again, these measurements were well below the regulatory limits.

6.0 CONCLUSION

In all Sample Lots, the highest quantitative total alpha measurement was 13 dpm/100cm^2, and highest removable alpha found was 5 dpm/100cm^2. The highest quantitative total beta measurement was 961 dpm/100cm^2, and highest removable beta found was 25 dpm/100cm^2. The highest test statistic for the distribution of contamination was well below DOE approved acceptance limits for both alpha and beta contamination. The highest measured Cs-137 activity found was 1.8 pCi/gm. This area was remediated. Based on the results of the investigations reported here, the High Bay, Room 109, Reactor Test Chamber, facility High Bay crane, Room 110, and office areas of Building 4019 are free of contamination. They meet the Department of Energy approved acceptance criteria and Building 4019 is therefore releasable for "unrestricted use" with no radiological restrictions

7.0 REFERENCES

1. GEN-ZR-0010, "Radiological Survey of Buildings 4019 and 013", 1988.

2. 10CFR32.110, "Acceptance Sampling Procedures Under Specific Licenses".

3. Cumplot, Proprietary Statistical Program.

4. ORISE 96/C-5, "Verification Survey of Buildings 4019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California", February 1996

5. DECON-1, "State of California for Decontaminating Facilities and Equipment Prior to Release for Unrestricted Use", June 1977

6. N001SRR140131, Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the Santa Susana Field Lab", February 1999.

7. DOE Order 5400.5 "Radiation Protection of the Public and Environment", Department of Energy, January 1992, (Figure IV-1).

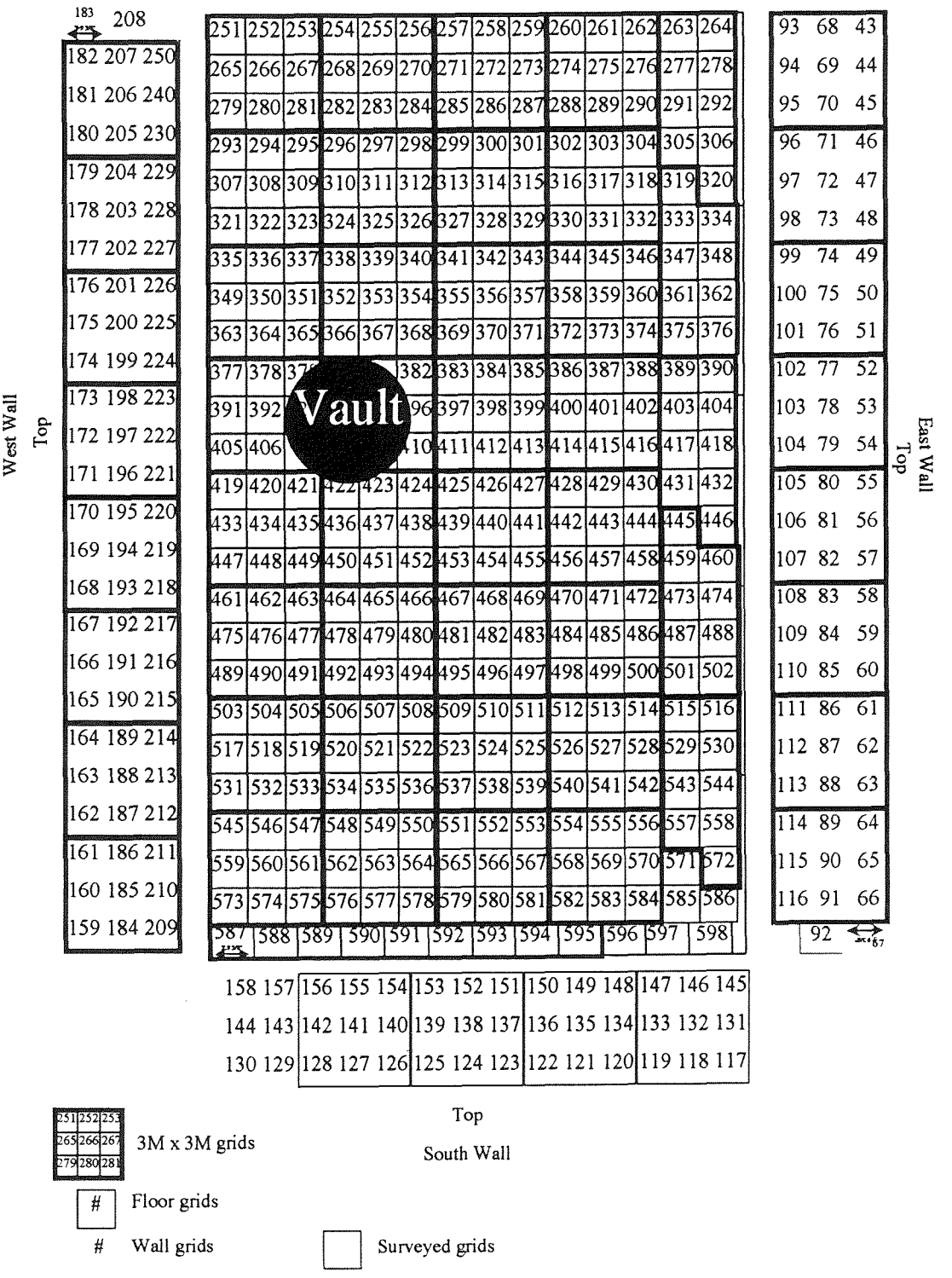
8. MIL-STD-414, "Sampling Procedures and Tables for Inspection by Variables for Percent Defective", June 1957.

9. USNRC Regulatory Guide 6.6,"Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing By-Product Material"

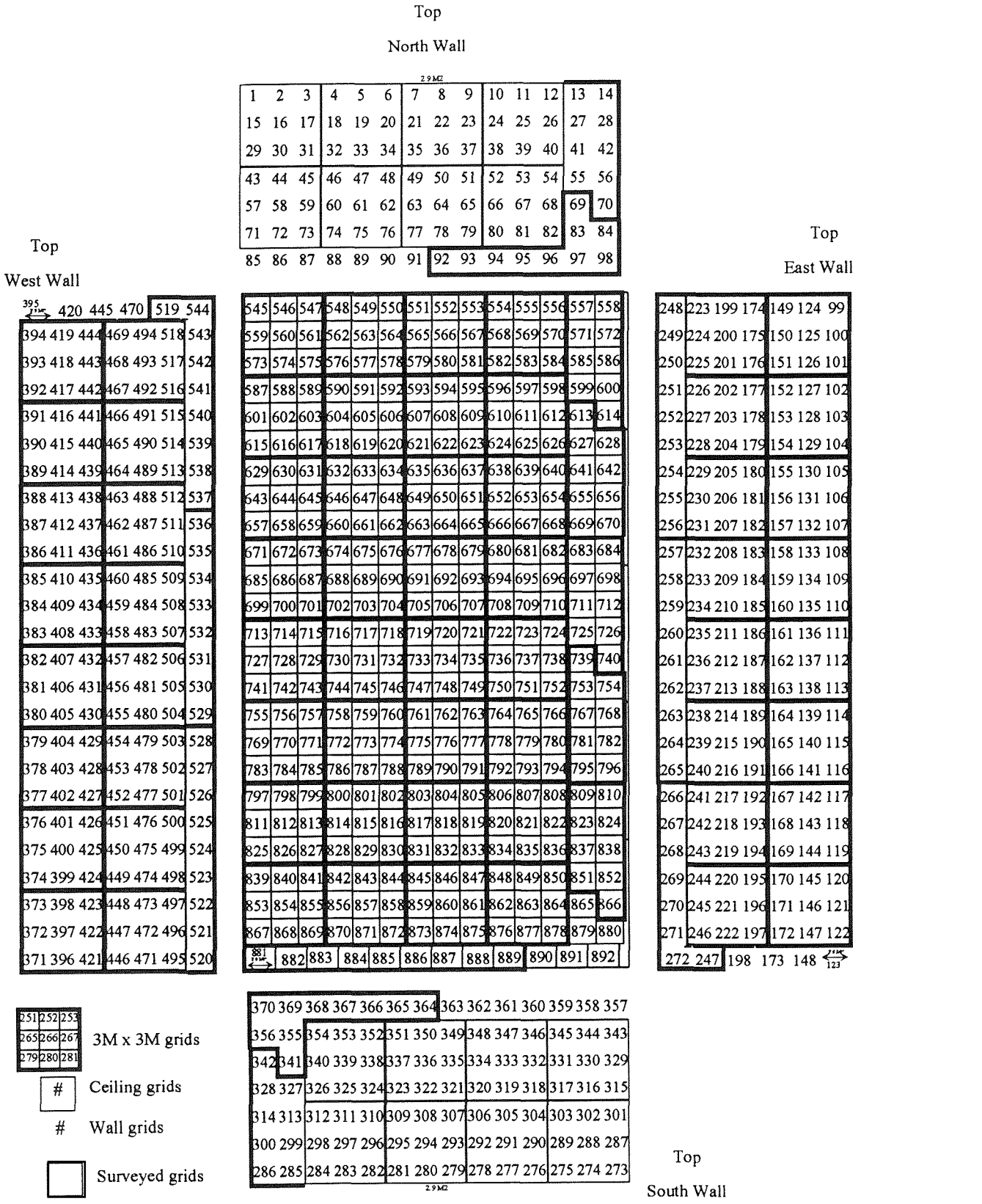
APPENDIX A

MAPS

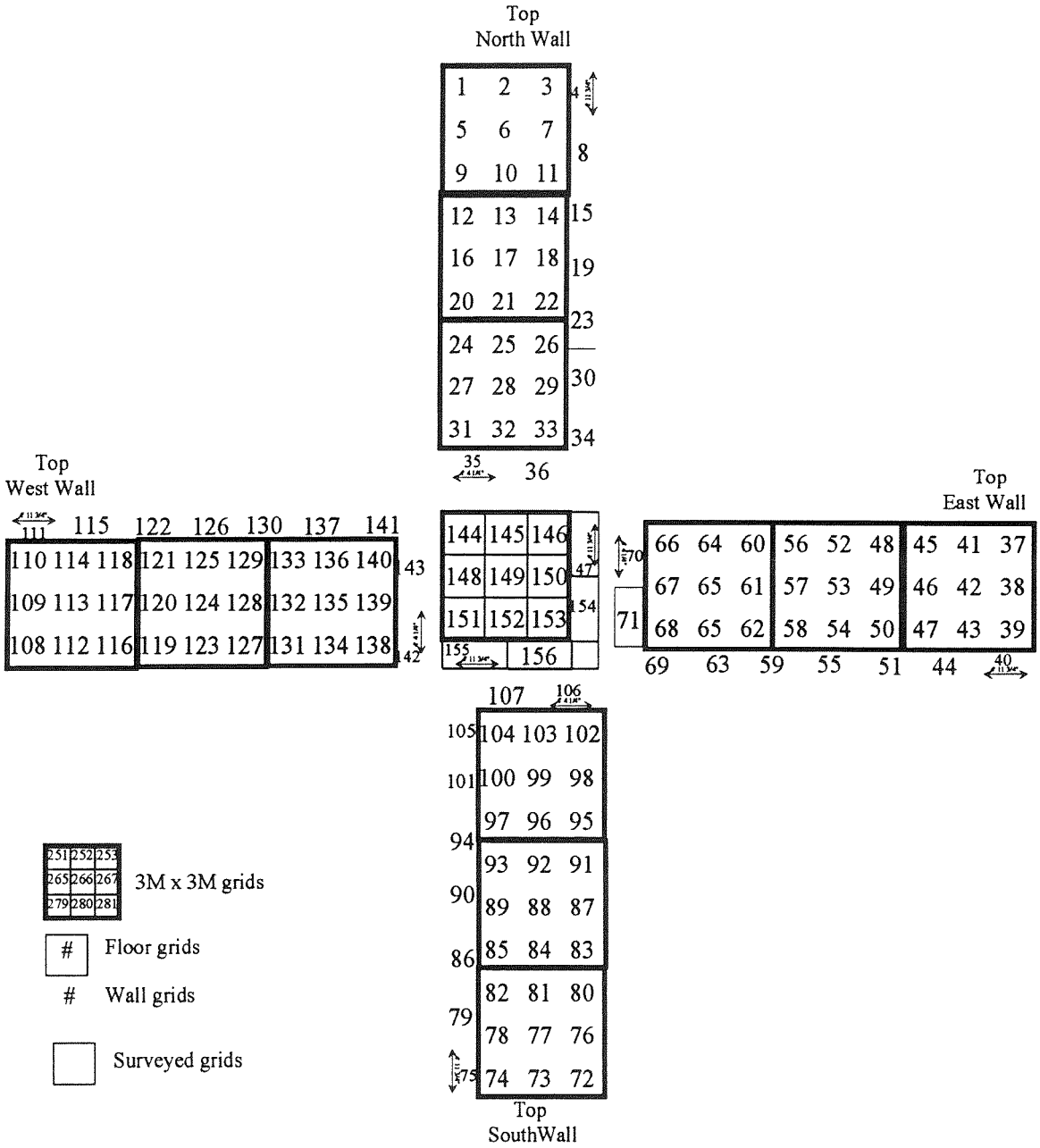
LOT 1: T019 HIGH BAY- AFFECTED AREAS



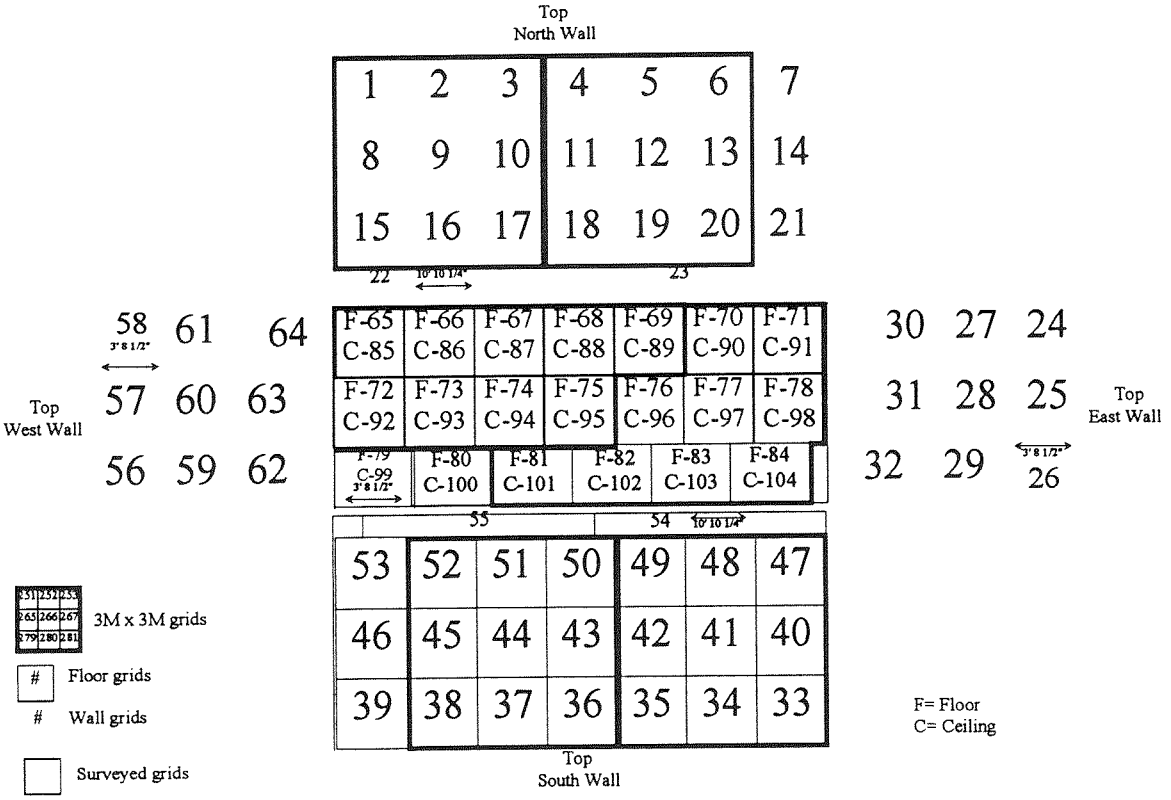
LOT 2: HIGH BAY UNAFECTED AREA



LOT 3: REACTOR TEST CHAMBER GRID MAP



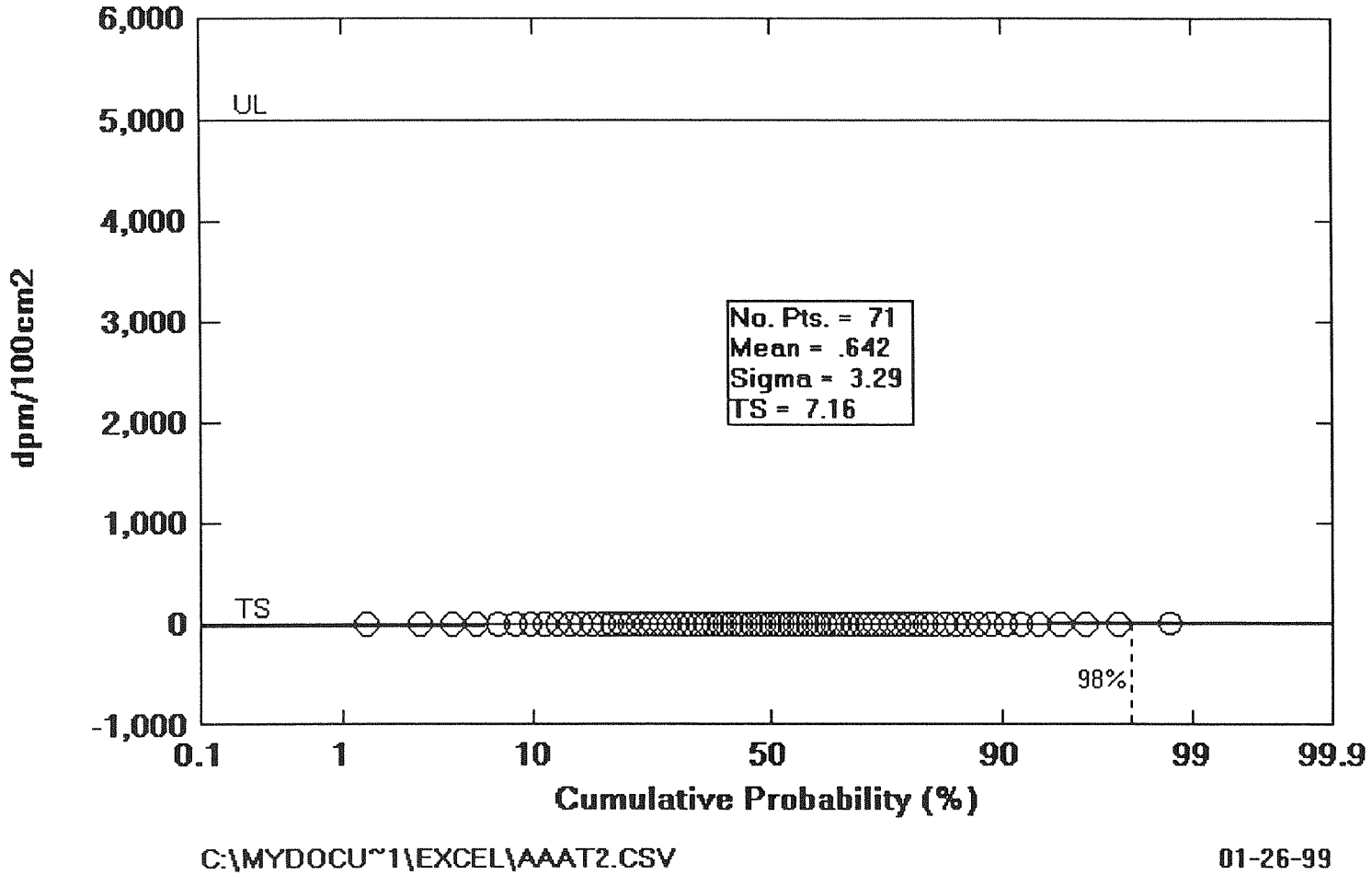
LOT 4: FUEL STORAGE ROOM 109



APPENDIX B

SAMPLE LOT 1

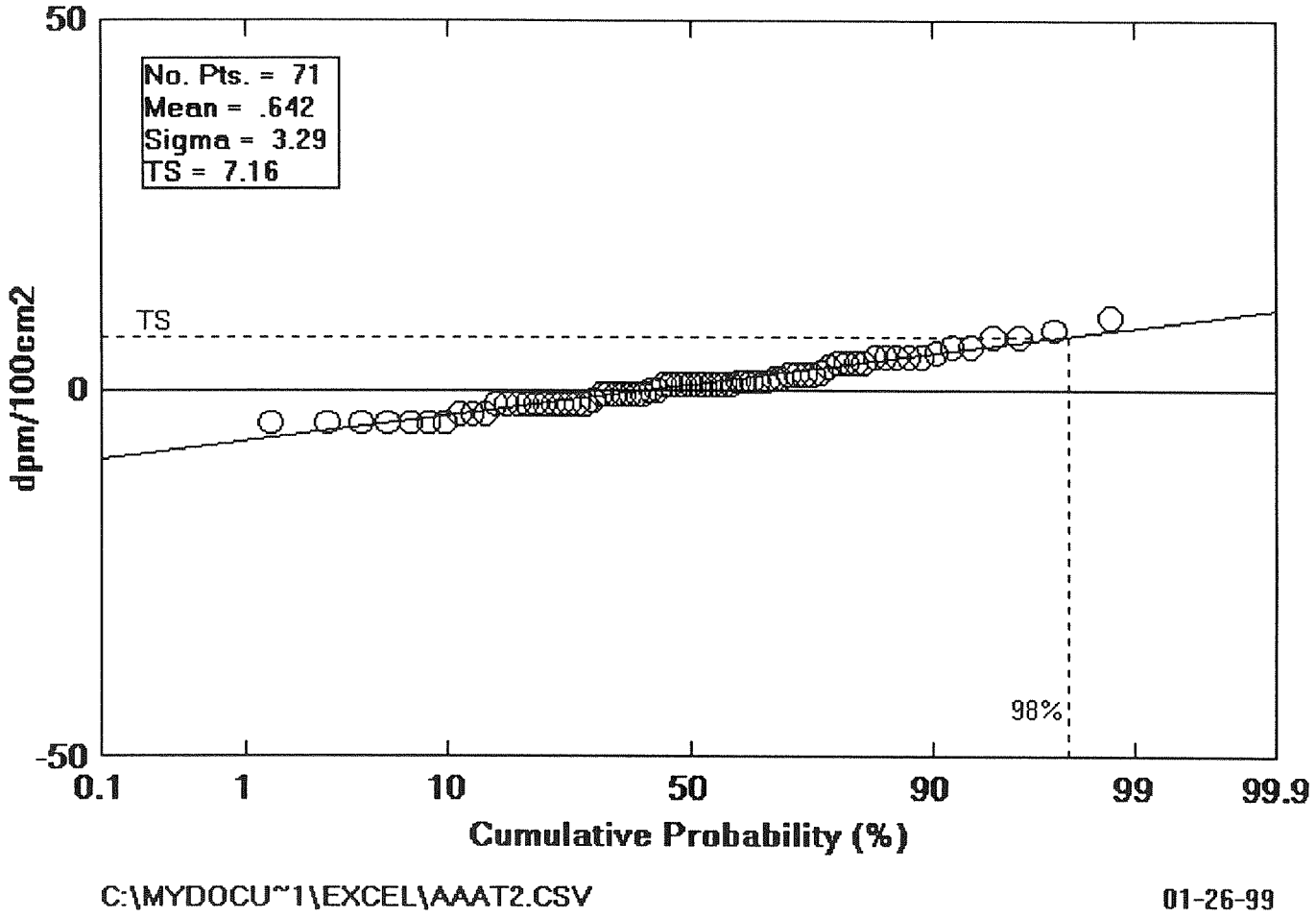
Quantitative Total Alpha Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AAAT2.CSV

01-26-99

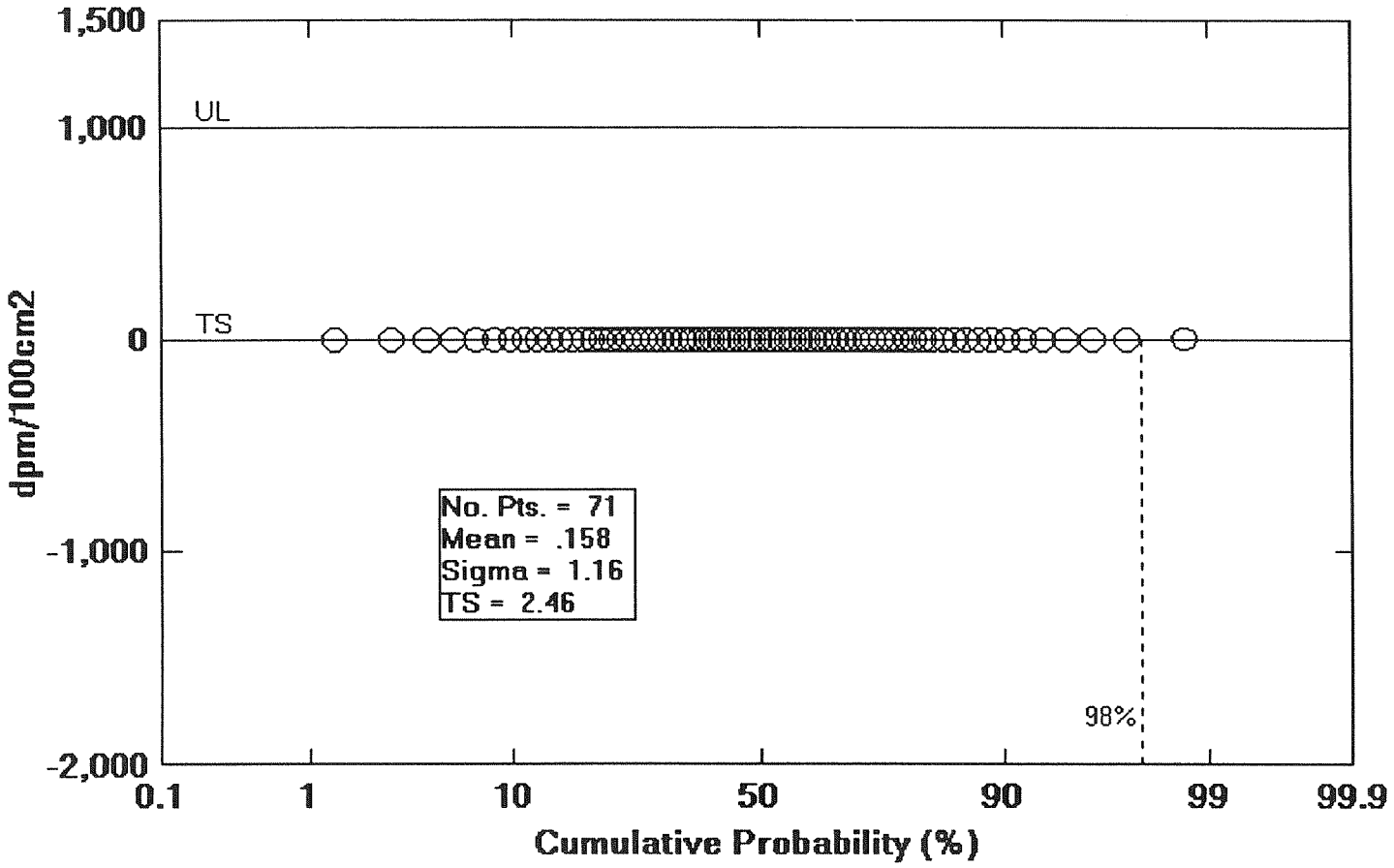
Quantitative Total Alpha Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AAAT2.CSV

01-26-99

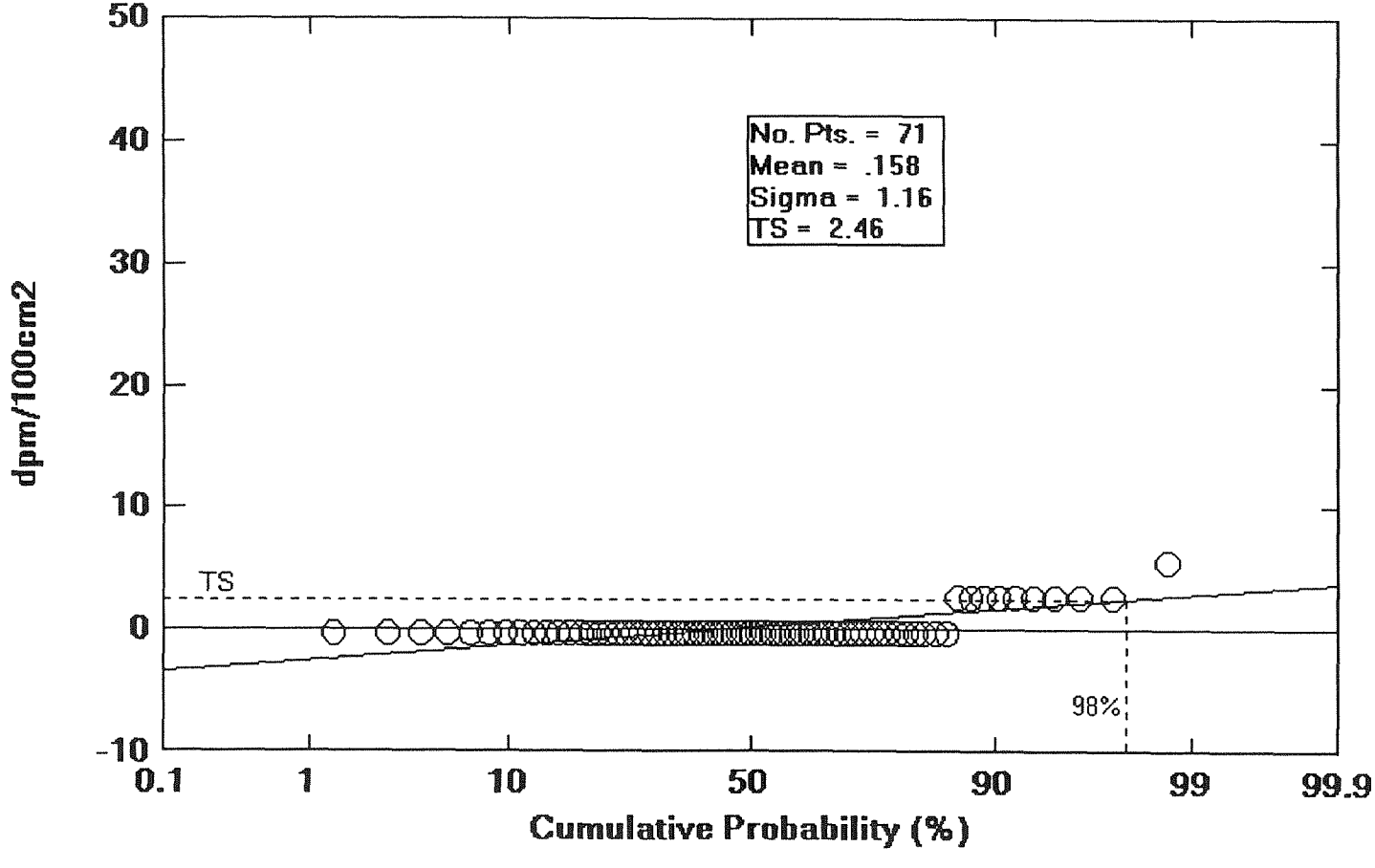
Removable Alpha Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AAAR.CSV

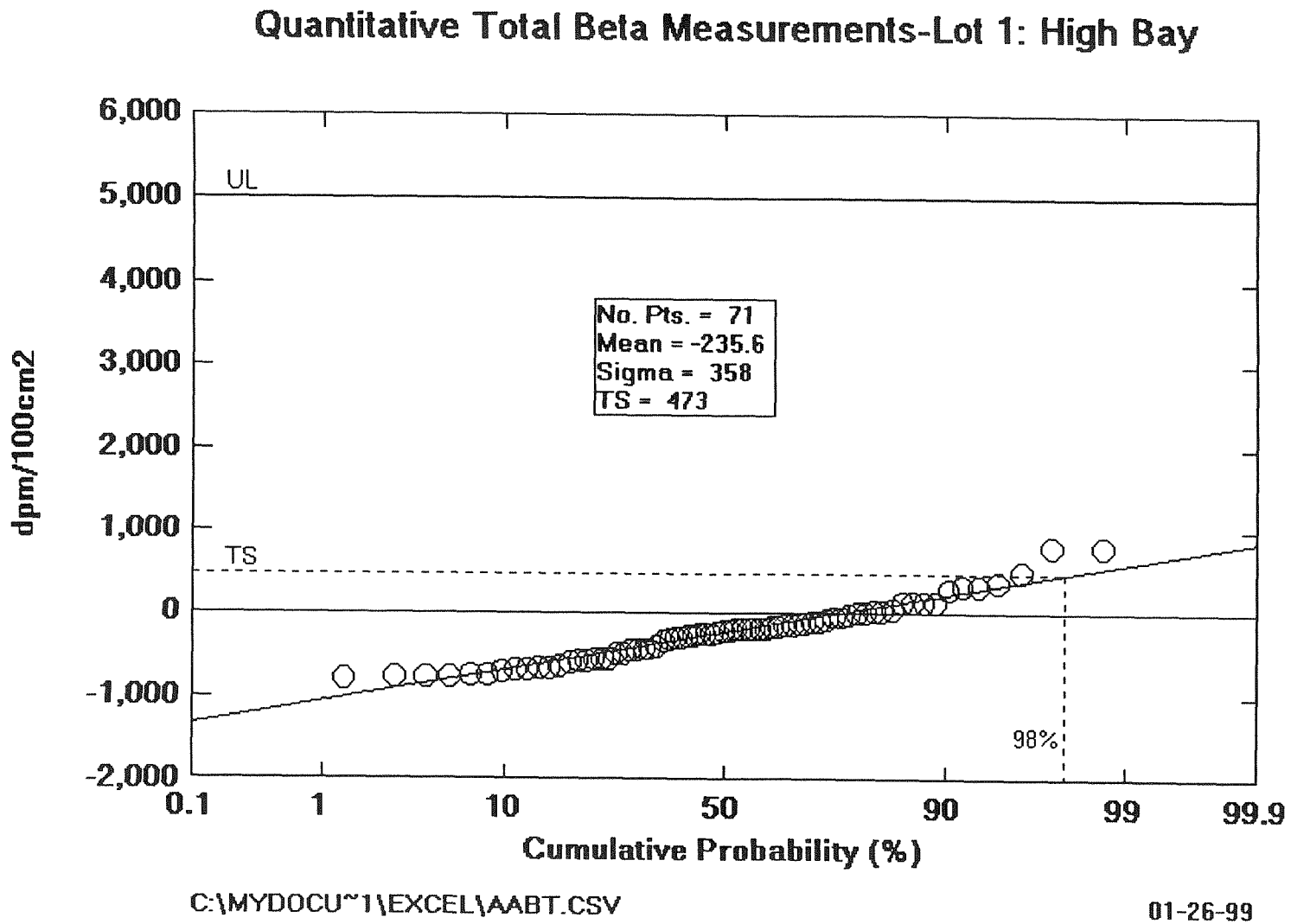
01-26-99

Removable Alpha Measurements-Lot 1: High Bay

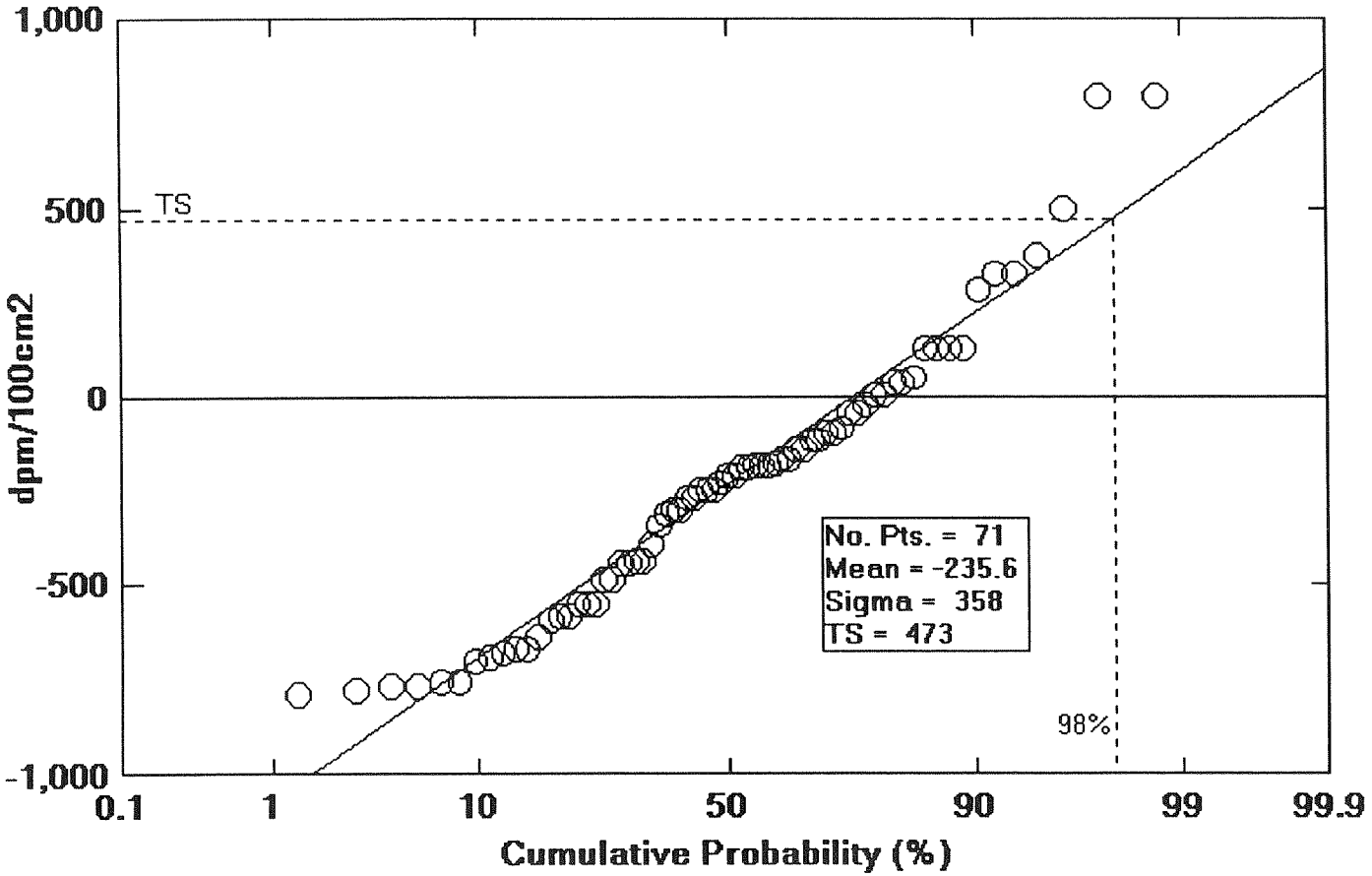


C:\MYDOCU~1\EXCEL\AAAR.CSV

01-26-99


Quantitative Total Beta Measurements-Lot 1: High Bay
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
dpm/100cm2
UL
TS
No. Pts. = 71
Mean = -235.6
Sigma = 358
TS = 473
98%
0.1
1
10
50
90
99
99.9
Cumulative Probability (%)
C:\MYDOCU~1\EXCEL\AABT.CSV
01-26-99

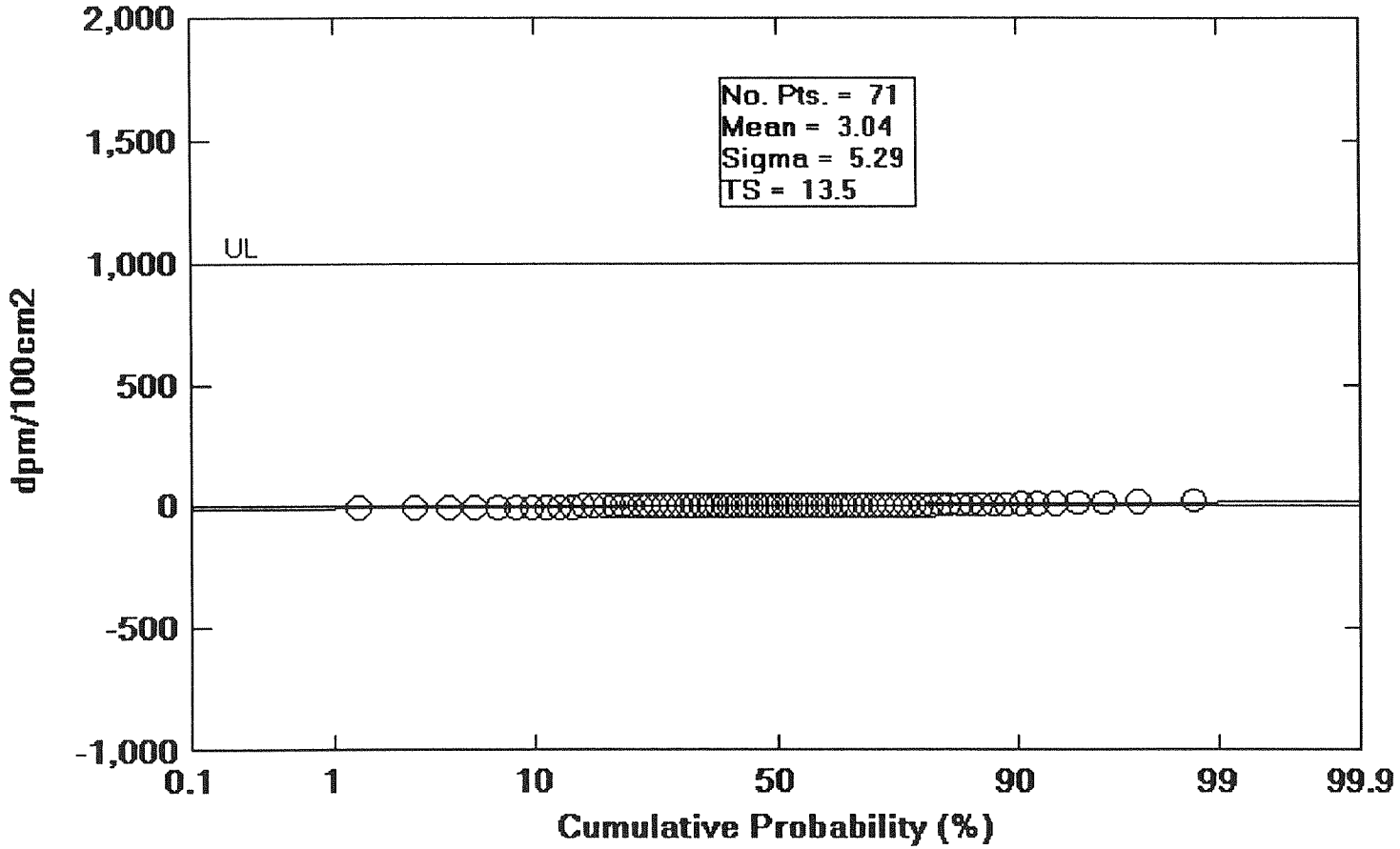
Quantitative Total Beta Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AABT.CSV

01-26-99

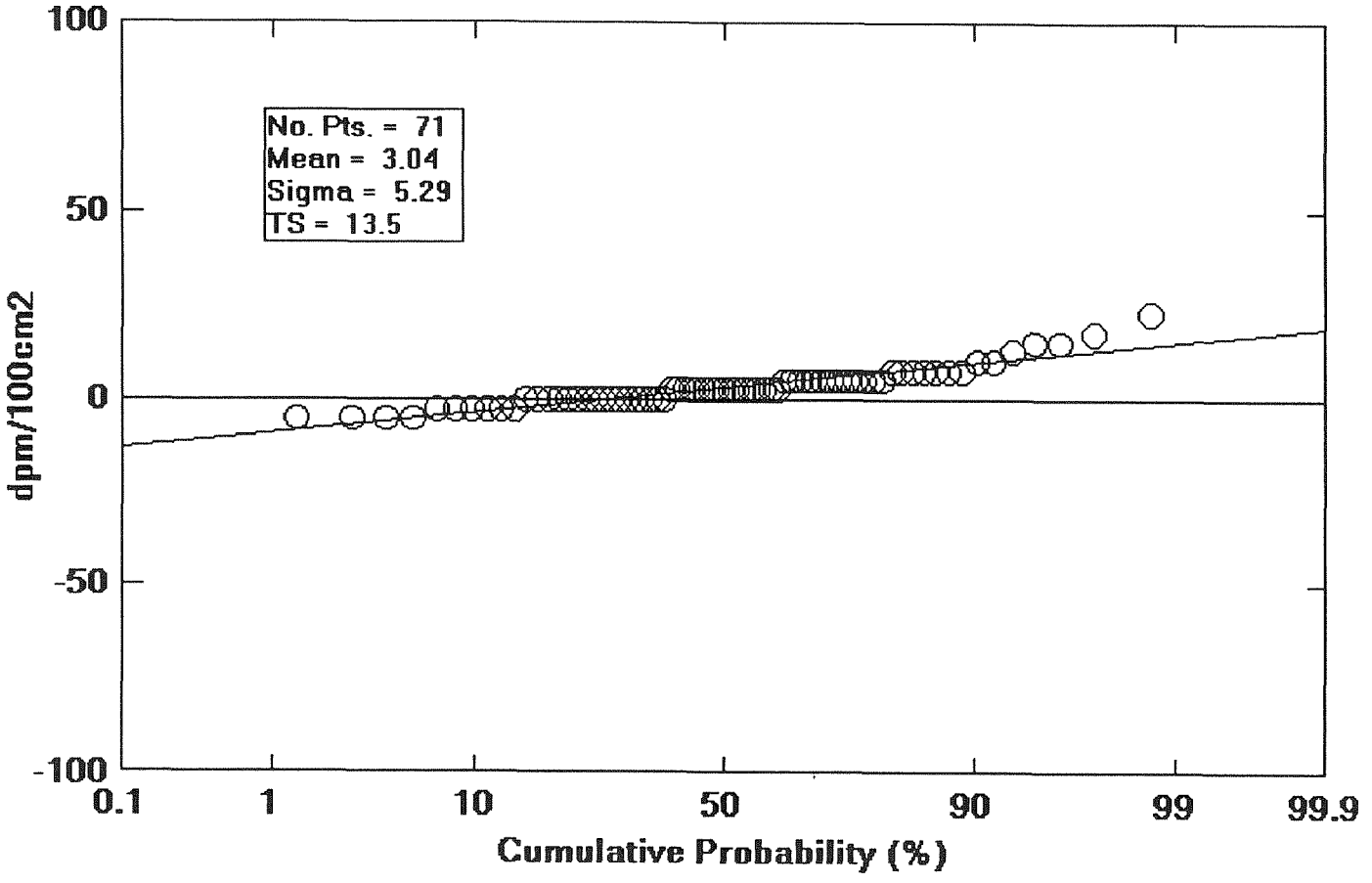
Removable Beta Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AABR.CSV

01-26-99

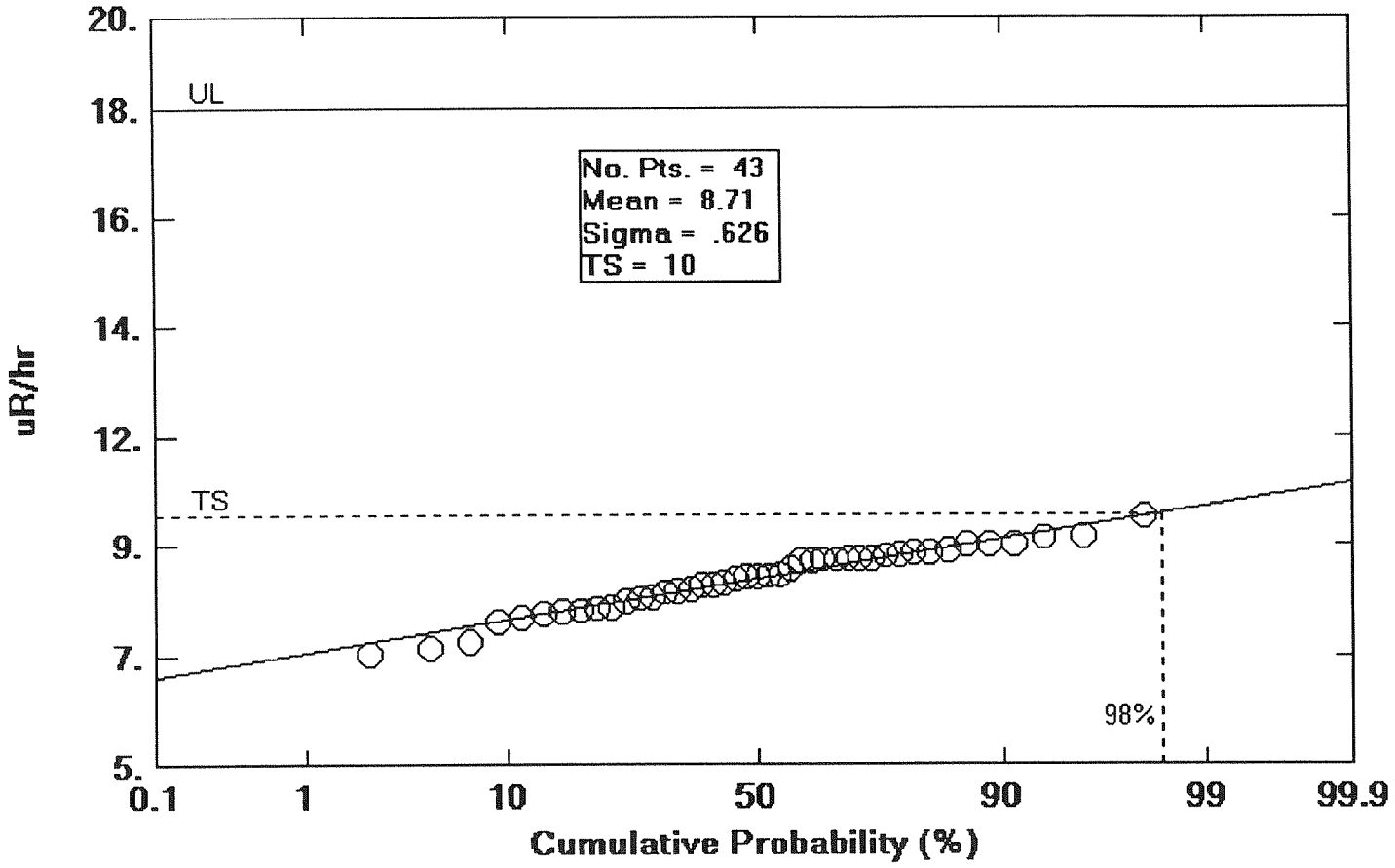
Removable Beta Measurements-Lot 1: High Bay



C:\MYDOCU~1\EXCEL\AABR.CSV

01-26-99

Gross Gamma Measurement - T019 Affected Area



C:\MYDOCU~1\EXCEL\GROSSGAA.CMP

04-08-99

Lot 1 High Bay
Affected Area

TITLE: Final Survey T019 High Bay
Data Description: Floor Grids

No. of Samples: 71

		5 MIN	1 MI		5 MIN	1 MI		1 MIN	ALPHA						BETA						GAMMA	
SAMPLE	GRID	ALPHA			BETA			GAM	INSTRUMENT			SMEAR			INSTRUMENT			SMEAR				
NAME	AM	TOTA	MAX	REM	TOTAL	MAX	REM	TOTAL	BACK	EFACT	AFACT	BACK	EFACT		BACK	EFACT	AFACT	BACK	EFACT		BACKG	EFACT
Floor Grid: 9/14/9	287	6		0	328		4	1979	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	288	5		0	325		4	2023	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	295	8		0	320		3	1725	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	299	6		0	313		3	2060	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	302	8		0	304		2	1962	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	310	3		0	308		2	1756	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	349	4		0	298		4	1580	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	353	3		0	251		7	1749	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	359	8		0	250		3	1829	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	370	3		1	306		2	1885	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	377	3		0	295		5	1553	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	389	2		0	282		2	1849	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	397	5		0	402		5	1976	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	401	4		0	337		3	1881	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	413	1		0	337		2	1919	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	420	3		0	315		2	1609	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	430	3		0	291		4	1783	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	437	9		0	361		4	1737	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	439	10		0	286		1	1823	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	482	12		0	356		2	1989	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	486	1		0	328		2	1848	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	487	3		0	325		8	1799	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	490	1		0	320		6	1741	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	504	1		0	313		3	1819	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	507	5		0	304		2	1954	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	526	10		0	308		3	2026	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	530	3		1	298		2	1892	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	537	9		0	251		2	1992	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	554	6		0	250		5	1995	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	558	2		1	306		3	2023	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	563	5		0	295		3	1889	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	572	3		0	282		3	2054	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	574	4		0	402		4	1793	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	579	5		1	337		9	1878	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	589	4		0	337		0	2143	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	253	3		2	307		3	1690	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	266	1		0	302		4	1710	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005
Floor Grid	277	1		0	352		4	1961	4.5	4.66	1.4	0.01	0.3455		324.5	10.29	5	2.1	0.3892		14256	0.005

Lot 1 High Bay
Affected Area

		5 MIN	1 MI		5 MIN	1 MI		1 MIN	ALPHA					BETA					GAMMA	
SAMPLE	GRID	ALPHA			BETA			GAM	INSTRUMENT			SMEAR		INSTRUMENT			SMEAR			
NAME	AM	TOTA	MAX	REM	TOTAL	MAX	REM	TOTAL	BACK	EFACT	AFACT	BACK	EFACT	BACK	EFACT	AFACT	BACK	EFACT	BACKG	EFACT
Floor Grid	334	2		0	315		1	1858	4.5	4.66	1.4	0.01	0.3455	324.5	10.29	5	2.1	0.3892	14256	0.005
Floor Grid	465	1		0	373		2	1959	4.5	4.66	1.4	0.01	0.3455	324.5	10.29	5	2.1	0.3892	14256	0.005
Floor Grid: 9/16/9	466	3		0	330		8	1958	1.83	4.70	1.4	0.01	0.3455	332.3	10.3	5	2.1	0.3892	14256	0.005
Floor Grid	479	3		0	337		1	1957	1.83	4.70	1.4	0.01	0.3455	332.3	10.3	5	2.1	0.3892	14256	0.005
Floor Grid	480	8		0	364		4	1958	1.83	4.70	1.4	0.01	0.3455	332.3	10.3	5	2.1	0.3892	14256	0.005
North Wall: 9/10/	15	2		0	280		5		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
North Wall: 9/10/	23	2		0	286		3		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
North Wall: 9/10/	27	0		0	290		3		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
North Wall: 9/10/	33	1		0	249		2		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
North Wall: 9/10/	39	2		0	258		0		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	69	3		0	252		5		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	75	2		0	241		4		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	78	2		1	240		1		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	85	1		0	295		3		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	87	4		0	244		6		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	92	5		0	280		2		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	97	1		1	274		1		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	108	2		0	262		4		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
East Wall	115	5		0	286		4		1.5	4.60	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
South Wall: 9/11/	136	2		0	262		2		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
South Wall	141	5		0	230		0		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
South Wall	144	4		0	239		1		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
South Wall	147	4		0	238		3		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
South Wall	151	4		0	248		2		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	185	1		1	252		0		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	190	2		0	280		11		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	201	2		0	286		3		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	208	0		0	290		5		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	214	1		1	249		5		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	218	2		0	258		3		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	224	3		0	252		2		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	230	2		1	241		4		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005
West Wall	221	4		0	231		3		1.16	4.6	1.4	0.01	0.3455	303	10.8	5	2.1	0.3892	14256	0.005

Lot 1 High Bay
Affected Area

RADIOLOGICAL SURVEY DATA
Data Description: Floor Grids

SAMPLE NAME	GRID NAM	ALPHA (DPM/100CM2) TOTAL	STD DE	MAX	SD	REM	STD DE	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	SD	REM	STD DE	GAMMA (uR/hr) TOTAL	STD DEV
Floor Grid: 9/14/98	287	1.96	6.97			0.00	0.03	36.0	454.45			0.74	0.96	-4.06	0.59
Floor Grid	288	0.65	6.84			0.00	0.03	5.1	454.10			0.74	0.96	-3.85	0.59
Floor Grid	295	4.57	7.21			0.00	0.03	-46.3	453.52			0.35	0.88	-5.24	0.59
Floor Grid	299	1.96	6.97			0.00	0.03	-118.3	452.70			0.35	0.88	-3.68	0.59
Floor Grid	302	4.57	7.21			0.00	0.03	-210.9	451.65			-0.04	0.79	-4.13	0.59
Floor Grid	310	-1.96	6.59			0.00	0.03	-169.8	452.12			-0.04	0.79	-5.09	0.59
Floor Grid	349	-0.65	6.72			0.00	0.03	-272.7	450.94			0.74	0.96	-5.91	0.59
Floor Grid	353	-1.96	6.59			0.00	0.03	-756.3	445.39			1.91	1.17	-5.12	0.59
Floor Grid	359	4.57	7.21			0.00	0.03	-766.6	445.27			0.35	0.88	-4.75	0.59
Floor Grid	370	-1.96	6.59			0.34	0.35	-190.4	451.88			-0.04	0.79	-4.49	0.59
Floor Grid	377	-1.96	6.59			0.00	0.03	-303.6	450.59			1.13	1.04	-6.04	0.58
Floor Grid	389	-3.26	6.46			0.00	0.03	-437.3	449.06			-0.04	0.79	-4.66	0.59
Floor Grid	397	0.65	6.84			0.00	0.03	797.5	462.99			1.13	1.04	-4.07	0.59
Floor Grid	401	-0.65	6.72			0.00	0.03	128.6	455.50			0.35	0.88	-4.51	0.59
Floor Grid	413	-4.57	6.33			0.00	0.03	128.6	455.50			-0.04	0.79	-4.33	0.59
Floor Grid	420	-1.96	6.59			0.00	0.03	-97.8	452.94			-0.04	0.79	-5.78	0.59
Floor Grid	430	-1.96	6.59			0.00	0.03	-344.7	450.12			0.74	0.96	-4.97	0.59
Floor Grid	437	5.87	7.32			0.00	0.03	375.6	458.28			0.74	0.96	-5.18	0.59
Floor Grid	439	7.18	7.44			0.00	0.03	-396.2	449.53			-0.43	0.69	-4.78	0.59
Floor Grid	482	9.79	7.66			0.00	0.03	324.1	457.70			-0.04	0.79	-4.01	0.59
Floor Grid	486	-4.57	6.33			0.00	0.03	36.0	454.45			-0.04	0.79	-4.66	0.59
Floor Grid	487	-1.96	6.59			0.00	0.03	5.1	454.10			2.30	1.24	-4.89	0.59
Floor Grid	490	-4.57	6.33			0.00	0.03	-46.3	453.52			1.52	1.11	-5.16	0.59
Floor Grid	504	-4.57	6.33			0.00	0.03	-118.3	452.70			0.35	0.88	-4.80	0.59
Floor Grid	507	0.65	6.84			0.00	0.03	-210.9	451.65			-0.04	0.79	-4.17	0.59
Floor Grid	526	7.18	7.44			0.00	0.03	-169.8	452.12			0.35	0.88	-3.84	0.59
Floor Grid	530	-1.96	6.59			0.34	0.35	-272.7	450.94			-0.04	0.79	-4.46	0.59
Floor Grid	537	5.87	7.32			0.00	0.03	-756.3	445.39			-0.04	0.79	-3.99	0.59
Floor Grid	554	1.96	6.97			0.00	0.03	-766.6	445.27			1.13	1.04	-3.98	0.59
Floor Grid	558	-3.26	6.46			0.34	0.35	-190.4	451.88			0.35	0.88	-3.85	0.59
Floor Grid	563	0.65	6.84			0.00	0.03	-303.6	450.59			0.35	0.88	-4.47	0.59
Floor Grid	572	-1.96	6.59			0.00	0.03	-437.3	449.06			0.35	0.88	-3.71	0.59
Floor Grid	574	-0.65	6.72			0.00	0.03	797.5	462.99			0.74	0.96	-4.92	0.59
Floor Grid	579	0.65	6.84			0.34	0.35	128.6	455.50			2.69	1.30	-4.52	0.59
Floor Grid	589	-0.65	6.72			0.00	0.03	128.6	455.50			-0.82	0.56	-3.29	0.60
Floor Grid	253	-1.96	6.59			0.69	0.49	-180.1	452.00			0.35	0.88	-5.40	0.59
Floor Grid	266	-4.57	6.33			0.00	0.03	-231.5	451.41			0.74	0.96	-5.31	0.59
Floor Grid	277	-4.57	6.33			0.00	0.03	283.0	457.24			0.74	0.96	-4.14	0.59

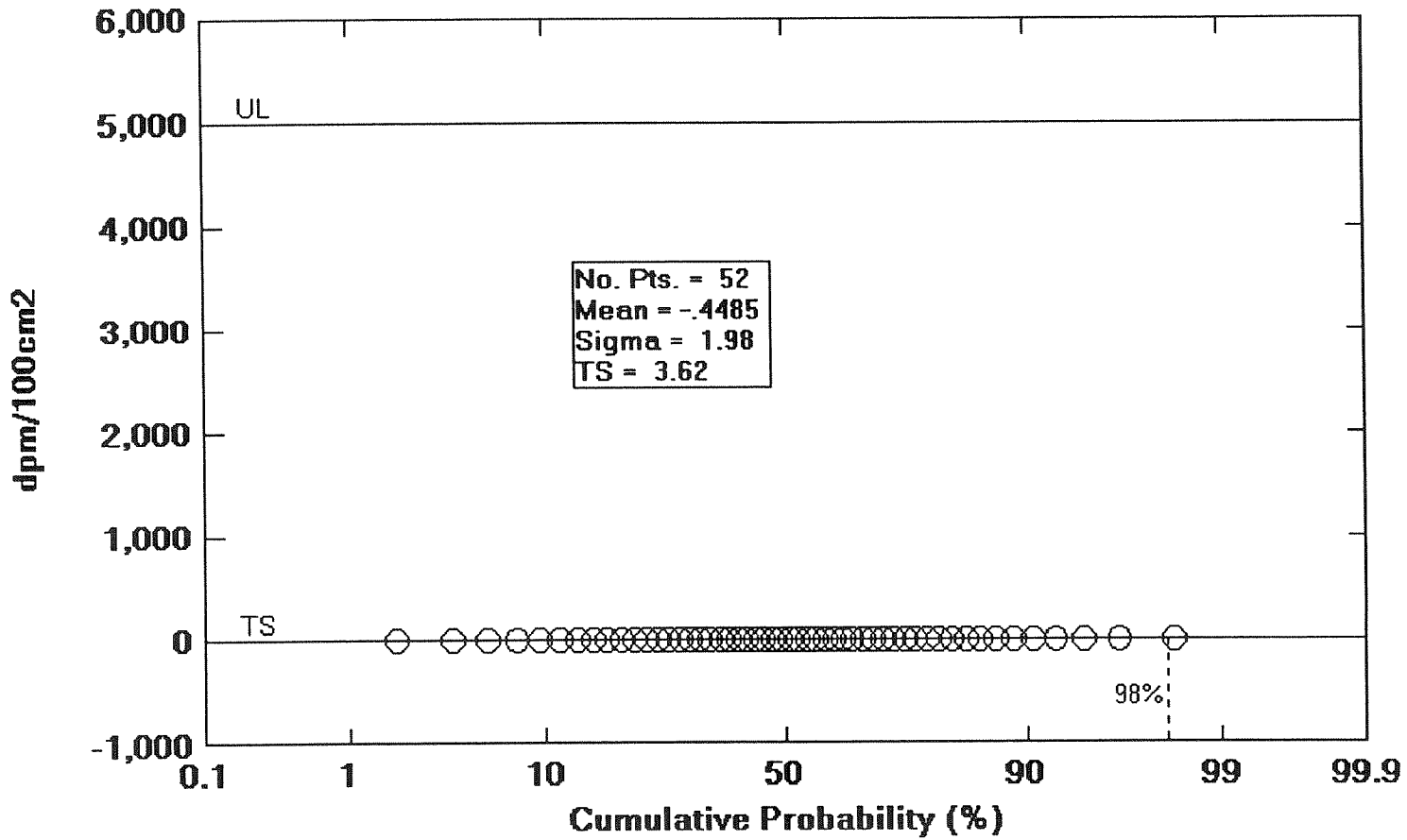
Lot 1 High Bay
Affected Area

SAMPLE NAME	GRID NAM	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA (uR/hr)	
		TOTAL	STD DE	MAX	SD	REM	STD DE	TOTAL	STD DEV	MAX	SD	REM	STD DE	TOTAL	STD DEV
Floor Grid	334	-3.26	6.46			0.00	0.03	-97.8	452.94			-0.43	0.69	-4.62	0.59
Floor Grid	465	-4.57	6.33			0.00	0.03	499.1	459.66			-0.04	0.79	-4.15	0.59
Floor Grid: 9/16/98	466	1.54	3.98			0.00	0.03	-23.7	459.65			2.30	1.24	-4.15	0.59
Floor Grid	479	1.54	3.98			0.00	0.03	48.4	460.46			-0.43	0.69	-4.16	0.59
Floor Grid	480	8.12	3.98			0.00	0.03	326.5	463.56			0.74	0.96	-4.15	0.59
North Wall: 9/10/9	15	0.64	3.97			0.00	0.03	-248.4	457.57			1.13	1.04		
North Wall: 9/10/9	23	0.64	3.97			0.00	0.03	-183.6	458.33			0.35	0.88		
North Wall: 9/10/9	27	-1.93	3.53			0.00	0.03	-140.4	458.84			0.35	0.88		
North Wall: 9/10/9	33	-0.64	3.76			0.00	0.03	-583.2	453.60			-0.04	0.79		
North Wall: 9/10/9	39	0.64	3.97			0.00	0.03	-486.0	454.76			-0.82	0.56		
East Wall	69	1.93	4.17			0.00	0.03	-550.8	453.99			1.13	1.04		
East Wall	75	0.64	3.97			0.00	0.03	-669.6	452.57			0.74	0.96		
East Wall	78	0.64	3.97			0.34	0.35	-680.4	452.44			-0.43	0.69		
East Wall	85	-0.64	3.76			0.00	0.03	-86.4	459.48			0.35	0.88		
East Wall	87	3.22	4.37			0.00	0.03	-637.2	452.96			1.52	1.11		
East Wall	92	4.51	4.55			0.00	0.03	-248.4	457.57			-0.04	0.79		
East Wall	97	-0.64	3.76			0.34	0.35	-313.2	456.80			-0.43	0.69		
East Wall	108	0.64	3.97			0.00	0.03	-442.8	455.27			0.74	0.96		
East Wall	115	4.51	4.55			0.00	0.03	-183.6	458.33			0.74	0.96		
South Wall: 9/11/9	136	1.08	3.60			0.00	0.03	-442.8	455.27			-0.04	0.79		
South Wall	141	4.95	4.23			0.00	0.03	-788.4	451.15			-0.82	0.56		
South Wall	144	3.66	4.03			0.00	0.03	-691.2	452.31			-0.43	0.69		
South Wall	147	3.66	4.03			0.00	0.03	-702.0	452.18			0.35	0.88		
South Wall	151	3.66	4.03			0.00	0.03	-594.0	453.47			-0.04	0.79		
West Wall	185	-0.21	3.36			0.34	0.35	-550.8	453.99			-0.82	0.56		
West Wall	190	1.08	3.60			0.00	0.03	-248.4	457.57			3.46	1.41		
West Wall	201	1.08	3.60			0.00	0.03	-183.6	458.33			0.35	0.88		
West Wall	208	-1.49	3.10			0.00	0.03	-140.4	458.84			1.13	1.04		
West Wall	214	-0.21	3.36			0.34	0.35	-583.2	453.60			1.13	1.04		
West Wall	218	1.08	3.60			0.00	0.03	-486.0	454.76			0.35	0.88		
West Wall	224	2.37	3.82			0.00	0.03	-550.8	453.99			-0.04	0.79		
West Wall	230	1.08	3.60			0.34	0.35	-669.6	452.57			0.74	0.96		
West Wall	221	3.66	4.03			0.00	0.03	-777.6	451.28			0.35	0.88		

APPENDIX C

SAMPLE LOT 2

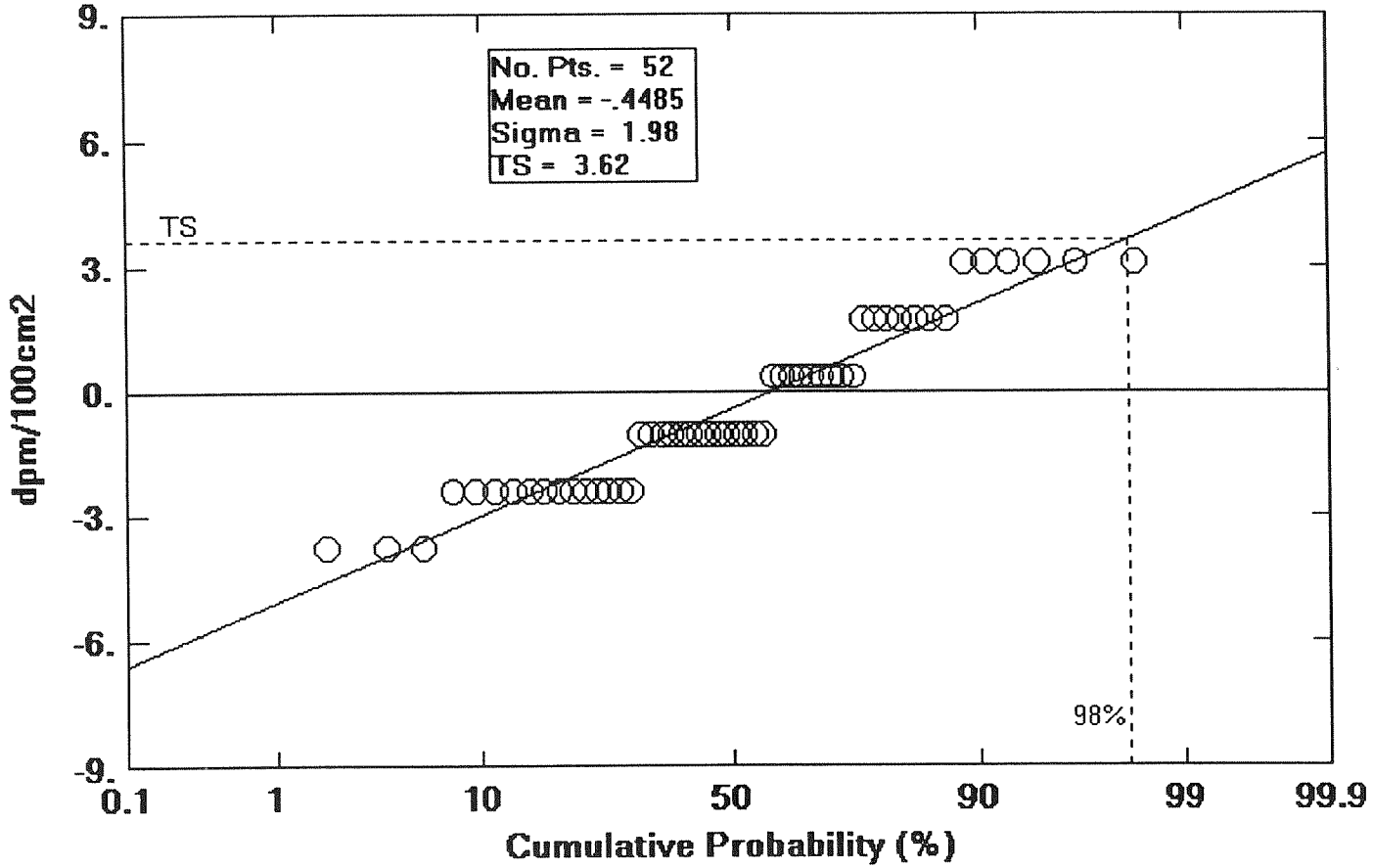
Quantitative Total Alpha Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\UAALPH~1.CSV

01-26-99

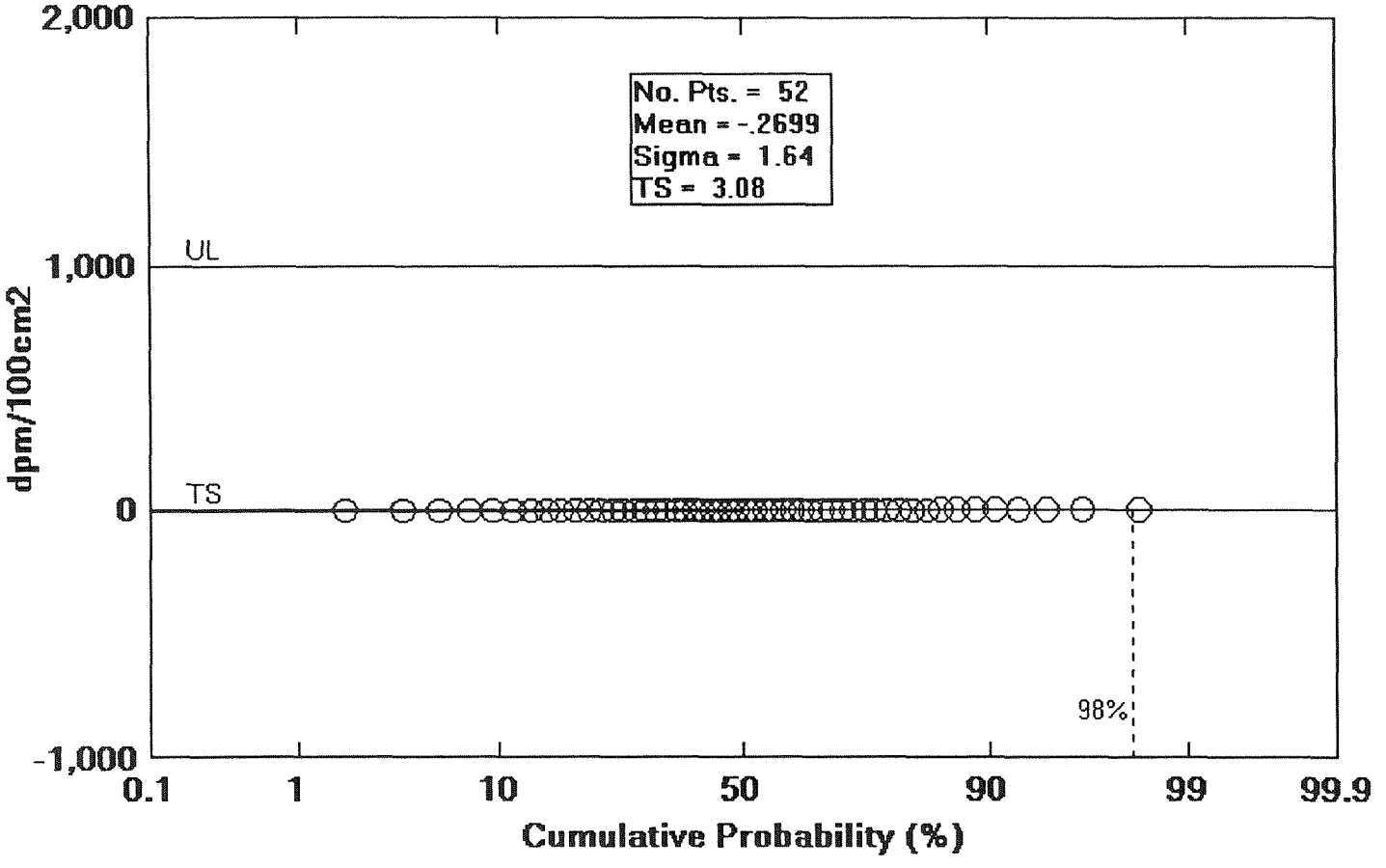
Quantitative Total Alpha Measurements-Lot2: High Bay



C:\MYDOCU~1\EXCEL\UAALPH~1.CSV

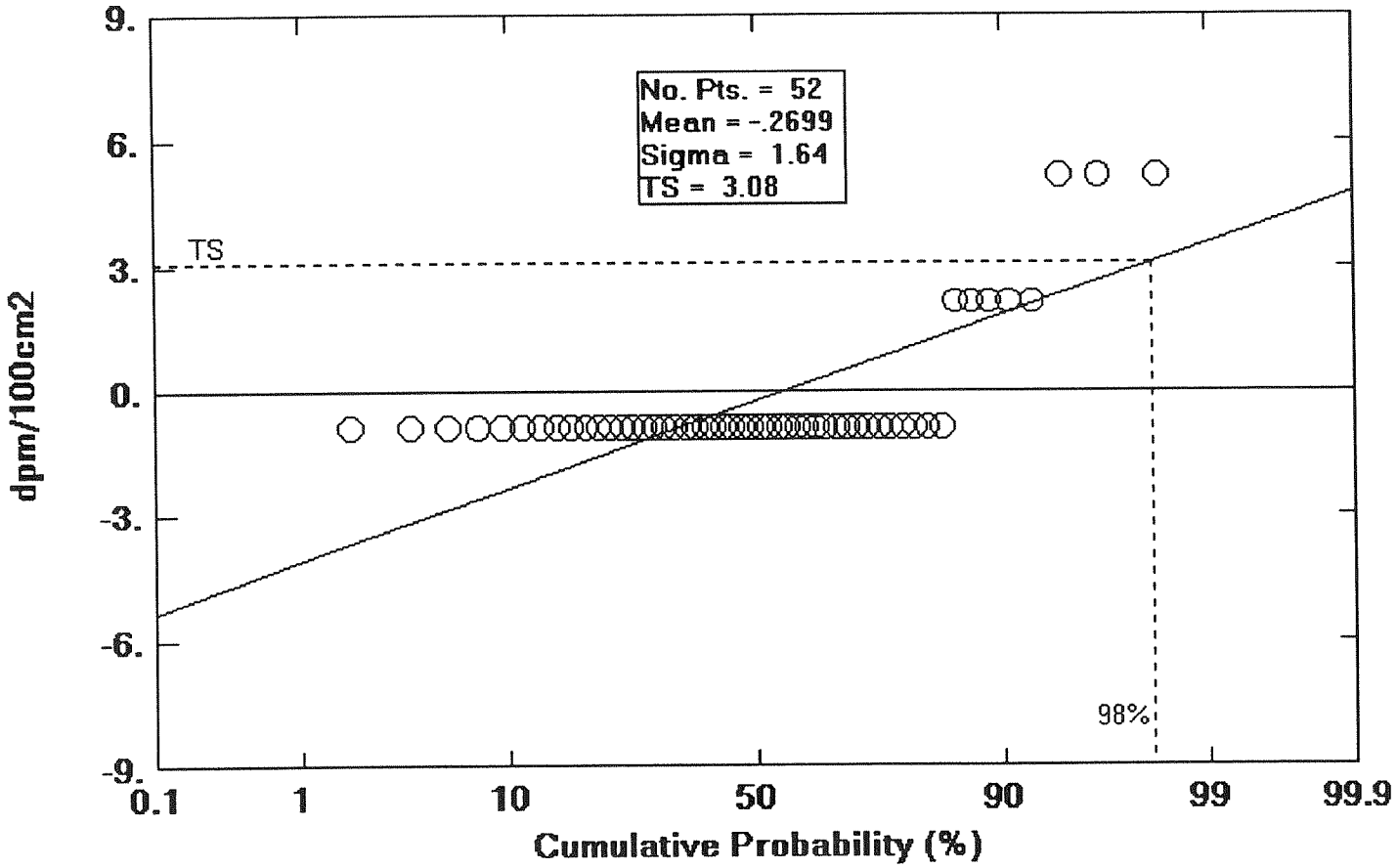
01-26-99

Removable Alpha Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\UAALPH~2.CSV 01-26-99

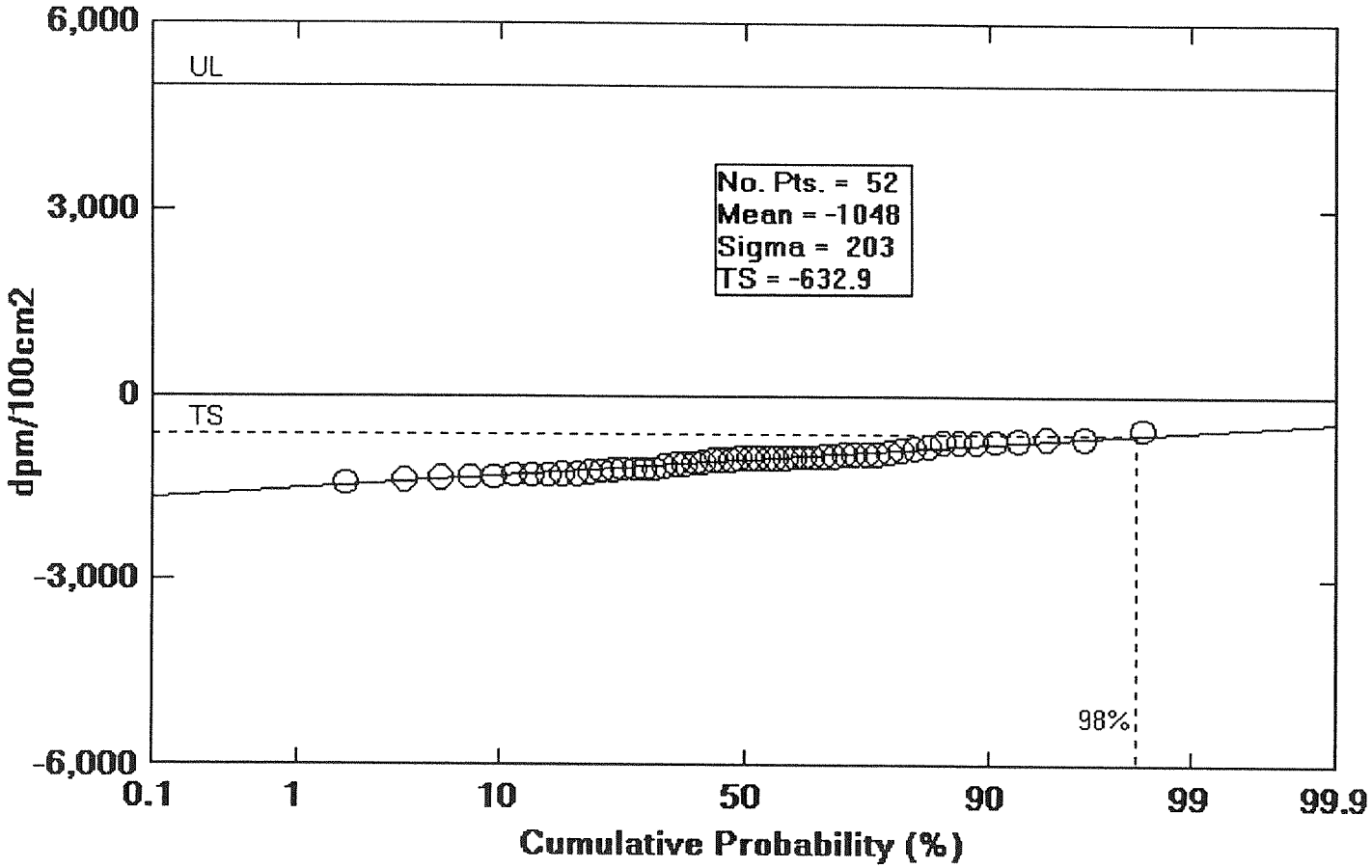
Removable Alpha Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\UAALPH~2.CSV

01-26-99

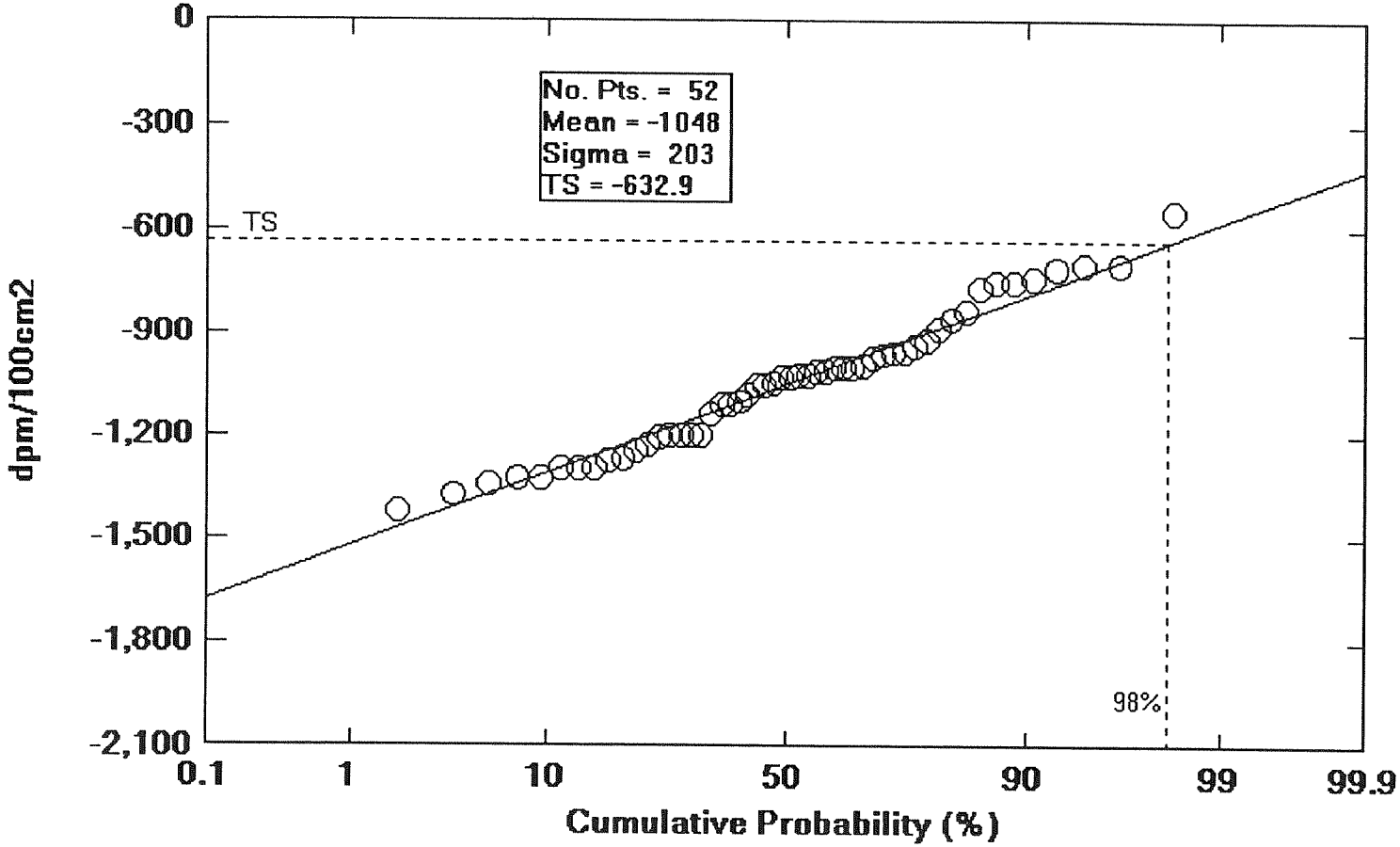
Net Quantitative Total Beta Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\NETB19.CSV

01-29-99

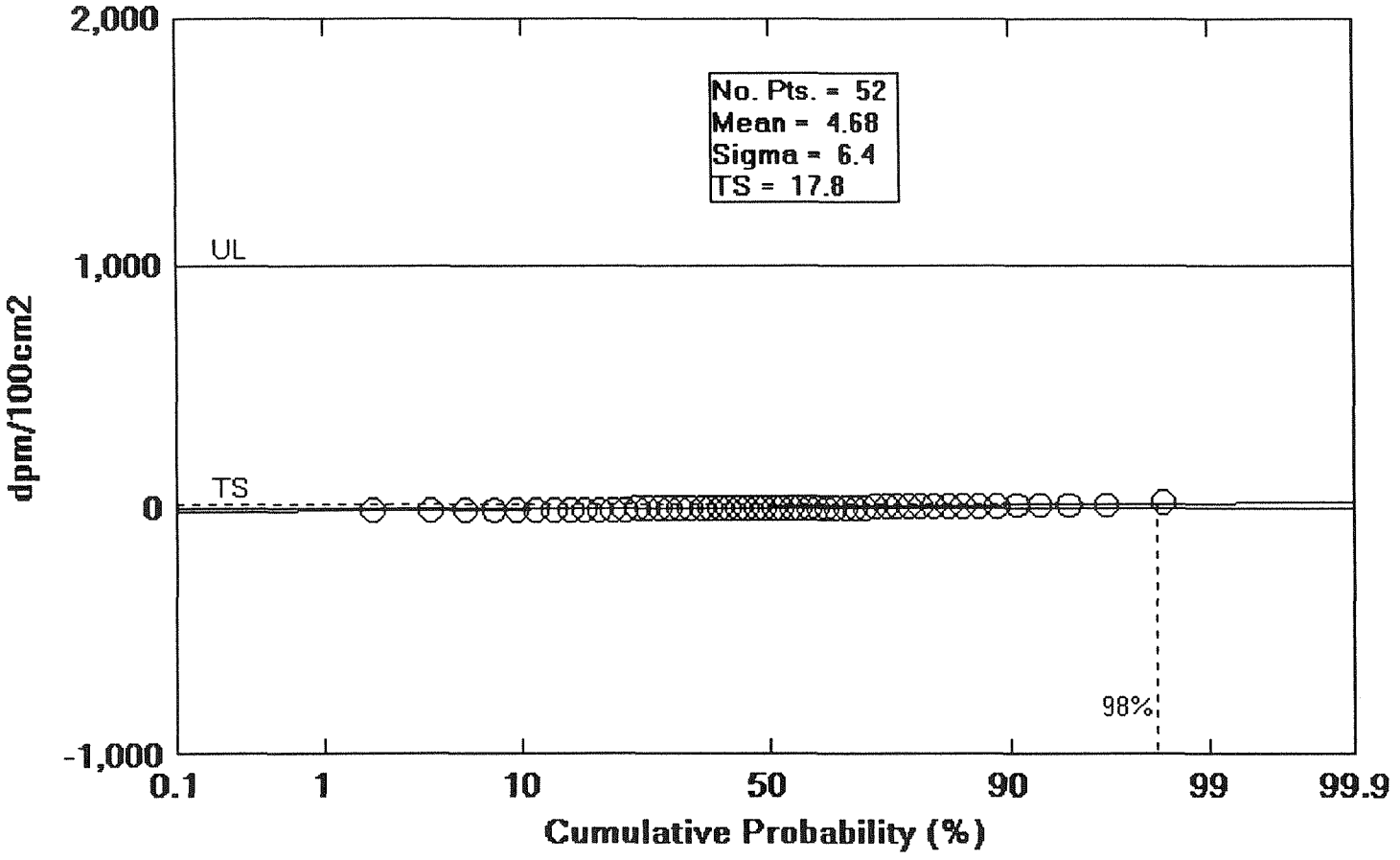
Gross Total Quantitative Beta Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\XBETA.CSV

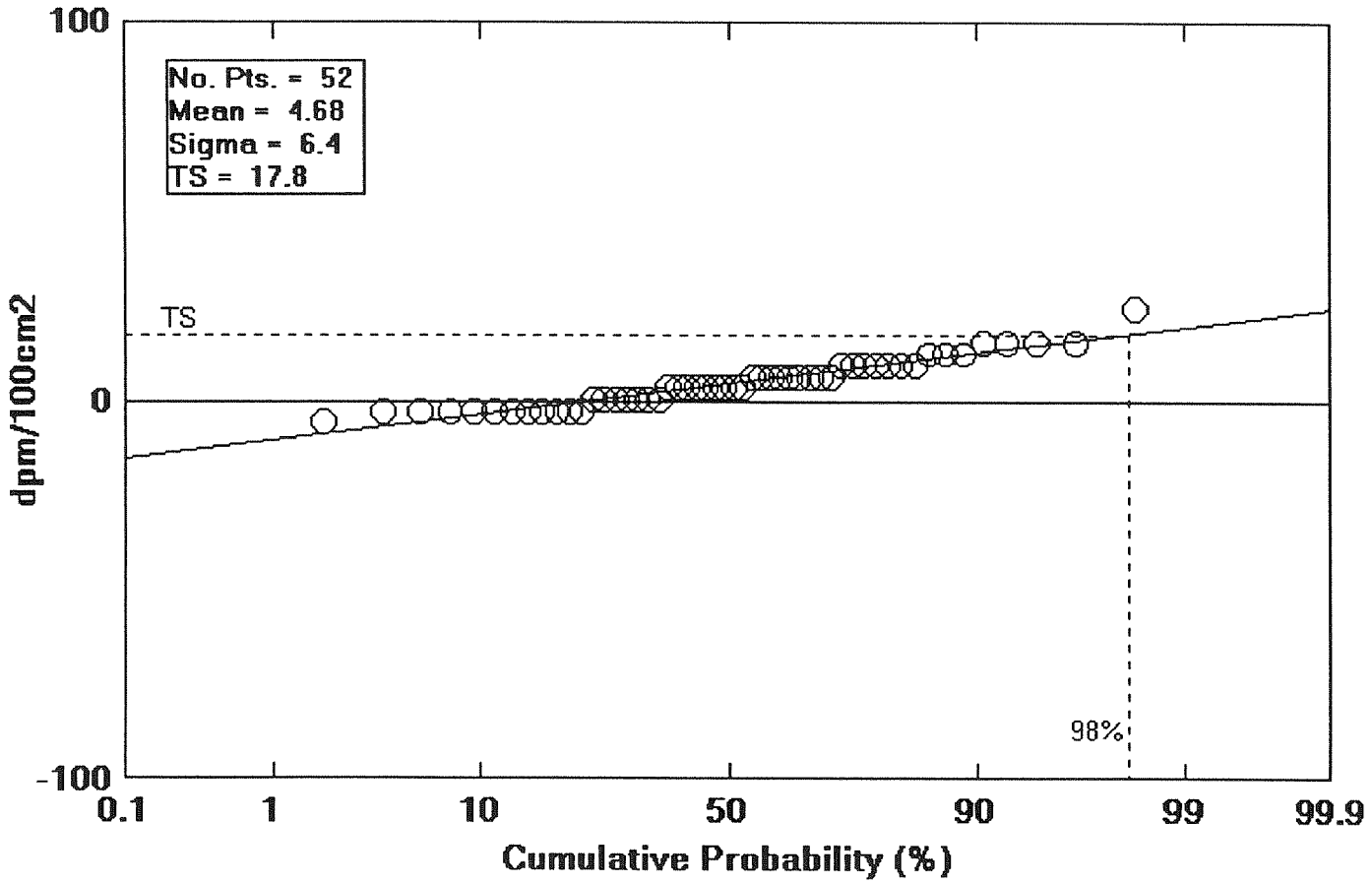
01-29-99

Removable Beta Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\UABETA~2.CSV 01-26-99

Removable Beta Measurements-Lot 2: High Bay



C:\MYDOCU~1\EXCEL\UABETA~2.CSV

01-26-99

TITLE: Final Survey T019 High Bay
Data Description: Floor & Wall Grids

No. of Samples: 54

		5 MIN	1 MI		5 MIN	1 MI		1 MIN	ALPHA					BETA					GAMMA	
SAMPLE	GRID	ALPHA			BETA			GAM	INSTRUMENT			SMEAR		INSTRUMENT			SMEAR			
NAME	AM	TOTA	MAX	REM	TOTA	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	BACK	FAC
Ceiling	560	2		2	229		2		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	571	2		0	201		2		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	581	2		0	219		9		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	596	3		0	240		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	604	2		0	206		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	643	3		0	196		15		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	664	0		0	237		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	671	4		0	231		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	683	5		2	214		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	707	5		0	243		12		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	731	3		0	209		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	751	2		0	219		9		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	777	2		0	238		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	786	5		0	216		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	816	1		0	212		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	821	4		0	209		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	823	4		0	219		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	852	4		0	219		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	854	3		0	206		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	868	1		0	265		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
Ceiling	874	1		0	244		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	295	1		0	239		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	297	1		0	239		9		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	299	2		2	269		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	303	1		0	225		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	307	1		0	234		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
South Wall	327	5		2	286		25		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		

Lot 2 High Bay
Unaffected Area

		5 MIN	1 MI		5 MIN	1 MI		1 MIN	ALPHA					BETA					GAMMA	
SAMPLE	GRID	ALPHA			BETA			GAM	INSTRUMENT			SMEAR		INSTRUMENT			SMEAR			
NAME	AM	TOTA	MAX	REM	TOTA	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	BACK	FAC
East Wall	131	2		2	237		15		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	144	2		0	242		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	150	2		0	265		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	162	4		0	251		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	178	0		0	238		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	221	2		0	256		15		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	233	2		0	270		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	239	1		0	270		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	250	3		5	263		3		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	267	1		0	239		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
East Wall	271	1		0	254		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
North Wall: 9/25/	16	1		2	250		9		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
North Wall	36	4		0	239		9		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
North Wall	46	3		0	241		12		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
North Wall	65	3		0	237		15		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
North Wall	69	4		0	260		9		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
North Wall	91	3		0	204		12		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
West Wall	374	2		0	234		6		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
West Wall	385	5		0	234		3		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
West Wall:9/26/9	436	1		0	228		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall	439	4		0	228		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall	446	3		0	209		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall: 9/25/	450	2		0	228		0		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		
West Wall: 9/26/	451	5		0	204		0		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall	455	1		0	219		6		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall	458	2		5	218		9		2.75	4.9	1.4	0.3	0.328	342.5	9.7	5	1.9	0.3295		
West Wall: 9/25/	467	0		0	227		0		2.75	4.9	1.4	0.3	0.328	348	9.5	5	1.9	0.3295		

Lot 2 High Bay
Unaffected Area

RADIOLOGICAL SURVEY DATA
Data Description: Floor & Wall Grids

SAMPLE NAME	GRID NAM	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA (uR/hr)	
		TOTAL	STD DEV	MAX	TD DE	REM	STD DEV	TOTAL	STD DEV	MAX	TD DE	REM	STD DEV	TOTAL	TD DE
Ceiling	560	-1.03	5.44			0.56	0.50	-1101	427.41			0.03	0.65		
Ceiling	571	-1.03	5.44			-0.10	0.18	-1373	424.31			0.03	0.65		
Ceiling	581	-1.03	5.44			-0.10	0.18	-1198	426.30			2.34	1.09		
Ceiling	596	0.34	5.62			-0.10	0.18	-994	428.61			0.36	0.73		
Ceiling	604	-1.03	5.44			-0.10	0.18	-1324	424.87			0.36	0.73		
Ceiling	643	0.34	5.62			-0.10	0.18	-1421	423.76			4.32	1.35		
Ceiling	664	-3.77	5.09			-0.10	0.18	-1023	428.29			0.36	0.73		
Ceiling	671	1.72	5.78			-0.10	0.18	-1082	427.63			1.35	0.93		
Ceiling	683	3.09	5.94			0.56	0.50	-1246	425.75			-0.63	0.45		
Ceiling	707	3.09	5.94			-0.10	0.18	-965	428.94			3.33	1.23		
Ceiling	731	0.34	5.62			-0.10	0.18	-1295	425.20			1.35	0.93		
Ceiling	751	-1.03	5.44			-0.10	0.18	-1198	426.30			2.34	1.09		
Ceiling	777	-1.03	5.44			-0.10	0.18	-1014	428.40			-0.63	0.45		
Ceiling	786	3.09	5.94			-0.10	0.18	-1227	425.97			-0.63	0.45		
Ceiling	816	-2.40	5.27			-0.10	0.18	-1266	425.53			0.36	0.73		
Ceiling	821	1.72	5.78			-0.10	0.18	-1295	425.20			1.35	0.93		
Ceiling	823	1.72	5.78			-0.10	0.18	-1198	426.30			-0.63	0.45		
Ceiling	852	1.72	5.78			-0.10	0.18	-1198	426.30			-0.63	0.45		
Ceiling	854	0.34	5.62			-0.10	0.18	-1324	424.87			-0.63	0.45		
Ceiling	868	-2.40	5.27			-0.10	0.18	-752	431.35			-0.63	0.45		
Ceiling	874	-2.40	5.27			-0.10	0.18	-955	429.05			0.36	0.73		
South Wall	295	-2.40	5.27			-0.10	0.18	-1004	428.51			1.35	0.93		
South Wall	297	-2.40	5.27			-0.10	0.18	-1004	428.51			2.34	1.09		
South Wall	299	-1.03	5.44			0.56	0.50	-713	431.79			-0.63	0.45		
South Wall	303	-2.40	5.27			-0.10	0.18	-1140	426.97			-0.63	0.45		
South Wall	307	-2.40	5.27			-0.10	0.18	-1052	427.96			-0.63	0.45		
South Wall	327	3.09	5.94			0.56	0.50	-548	433.63			7.61	1.71		

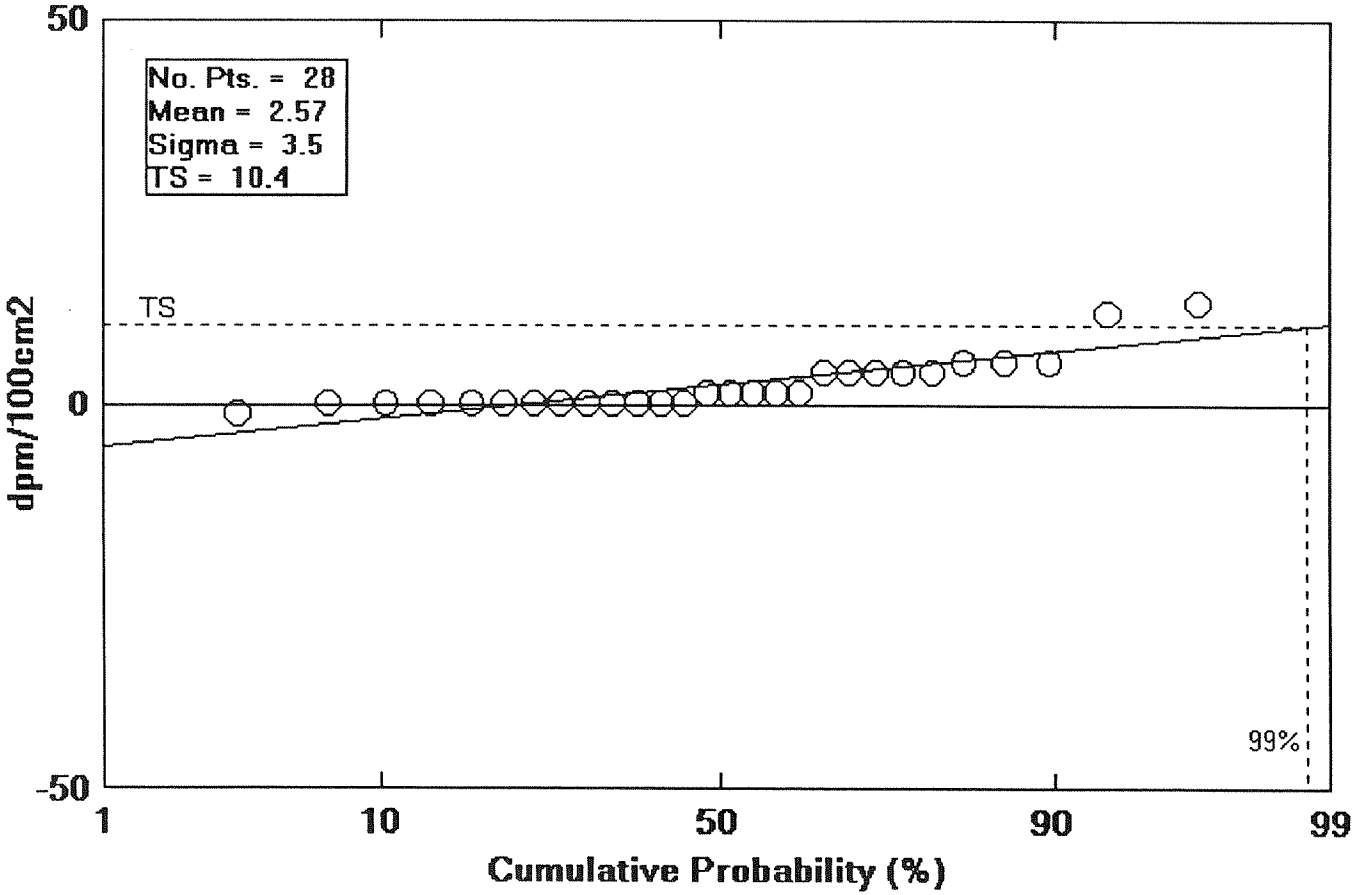
Lot 2 High Bay
Unaffected Area

SAMPLE NAME	GRID NAM	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA (uR/hr)	
		TOTAL	STD DEV	MAX	TD DE	REM	STD DEV	TOTAL	STD DEV	MAX	TD DE	REM	STD DEV	TOTAL	TD DE
East Wall	131	-1.03	5.44			0.56	0.50	-1023	428.29			4.32	1.35		
East Wall	144	-1.03	5.44			-0.10	0.18	-975	428.83			-0.63	0.45		
East Wall	150	-1.03	5.44			-0.10	0.18	-752	431.35			-0.63	0.45		
East Wall	162	1.72	5.78			-0.10	0.18	-888	429.82			-0.63	0.45		
East Wall	178	-3.77	5.09			-0.10	0.18	-1014	428.40			-0.63	0.45		
East Wall	221	-1.03	5.44			-0.10	0.18	-839	430.37			4.32	1.35		
East Wall	233	-1.03	5.44			-0.10	0.18	-703	431.90			1.35	0.93		
East Wall	239	-2.40	5.27			-0.10	0.18	-703	431.90			1.35	0.93		
East Wall	250	0.34	5.62			1.54	0.75	-771	431.13			0.36	0.73		
East Wall	267	-2.40	5.27			-0.10	0.18	-1004	428.51			-0.63	0.45		
East Wall	271	-2.40	5.27			-0.10	0.18	-858	430.15			-0.63	0.45		
North Wall: 9/25/9	16	-2.40	5.27			0.56	0.50	-931	423.79			2.34	1.09		
North Wall	36	1.72	5.78			-0.10	0.18	-1036	422.62			2.34	1.09		
North Wall	46	0.34	5.62			-0.10	0.18	-1017	422.83			3.33	1.23		
North Wall	65	0.34	5.62			-0.10	0.18	-1055	422.40			4.32	1.35		
North Wall	69	1.72	5.78			-0.10	0.18	-836	424.85			2.34	1.09		
North Wall	91	0.34	5.62			-0.10	0.18	-1368	418.86			3.33	1.23		
West Wall	374	-1.03	5.44			-0.10	0.18	-1083	422.08			1.35	0.93		
West Wall	385	3.09	5.94			-0.10	0.18	-1083	422.08			0.36	0.73		
West Wall:9/26/98	436	-2.40	5.27			-0.10	0.18	-1111	427.30			1.35	0.93		
West Wall	439	1.72	5.78			-0.10	0.18	-1111	427.30			-0.63	0.45		
West Wall	446	0.34	5.62			-0.10	0.18	-1295	425.20			-0.63	0.45		
West Wall: 9/25/9	450	-1.03	5.44			-0.10	0.18	-1140	421.44			-0.63	0.45		
West Wall: 9/26/9	451	3.09	5.94			-0.10	0.18	-1343	424.65			-0.63	0.45		
West Wall	455	-2.40	5.27			-0.10	0.18	-1198	426.30			1.35	0.93		
West Wall	458	-1.03	5.44			1.54	0.75	-1208	426.19			2.34	1.09		
West Wall: 9/25/9	467	-3.77	5.09			-0.10	0.18	-1150	421.33			-0.63	0.45		

APPENDIX D

SAMPLE LOT 3

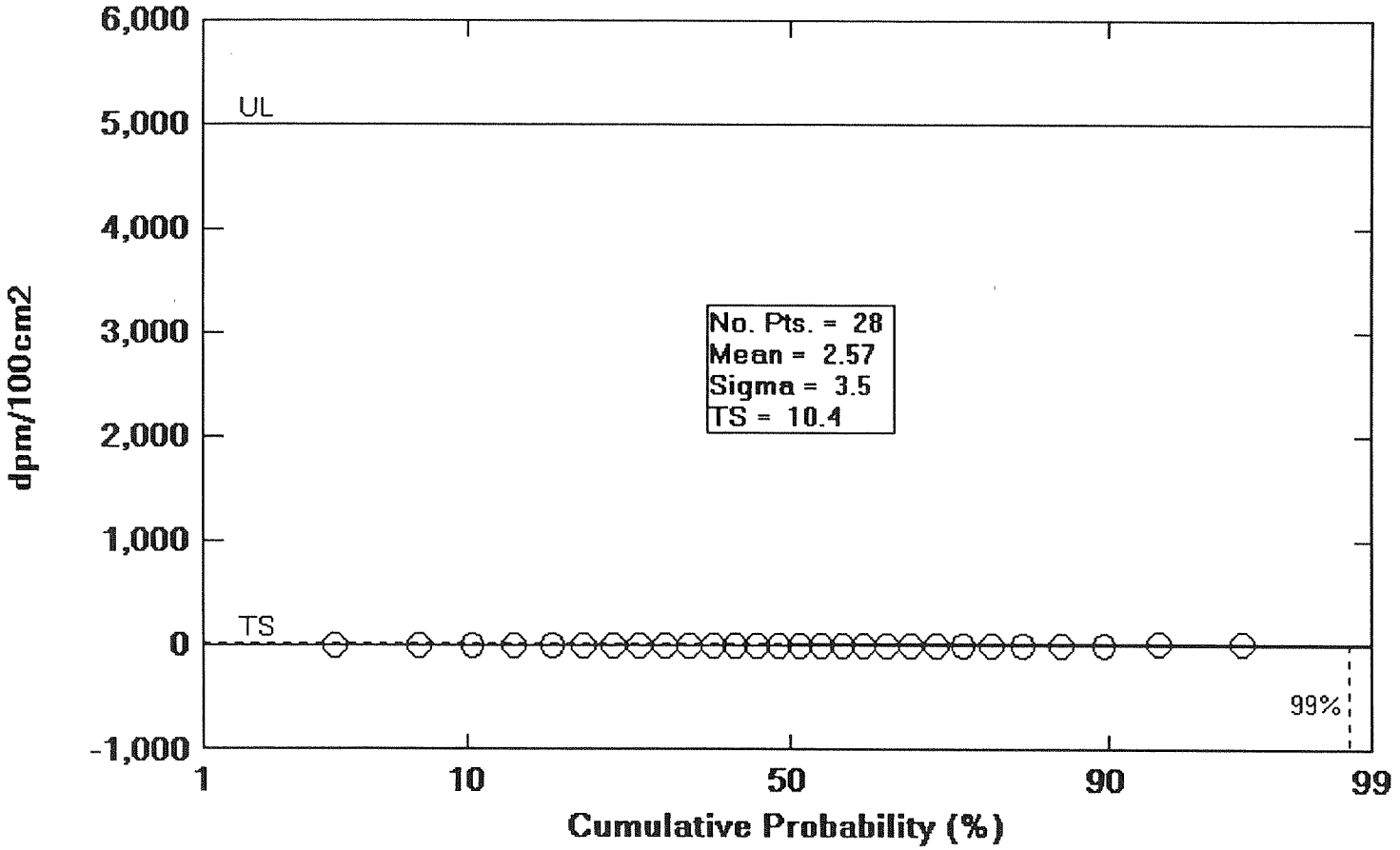
Quantitative Total Alpha Measurements, Lot 3: Rx Test



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

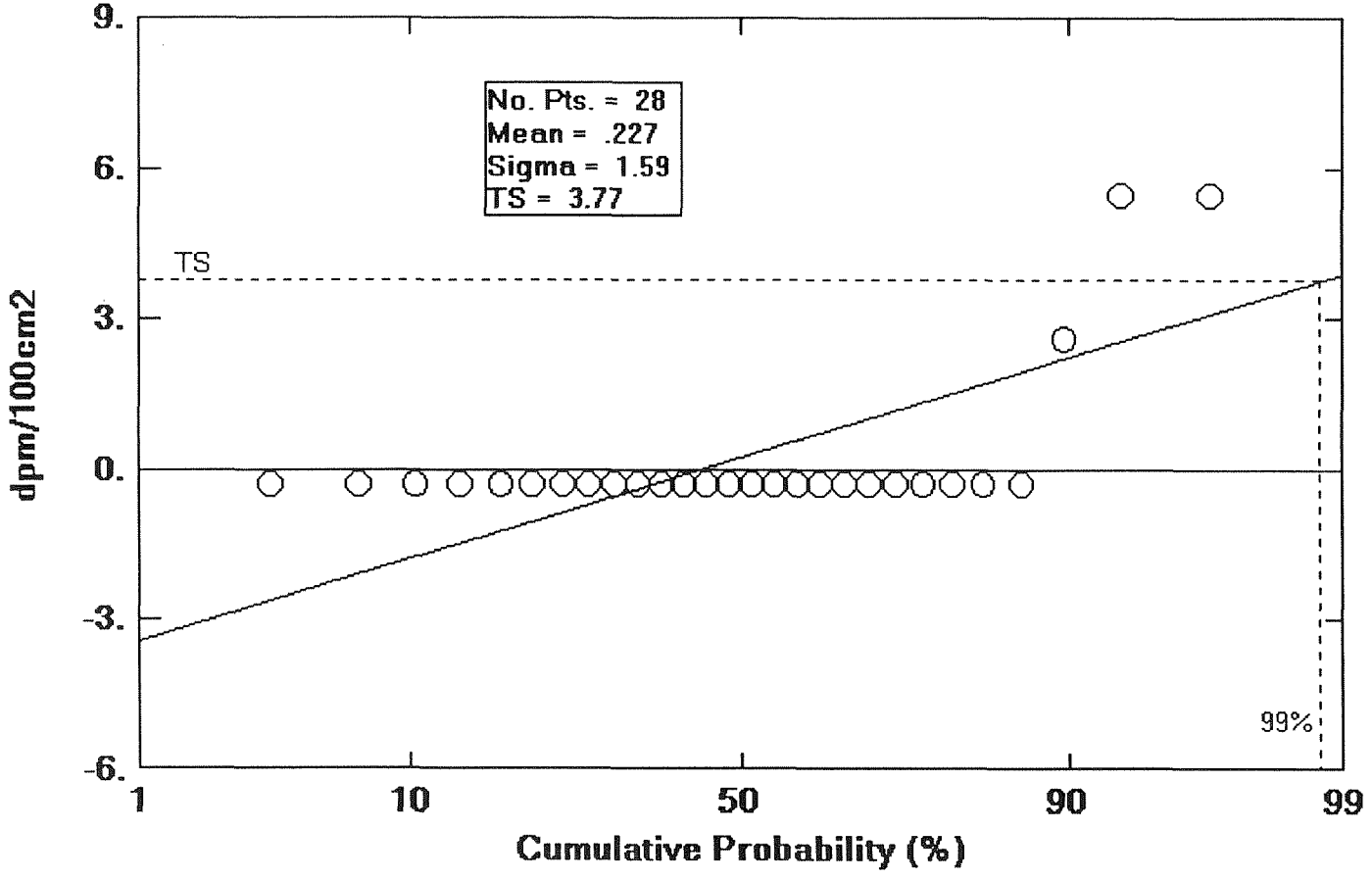
Quantitative Total Alpha Measurements, Lot 3: Rx Test



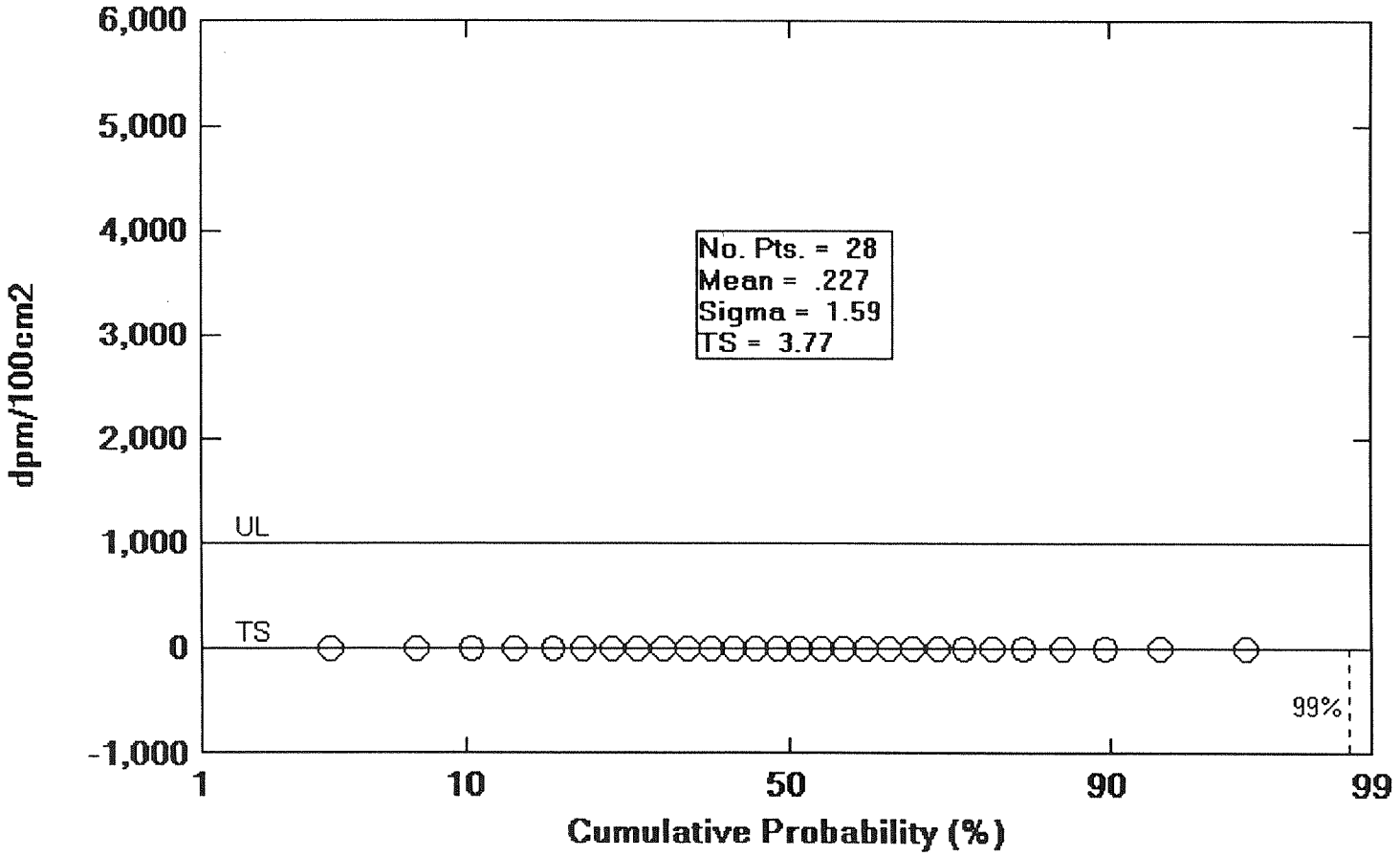
C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Removable Alpha Measurement, Lot 3: Reactor Test Chamber



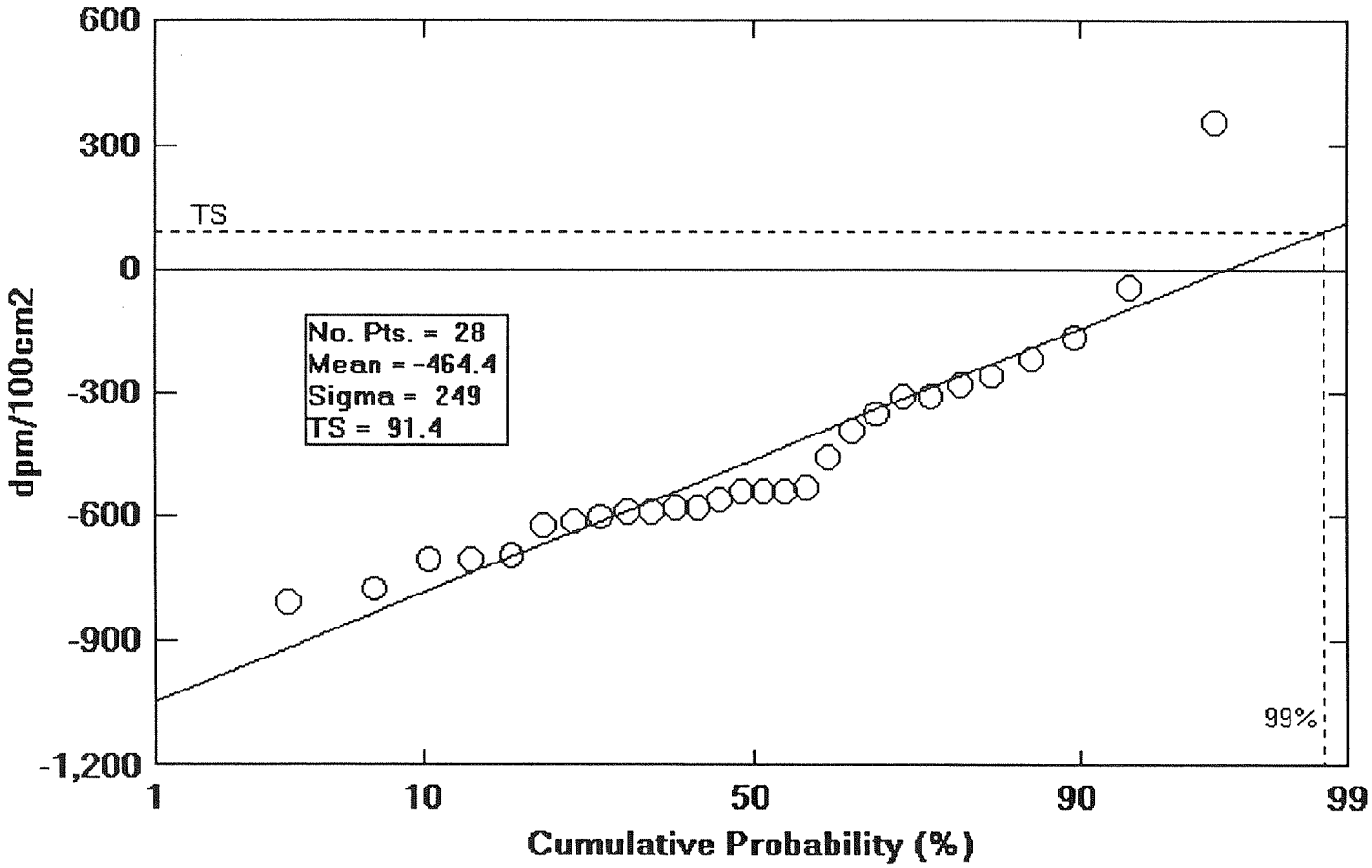
Removable Alpha Measurements, Lot 3: Reactor Test Chamber



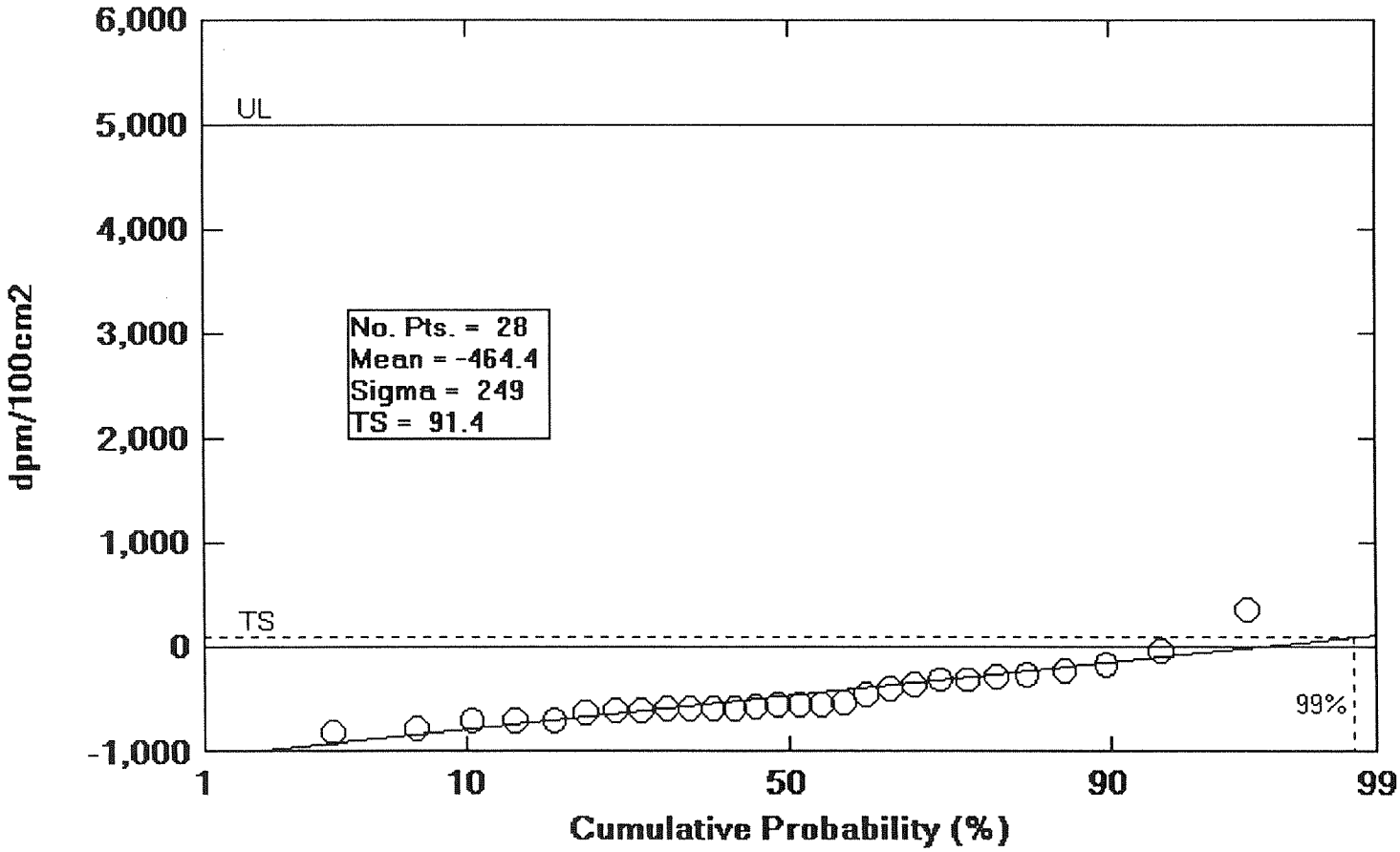
C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

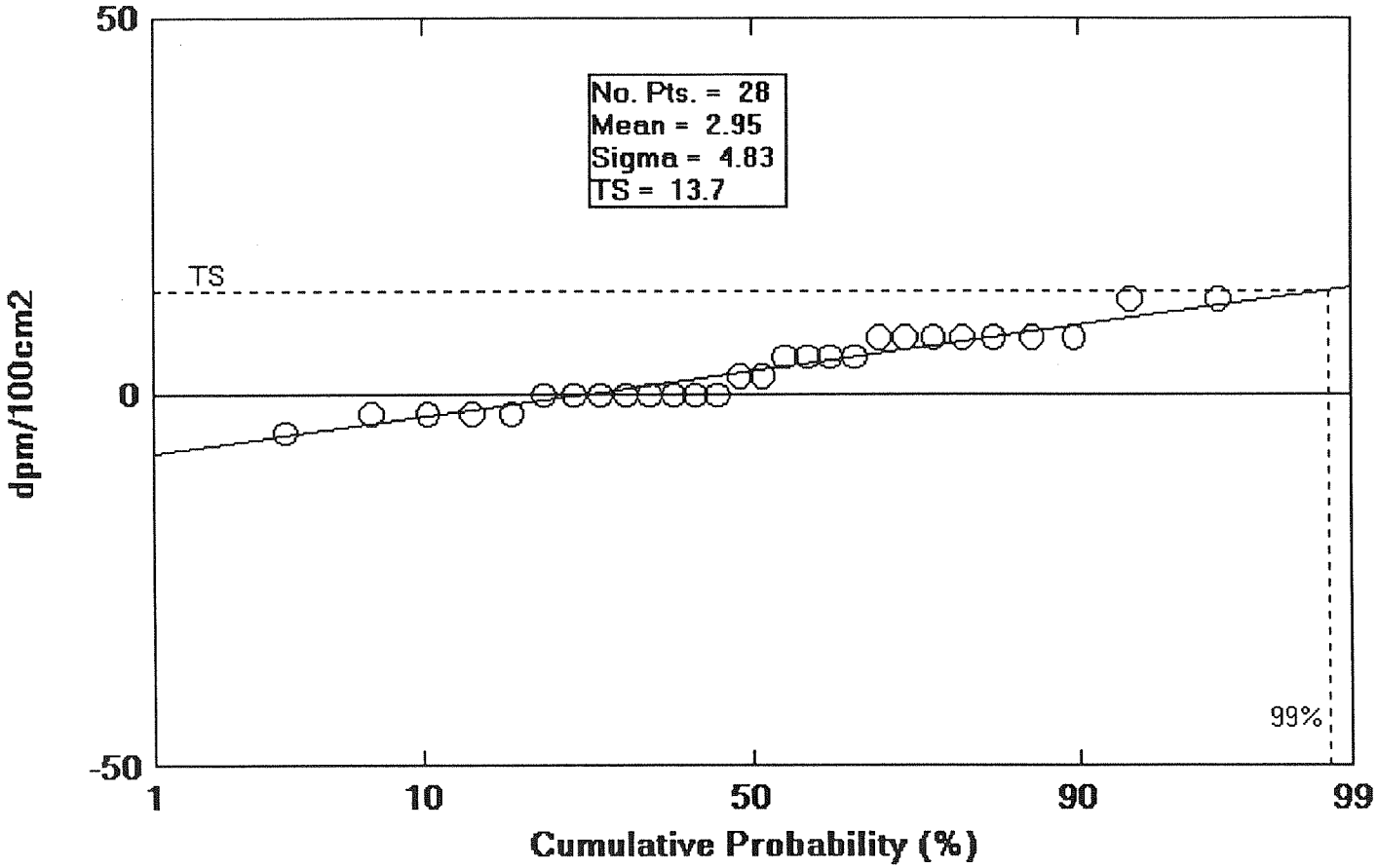
Total Quantitative Beta Measurements, Lot 3, Rx Test Chamber



Total Quantitative Beta Measurements, Lot 3, Rx Test Chamber



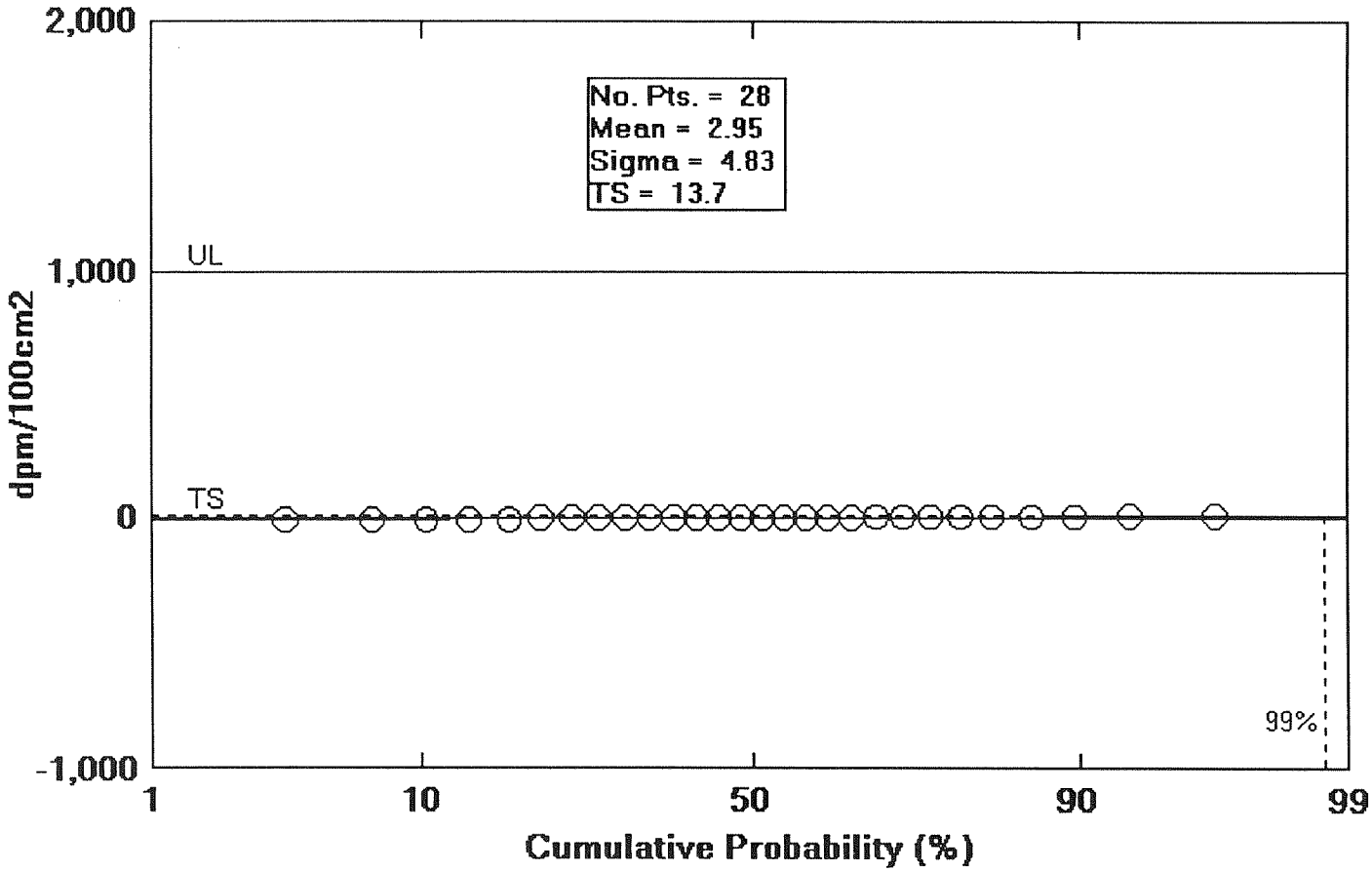
Removable Beta Measurements, Lot 3, Rx Test Chamber



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Removable Beta Measurements, Lot 3, Rx Test Chamber



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Lot 3
Reactor Test Chamber
Affected Area

TITLE: Final Survey T019 High Bay Rx Test Chamber
Data Description: Affected Area
Samples: 28

		5 MIN		1 MIN	5 MIN		1 MIN	1 MIN	ALPHA					BETA				
SAMPLE	GRID	ALPHA			BETA			GAM	INSTRUMENT			SMEAR		INSTRUMENT			SMEAR	
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT
N. Wall 9/17/98	13	6		0	367		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
North Wall	30	2		0	294		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
North Wall	31	5		1	276		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
North Wall	33	3		0	254		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
East Wall 9/17	47	2		0	273		1		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
East Wall	53	2		0	278		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
East Wall	66	2		0	275		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
East Wall	71	6		0	274		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
South Wall 9/17	81	2		0	305		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
South Wall	88	2		0	307		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
South Wall	92	3		0	264		3		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
South Wall	96	2		0	257		3		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall 9/17	113	5		0	281		7		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall	120	2		0	265		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall	124	2		0	280		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall	132	3		0	280		1		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall	139	3		0	264		4		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
West Wall	140	3		0	280		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Floor 9/17	148	2		0	276		5		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Floor	150	2		0	288		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Shield Block 9/17	HP1	11		0	328		1		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Shield Block	HP2	12		2	311		4		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Shield Block	HP3	5		0	302		7		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Shield Block	HP4	5		0	316		1		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Round Section 1	P2	2		0	302		2		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Round Section 1	P7	5		2	275		4		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Round Section 2	P15	1		0	298		0		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892
Round Section 2	P18	6		0	272		4		1.83	4.70	1.4	0.1	0.3455	332.3	10.3	5	2.1	0.3892

Lot 3
Reactor Test Chamber
Affected Area

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)				
		TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	TOTAL	STD DEV	MAX	REM	STD DEV
N. Wall 9/17/98	13	5.49	3.98			-0.29	0.11	357.4	463.90		7.45	1.04
North Wall	30	0.22	3.98			-0.29	0.11	-394.5	455.48		-0.26	0.79
North Wall	31	4.17	4.19			2.60	0.36	-579.9	453.38		7.45	1.04
North Wall	33	1.54	3.98			-0.29	0.11	-806.5	450.79		-0.26	0.79
East Wall 9/17	47	0.22	3.98			-0.29	0.11	-610.8	453.02		-2.83	0.69
East Wall	53	0.22	3.98			-0.29	0.11	-559.3	453.61		-0.26	0.79
East Wall	66	0.22	3.98			-0.29	0.11	-590.2	453.26		7.45	1.04
East Wall	71	5.49	3.98			-0.29	0.11	-600.5	453.14		-0.26	0.79
South Wall 9/17	81	0.22	3.98			-0.29	0.11	-281.2	456.76		-0.26	0.79
South Wall	88	0.22	3.98			-0.29	0.11	-260.6	456.99		7.45	1.04
South Wall	92	1.54	3.98			-0.29	0.11	-703.5	451.97		2.31	0.88
South Wall	96	0.22	3.98			-0.29	0.11	-775.6	451.15		2.31	0.88
West Wall 9/17	113	4.17	3.98			-0.29	0.11	-528.4	453.96		12.59	1.17
West Wall	120	0.22	3.98			-0.29	0.11	-693.2	452.09		-0.26	0.79
West Wall	124	0.22	3.98			-0.29	0.11	-538.7	453.84		7.45	1.04
West Wall	132	1.54	3.98			-0.29	0.11	-538.7	453.84		-2.83	0.69
West Wall	139	1.54	3.98			-0.29	0.11	-703.5	451.97		4.88	0.96
West Wall	140	1.54	3.98			-0.29	0.11	-538.7	453.84		7.45	1.04
Floor 9/17	148	0.22	3.98			-0.29	0.11	-579.9	453.38		7.45	1.04
Floor	150	0.22	3.98			-0.29	0.11	-456.3	454.78		-0.26	0.79
Shield Block 9/17	HP1	12.07	3.98			-0.29	0.11	-44.3	459.42		-2.83	0.69
Shield Block	HP2	13.38	4.39			5.50	0.50	-219.4	457.45		4.88	0.96
Shield Block	HP3	4.17	3.98			-0.29	0.11	-312.1	456.41		12.59	1.17
Shield Block	HP4	4.17	3.98			-0.29	0.11	-167.9	458.03		-2.83	0.69
Round Section 1	P2	0.22	3.98			-0.29	0.11	-312.1	456.41		-0.26	0.79
Round Section 1	P7	4.17	4.39			5.50	0.50	-590.2	453.26		4.88	0.96
Round Section 2	P15	-1.09	3.98			-0.29	0.11	-353.3	455.94		-5.40	0.56
Round Section 2	P18	5.49	3.98			-0.29	0.11	-621.1	452.91		4.88	0.96

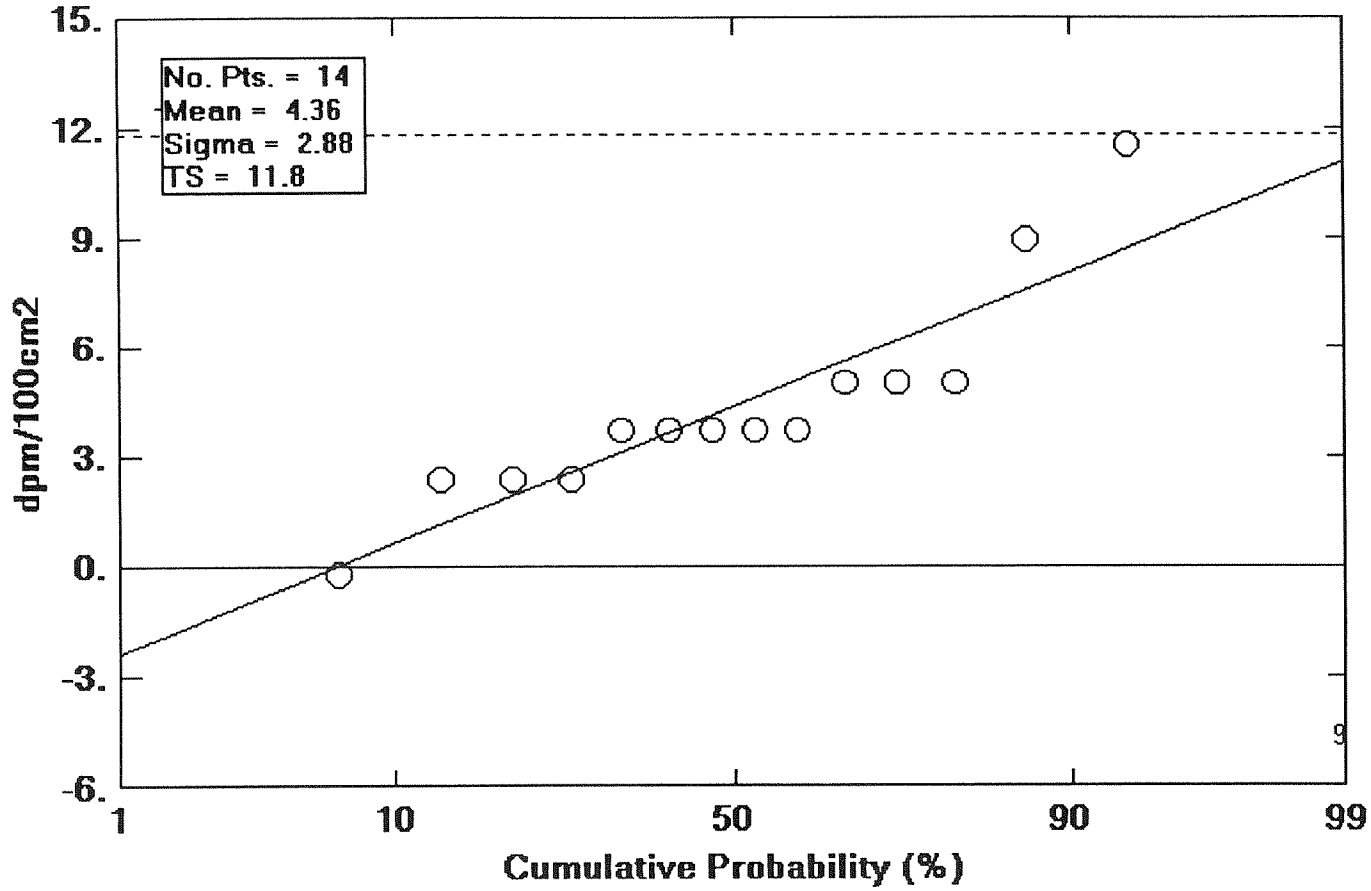
APPENDIX E

SAMPLE LOT 4

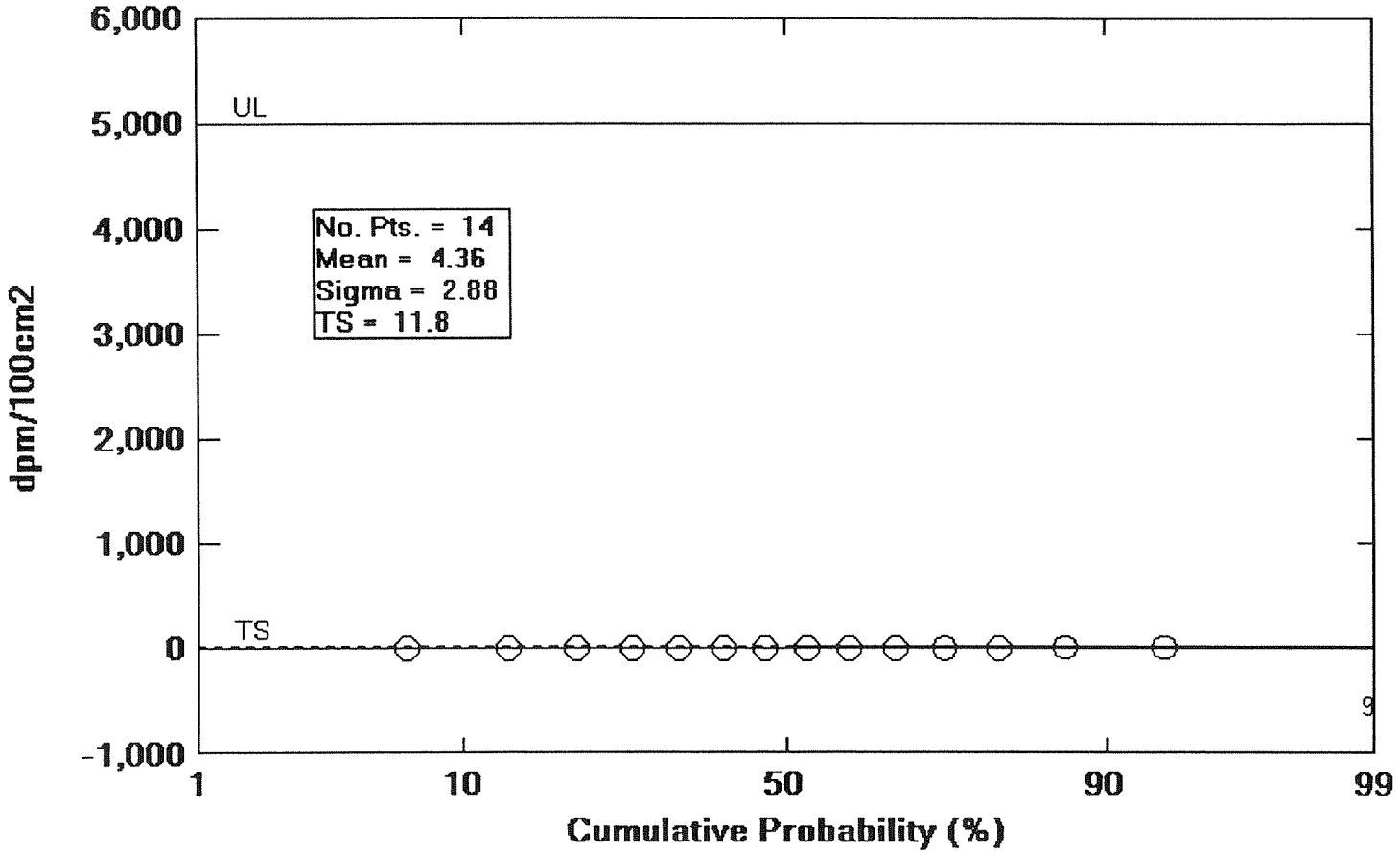
Lot 4
Room 109
Fuel Storage Vault

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA
		TOTAL	TD DE	MAX	TD DE	REM	TD DE	TOTAL	TD DE	A		REM	STD DEV	TOTAL
N. Wall 9/15/98	2	3.71	4.08			0.31	0.36	540.0	466.78			2.30	1.24	
N. Wall	14	5.01	4.29			-0.03	0.11	583.2	467.28			2.30	1.24	
N. Wall	19	3.71	4.08			0.31	0.36	453.6	465.78			1.13	1.04	
E. Wall	24	3.71	4.08			0.31	0.36	583.2	467.28			-0.43	0.69	
S. Wall	43	5.01	4.29			-0.03	0.11	507.6	466.40			0.74	0.96	
S. Wall	48	2.40	3.87			-0.03	0.11	745.2	469.15			-0.04	0.79	
S. Wall	53	3.71	4.08			-0.03	0.11	572.4	467.15			-0.04	0.79	
W. Wall	63	2.40	3.87			-0.03	0.11	0.0	460.49			0.35	0.88	
Floor	F66	11.53	5.19			3.42	1.10	680.4	468.40			0.35	0.88	-0.11
Floor	F77	8.92	4.85			1.35	0.70	874.8	470.64			1.13	1.04	2.49
Ceiling	C86	-0.21	3.40			0.66	0.50	-32.4	460.11			-0.04	0.79	
Ceiling	C97	2.40	3.87			-0.03	0.11	334.8	464.40			0.35	0.88	
Ceiling	C100	5.01	4.29			0.31	0.36	0.0	460.49			-0.04	0.79	
Floor	F80	3.71	4.08			-0.03	0.11	961.2	471.63			0.35	0.88	2.21

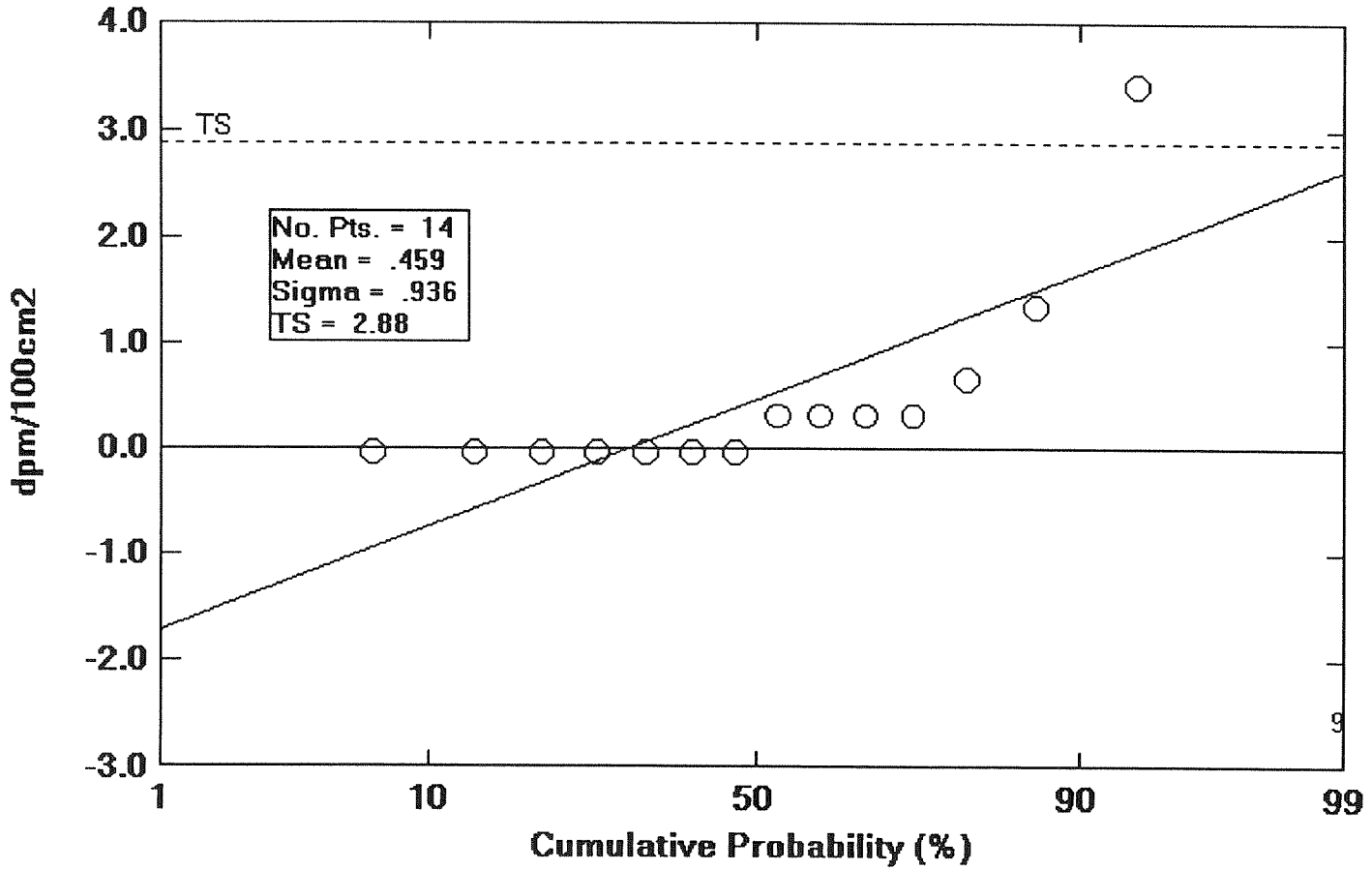
Quantitative Total Alpha Measurements, Lot 4: Room 109



Quantitative Total Alpha Measurements, Lot 4: Room 109



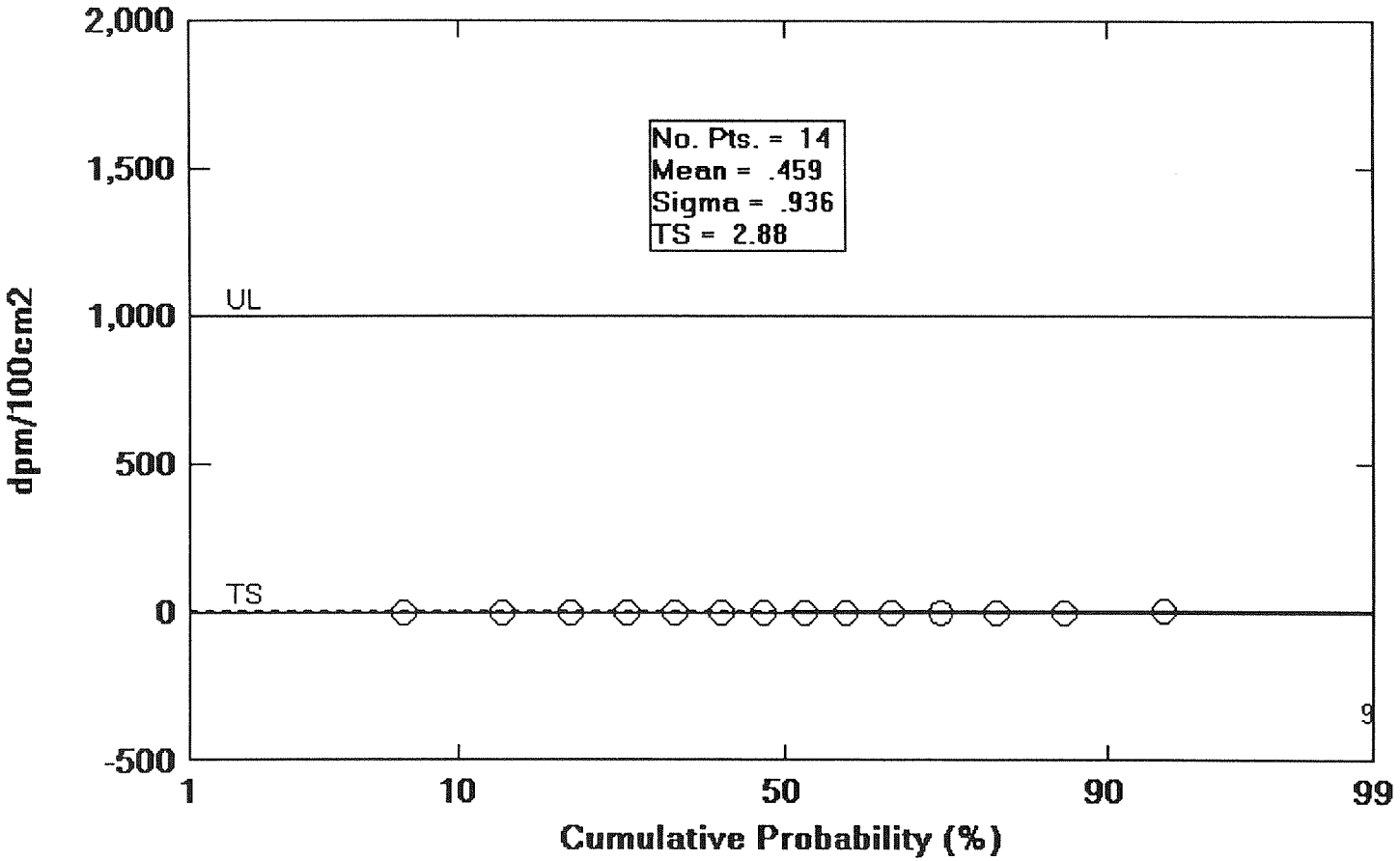
Removable Alpha Measurements, Lot 4: Room 109



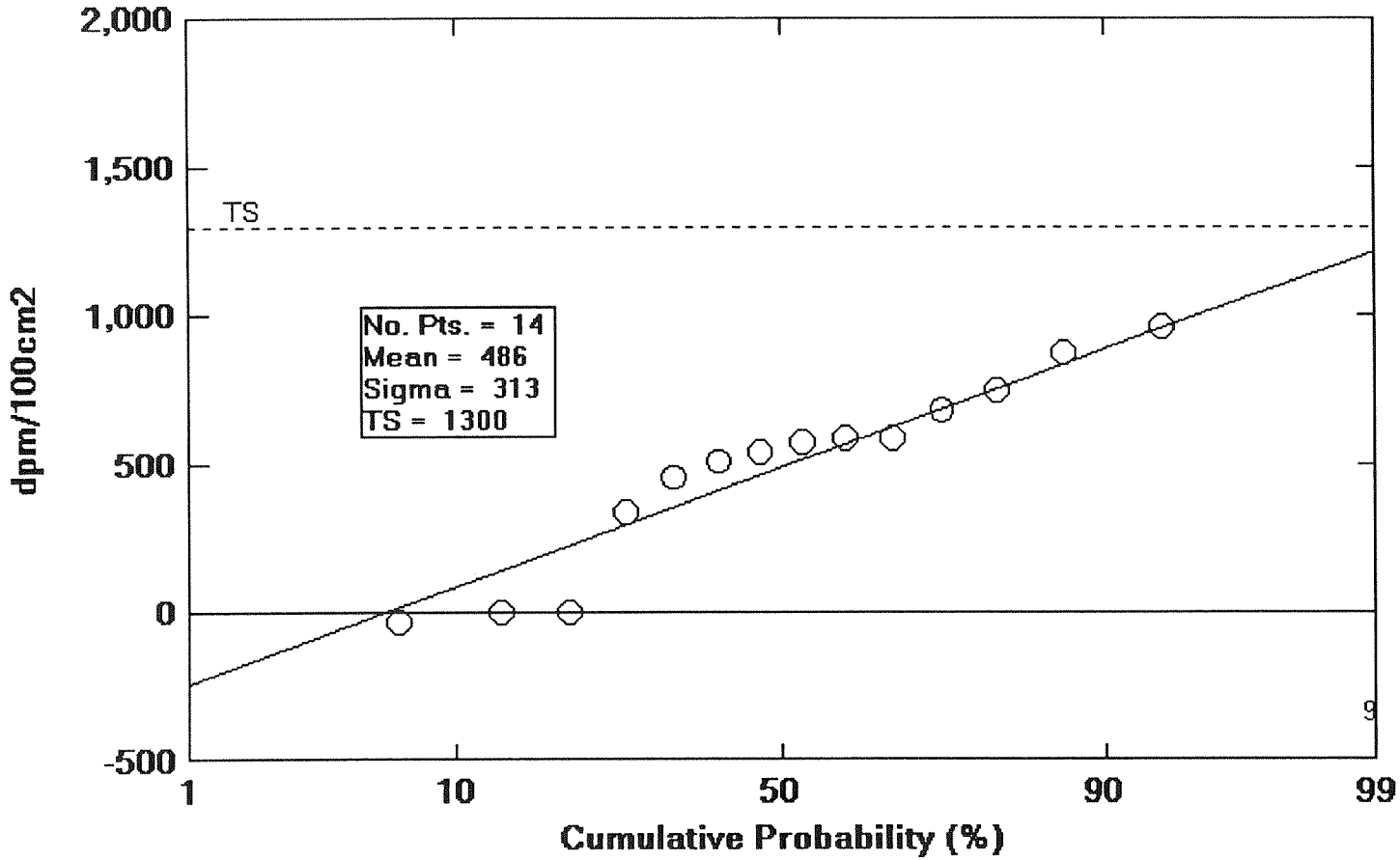
C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Removable Alpha Measurements, Lot 4: Room 109

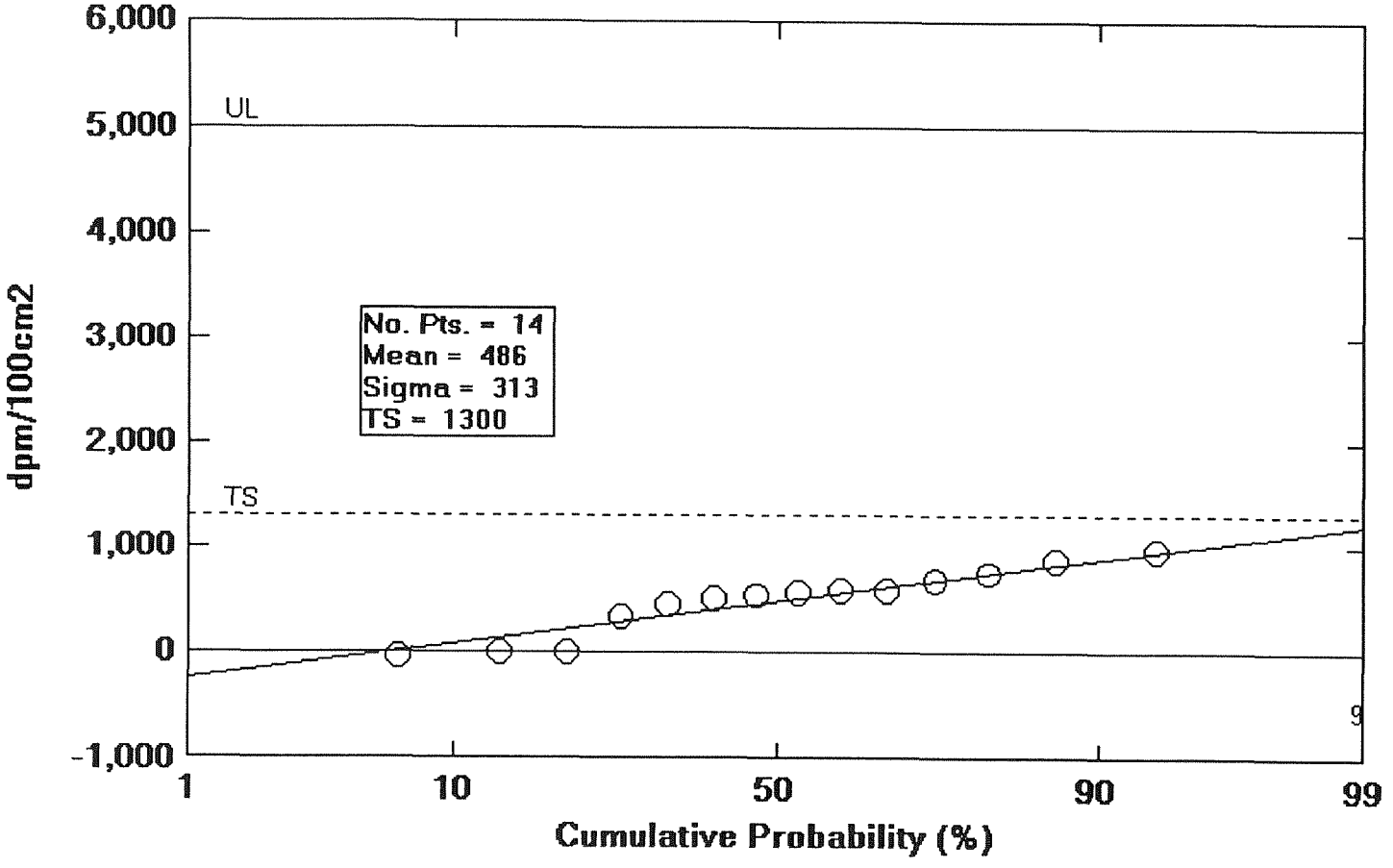


Quantitative Total Beta Measurements, Lot 4: Room 109



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP 06-09-99

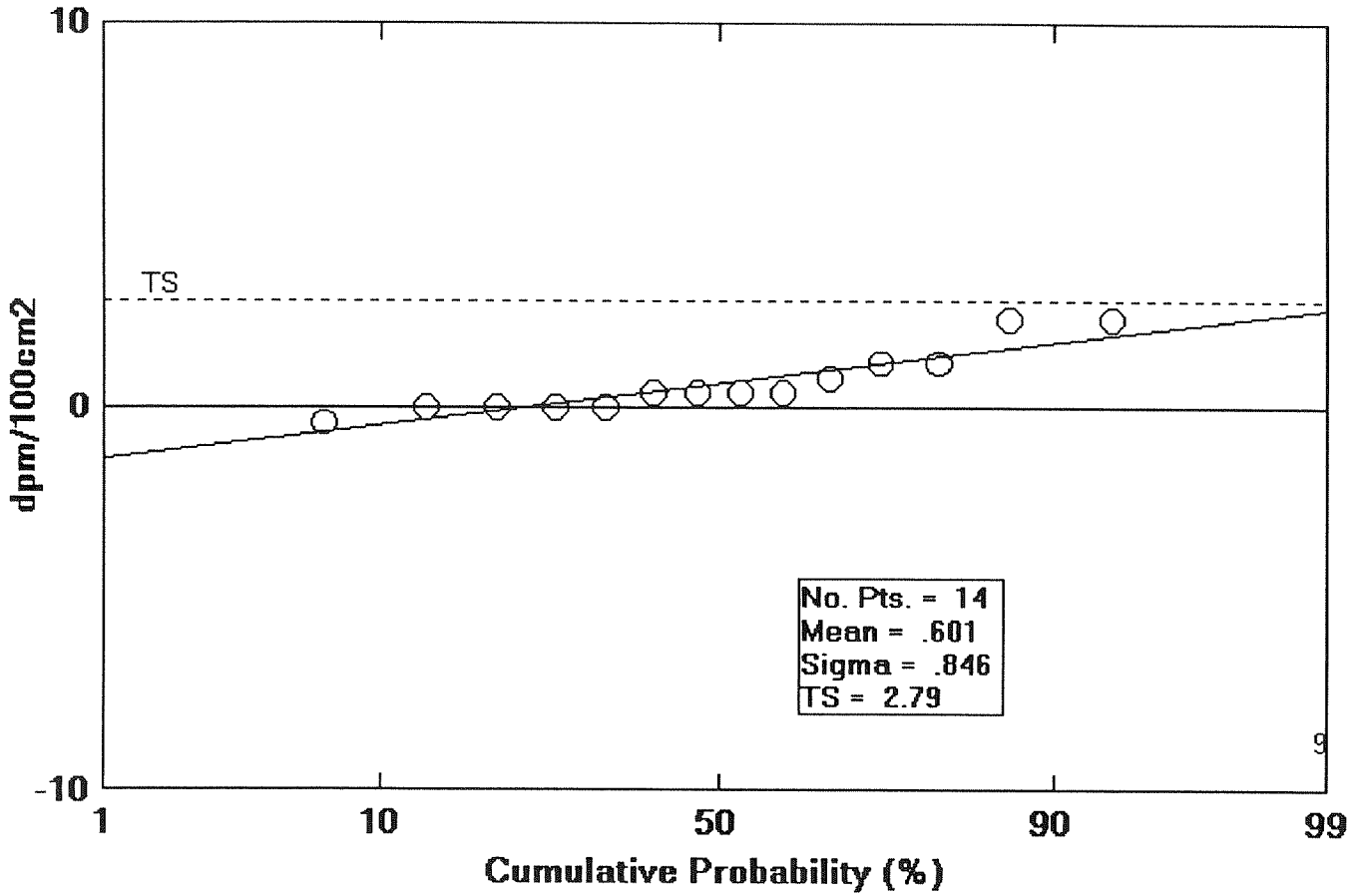
Quantitative Total Beta Measurements, Lot 4: Room 109



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

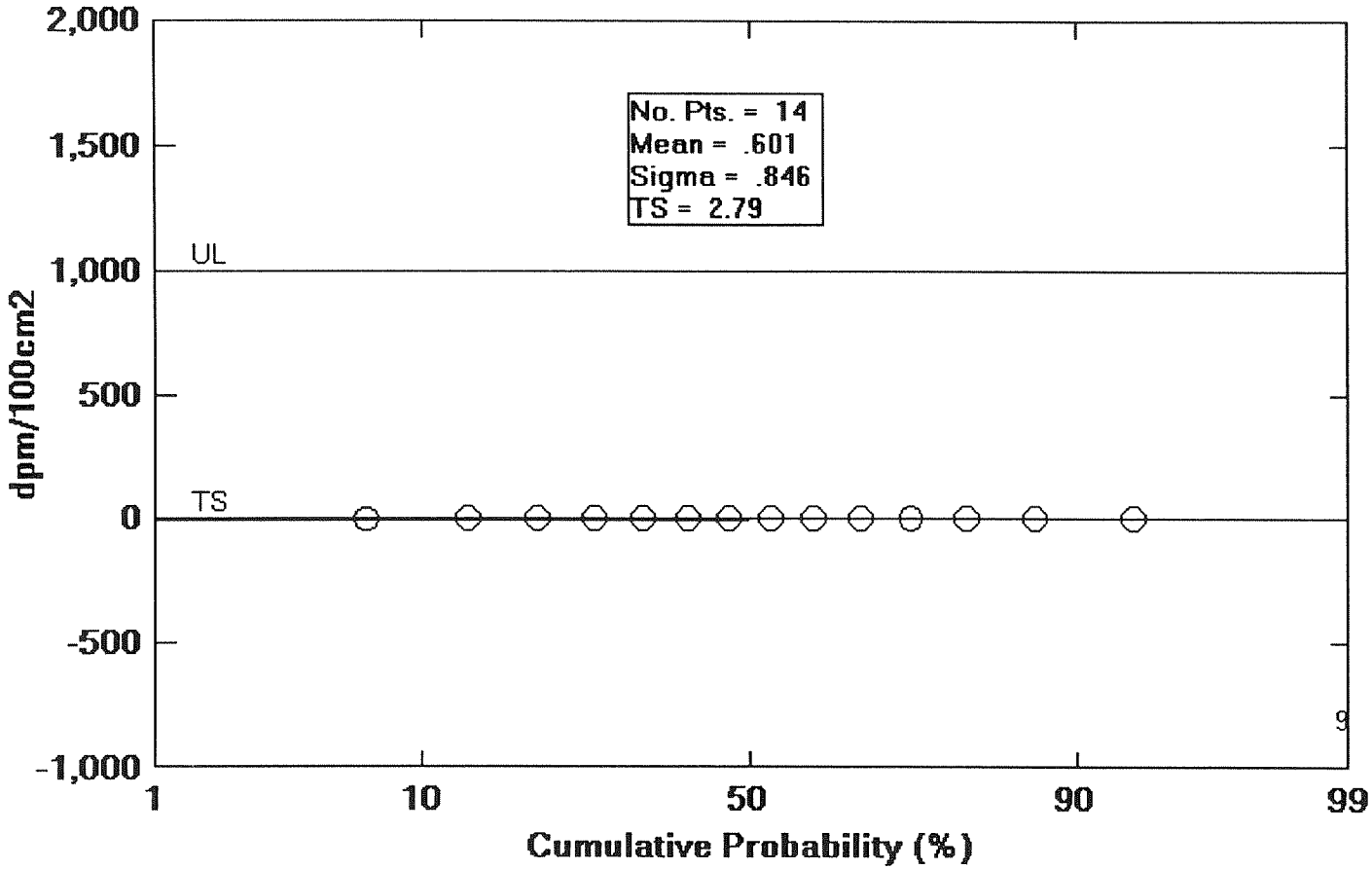
Removable Beta Measurements, Lot 4: Room 109



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Removable Beta Measurements, Lot 4: Room 109



C:\MYDOCU~1\EXCEL\64GAMA~1.CMP

06-09-99

Lot 4
Room 109
Fuel Storage Vault

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA
		TOTAL	TD DE	MAX	TD DE	REM	TD DE	TOTAL	TD DE	A		REM	STD DEV	TOTAL
N. Wall 9/15/98	2	3.71	4.08			0.31	0.36	540.0	466.78			2.30	1.24	
N. Wall	14	5.01	4.29			-0.03	0.11	583.2	467.28			2.30	1.24	
N. Wall	19	3.71	4.08			0.31	0.36	453.6	465.78			1.13	1.04	
E. Wall	24	3.71	4.08			0.31	0.36	583.2	467.28			-0.43	0.69	
S. Wall	43	5.01	4.29			-0.03	0.11	507.6	466.40			0.74	0.96	
S. Wall	48	2.40	3.87			-0.03	0.11	745.2	469.15			-0.04	0.79	
S. Wall	53	3.71	4.08			-0.03	0.11	572.4	467.15			-0.04	0.79	
W. Wall	63	2.40	3.87			-0.03	0.11	0.0	460.49			0.35	0.88	
Floor	F66	11.53	5.19			3.42	1.10	680.4	468.40			0.35	0.88	-0.11
Floor	F77	8.92	4.85			1.35	0.70	874.8	470.64			1.13	1.04	2.49
Ceiling	C86	-0.21	3.40			0.66	0.50	-32.4	460.11			-0.04	0.79	
Ceiling	C97	2.40	3.87			-0.03	0.11	334.8	464.40			0.35	0.88	
Ceiling	C100	5.01	4.29			0.31	0.36	0.0	460.49			-0.04	0.79	
Floor	F80	3.71	4.08			-0.03	0.11	961.2	471.63			0.35	0.88	2.21