DOE/CD-ETEC-4064

DRAFT DOCKET

FOR THE RELEASE OF FACILITY 4064 AT THE FORMER ENERGY TECHNOLOGY ENGINEERING CENTER

September 1999

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

LR-66332

The Boeing Company
Rocketdyne Propulsion & Power
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922

BOEING

September 28, 1999
In reply refer to 99RC-5126

Mr. Michael E. Lopez
US Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, CA 94612-5208

Subject: Additional Information to be inserted in the B/4064 Draft Certification Docket
Reference: Letter from M. Lee to M. Lopez, 99RC-5029, 24 September 1999

Dear Mr. Lopez:

The referenced letter was the submittal letter for the Draft Docket for Facility 4064, which was located in Area IV of Rocketdyne's Santa Susana Field Laboratory. The Radiological Assessment of the Building 4064 Fenced-In Yard was inadvertently left out of the docket. The Assessment report, Rocketdyne document number N704SRR990035, is enclosed with this letter. This report is a part of the Exhibit V, "Final Documentation and Radiological Survey of Facility 4064 after decontamination and decommissioning", in the docket, and should be inserted after SSWA-ZR-0001, "Final Radiological Survey Report of Building 064 Interior", and before N704SRR990031, "Final Decontamination and Radiological Survey of the Building T064 Side Yard".

We apologize for the inconvenience.

Should you have any questions concerning this transmittal, please contact the undersigned at (818) 586-5283.

Sincerely,

Majelle Lee

Majelle Lee
Program Manager
Environmental Programs

ML:sns

Encl.: N704SRR99035, "Radiological Assessment of the Building T064 Fenced-In Yard", 2 copies

cc: (w/attach) Office of Scientific and Technical Information, Department of Energy, 175 Oak Ridge Turnpike, P.O. Box 62, Oak Ridge, TN 37831

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DATE: September 28, 1999 **D/092 OUTGOING** **LAND POWER PROGRAMS**

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96212	12600	60	60	New	N704SRR990035

PROGRAM TITLE
Assessment Surveys and Release of Equipment from Building T064

DOCUMENT TITLE
Radiological Assessment of the Building T064 Fenced-In Yard

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Safety Review Report

KEY NOUNS SSFL, radioactivity, survey, contamination measurements

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Name	DEPT	MAIL ADDR
D. W. Kneff	642	NA02
R. J. Tuttle 931222	641	T100
G. Subbaraman 12/23/93	030	T038

IR&D PROGRAM? YES ☐ NO ☐
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ABSTRACT

A radiological survey was performed to assess the residual radioactivity in the 6580-ft^2 area of fenced-in yard surrounding Building T064 at the SSFL. Data were obtained by alpha and beta counting and gamma exposure rate measurements, and by laboratory analyses of surface material for radioactivity. Results show that residual radioactivity in the area is well below acceptance limits. The results also indicate consistency between the present data and data obtained from previous surveys of the fenced-in yard.

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SUMMARY

PURPOSE. This Safety Review Report documents findings from a radiological assessment survey performed in the fenced-in portions of Building T064, located in Rockwell International's Santa Susana Field Laboratory (SSFL). The survey is part of an ongoing U.S. Department of Energy (DOE) environmental restoration program to decontaminate and decommission (D&D) SSFL facilities and work areas. The survey is intended to provide data on previously known or suspected radiological conditions and to assist in subsequent D&D operations.

BACKGROUND. Since the late 1950s, Building T064 and its fenced-in yard were utilized by Rockwell and its predecessor firms in support of a number of the U.S. Government's nuclear programs. In the early 1960s, a contamination incident involving radioactive mixed fission products from a reactor fuel-element shipping cask occurred in an area near the eastern portion of the fenced-in yard. The area was cleaned up in 1963. A general gamma survey in 1988 indicated contamination within the eastern fence line and in an adjacent area outside the fence. That area was cleaned up in 1989 by removing affected top soil, and it was concluded from the results of a subsequent 1989 survey that the remediated area is suitable for release for unrestricted use. The present work was performed to assess the entire fenced-in yard area for unrestricted release.

WORK PERFORMED. The 6580 ft^2 area comprising the fenced-in yard was gridded and surveyed for residual alpha-, beta-, and gamma-emitting radionuclides. Top-layer materials (asphalt and soil) were collected from randomly selected locations for analysis to identify and quantify specific radionuclides. The survey data and soil data have been analyzed and compared with acceptance limits and with previous survey data from the same location.

STATUS. The fenced-in yard continues to be unoccupied and unused for radiological or other purposes. Building T064 proper has undergone remediation and final survey.

CONCLUSION. Results of the present assessment survey indicate that the fenced-in yard is suitable for release for unrestricted use.

1. INTRODUCTION

Since the 1950s, Rockwell International and its predecessor companies have performed nuclear activities sponsored by the U. S. Department of Energy (DOE) and its predecessor agencies at the Santa Susana Field Laboratory (SSFL). Several facilities were constructed and operated at the SSFL to support programs involving nuclear materials. These programs have ended, but some of the facilities and work areas contain residual radioactive material. These facilities and areas are currently undergoing decontamination and decommissioning (D&D) to prepare them for future release for unrestricted use.

The D&D program is being performed under an established environmental restoration plan.(1) Included in this plan are surveys to assess the radiological conditions of the affected facilities and work areas. One such facility, designated Building T064, and including its surrounding yards, is undergoing environmental restoration and related radiological assessments. This facility was used previously to receive and temporarily store Source and Special Nuclear Materials, and more recently to store low-level radioactive waste waiting shipment for offsite disposal.

This report presents the findings from a radiological survey performed in the fenced-in portion of the yard immediately surrounding Building T064. The survey included performance of a variety of radioactivity measurements on the 6580 ft^2 area comprising the fenced-in yard, interpretation of the data, and data comparison against established acceptance limits and other data obtained from previous surveys.(2,3) The present report covers the in-situ alpha, beta, and gamma activity measurements, plus the laboratory analyses of soil and asphalt samples extracted from the site.

This report is organized as follows: Section 2 summarizes the background on the location, operating history, and previous surveys of the fenced-in yard; details may be found in References 2 and 3. Section 3 describes the procedures used for the survey and data reduction. Section 4 discusses the results, and Section 5 presents the conclusions of the survey. Appendix A includes tabulated data from the surveys, and Appendix B consists of a list of survey records resulting from this survey and maintained in the Building T064 D&D files.

2. BACKGROUND

2.1 LOCATION

Building T064 is located within Rockwell International'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. A plan view of Building T064, formerly known as the "Source and Special Nuclear Material Storage Building," and its adjoining areas is shown in Figure 1. As indicated, T064 is totally fenced in with a chain-link fence. The area addressed in this report corresponds to about 6580 ft^2 of mostly asphaltic pavement and concrete dock surfaces, all inside the fence and entirely surrounding the building proper.

The formal reference to the location of Building T064 and the fenced-in yard, based on topographic maps of the U. S. Geological Survey (USGS), is Township T2N, Range R17W, Section 30, Calabasas Quadrangle. Figure 2 shows relevant portions of a 1967 edition of the USGS topographic map of the Calabasas Quadrangle where SSFL is located. A callout of the building location has been added.

Access to the fenced-in yard and the building is through two gates, one in the northeast corner, and the other in the southeast corner. These gates are also indicated in Figure 1.

Additional descriptions of the building, its surroundings, and topography, including both photographs and drawings, are provided in Refs. 2 and 3.

2.2 OPERATING HISTORY

Building T064 has been operated by Rockwell International and its predecessor companies since 1958 in support of the U.S. Department of Energy (DOE) and its predecessor agencies' nuclear programs. It was used actively through the mid-1970s for the storage of packaged items of Source Material (normal uranium, depleted uranium, and thorium) and Special Nuclear Material (enriched uranium, plutonium, and U-233).[2] The plutonium was temporarily stored in shipping containers prior to its shipment to its final destination. Since nuclear material was only stored there, there was no processing equipment within the building. Most of the major DOE nuclear projects have ended, and most of the material was sent to other DOE sites by 1980. Since then,

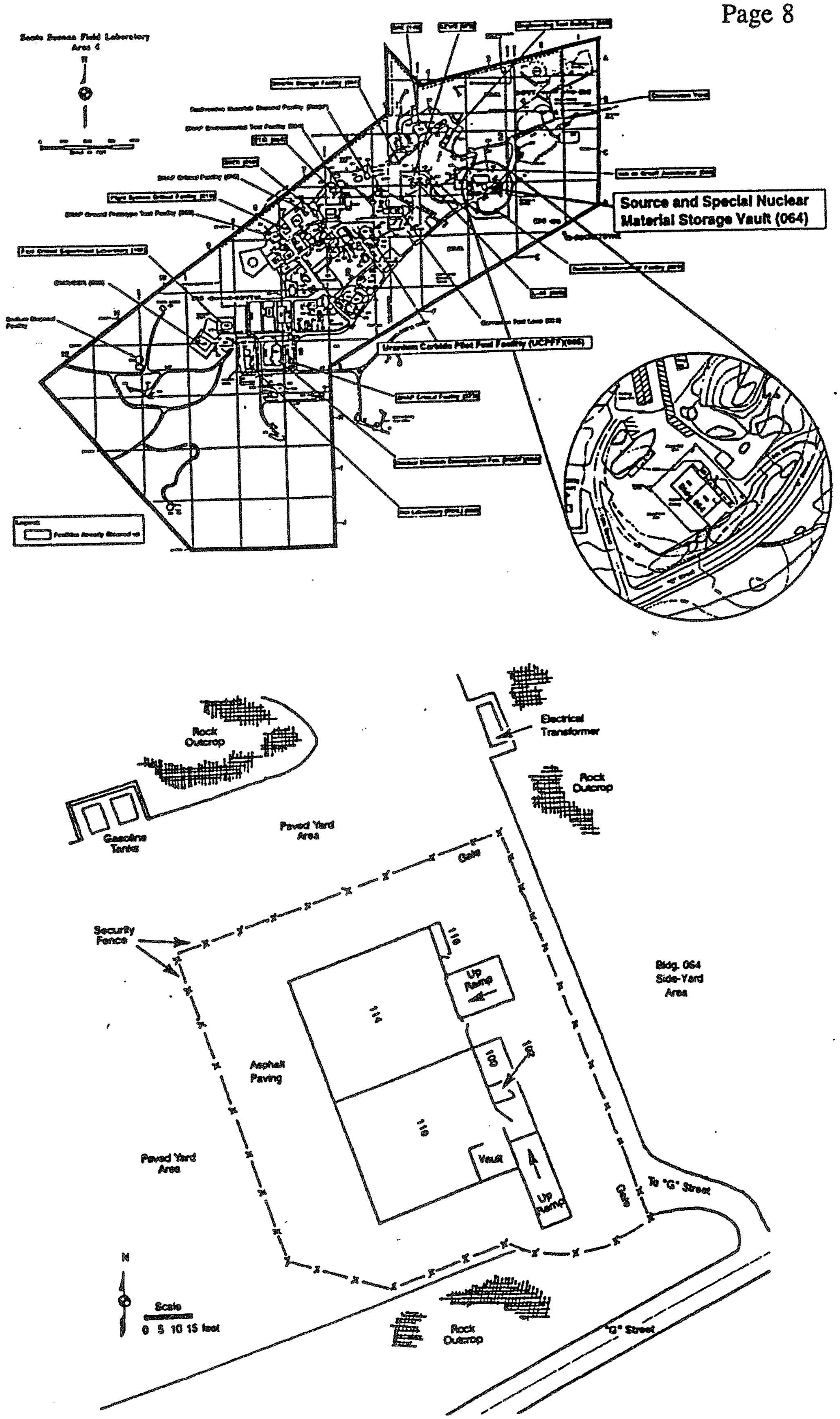

Figure 1. **Source and Special Nuclear Material Storage Building, T064**

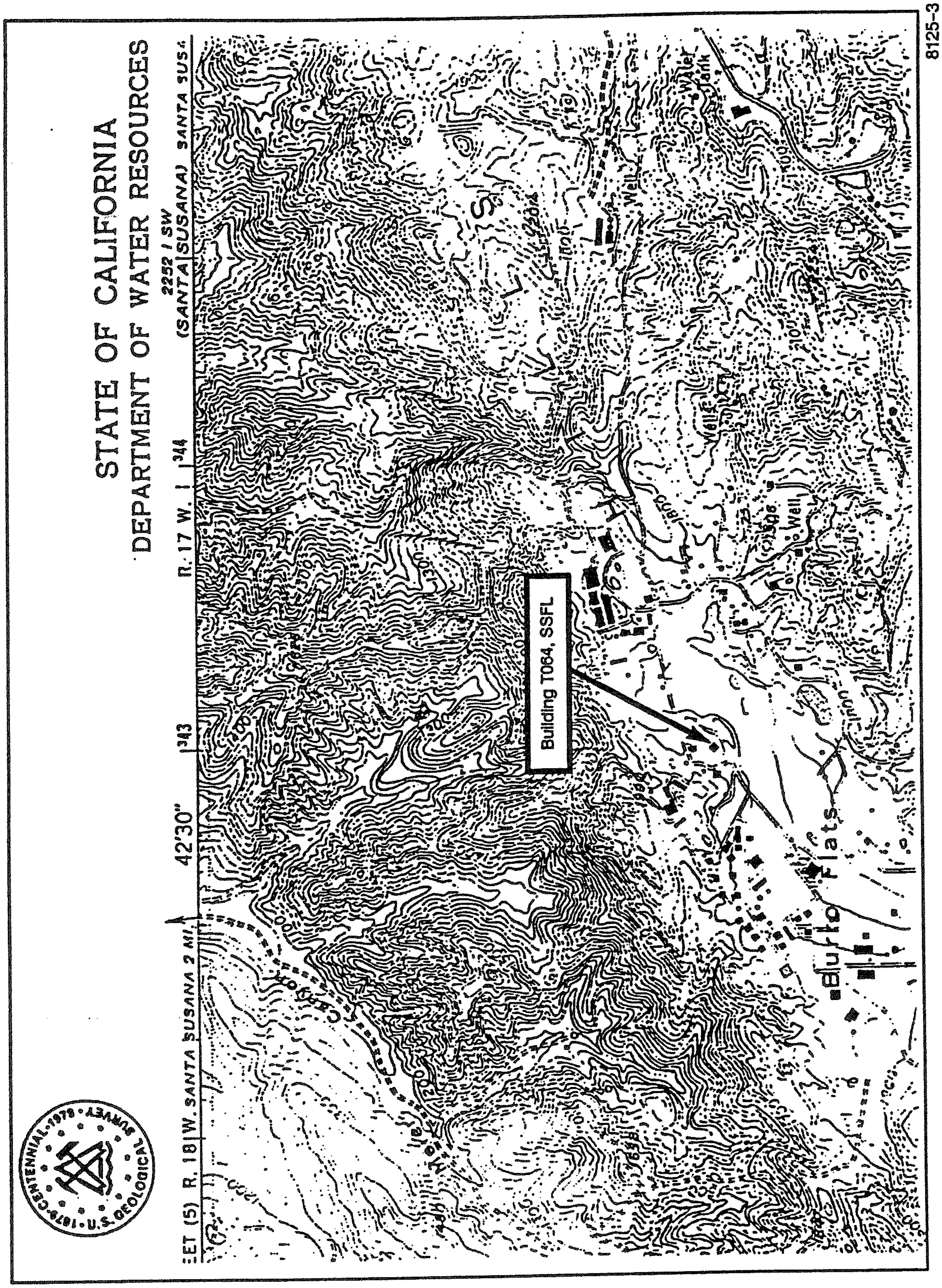

Figure 2. USGS Topographic Map of Portions of the Calabasas Quadrangle, with the SSFL in the Lower Left

the building has been used to store nonradioactive DOE components and supplies and low-level radioactive waste. The building was empty at the time of the 1992 fenced-in yard survey, with the exception of some limited uncontaminated debris and office furniture, and remains empty.

The fenced-in yard surrounding Building T064 was used on occasion for storing recoverable uranium scrap, irradiated fuel elements, and miscellaneous radioactive wastes. Spent fuel shipping casks and shipping trailers were also stored just outside the western fence line.

During the early 1960s a special lead-pig cask containing irradiated "Seawolf" fuel pins was stored in the east side of the fenced-in yard. The irradiated fuel pins had probably been transferred to the cask in a fuel storage pool at the site of their origin. Before shipping to the SSFL, the drain plug at the bottom of the cask should have been removed to drain the radioactive water, but was not. The shipping cask was stored in the fenced-in yard while still containing water. The drain plug eventually rusted out, and water leaked out to the yard surface. This water contained mixed fission products which contaminated the area. Following the identification of this leak in February 1963,[(4)] a large area (about 700 ft^2) of top soil was removed and transferred to the RMDF (Radioactive Materials Disposal Facility) for disposal. Radiation levels were then measured to range between 0.04 mrad/h (background) and 0.5 mrad/h, which was considered acceptable for the soil at that time. The yard was subsequently back-filled and repaved for continued use.

Additional details documenting this operating history are provided in Refs. 2 and 3.

2.3 RECENT RADIOLOGICAL SURVEYS AND REMEDIATION

A broad radiological survey plan was established in 1985 for all areas at the SSFL that were involved in operations with radioactive materials.[(5)] Building T064 and a surrounding 2-acre area were included in the survey plan, and a gamma activity survey was performed in 1988.

The results of the 1988 survey were used to identify a contaminated area of approximately 4000 ft^2, bordering and outside of the Building T064 eastern fence, as shown in Figure 3. Gamma exposure rates were measured to be higher than background in this area, and soil analysis for radionuclides showed ^{137}Cs concentrations higher than normal. Details are provided in Ref. 2. This broad-area survey did not identify any radiological contamination in the rest of the fenced-in yard.

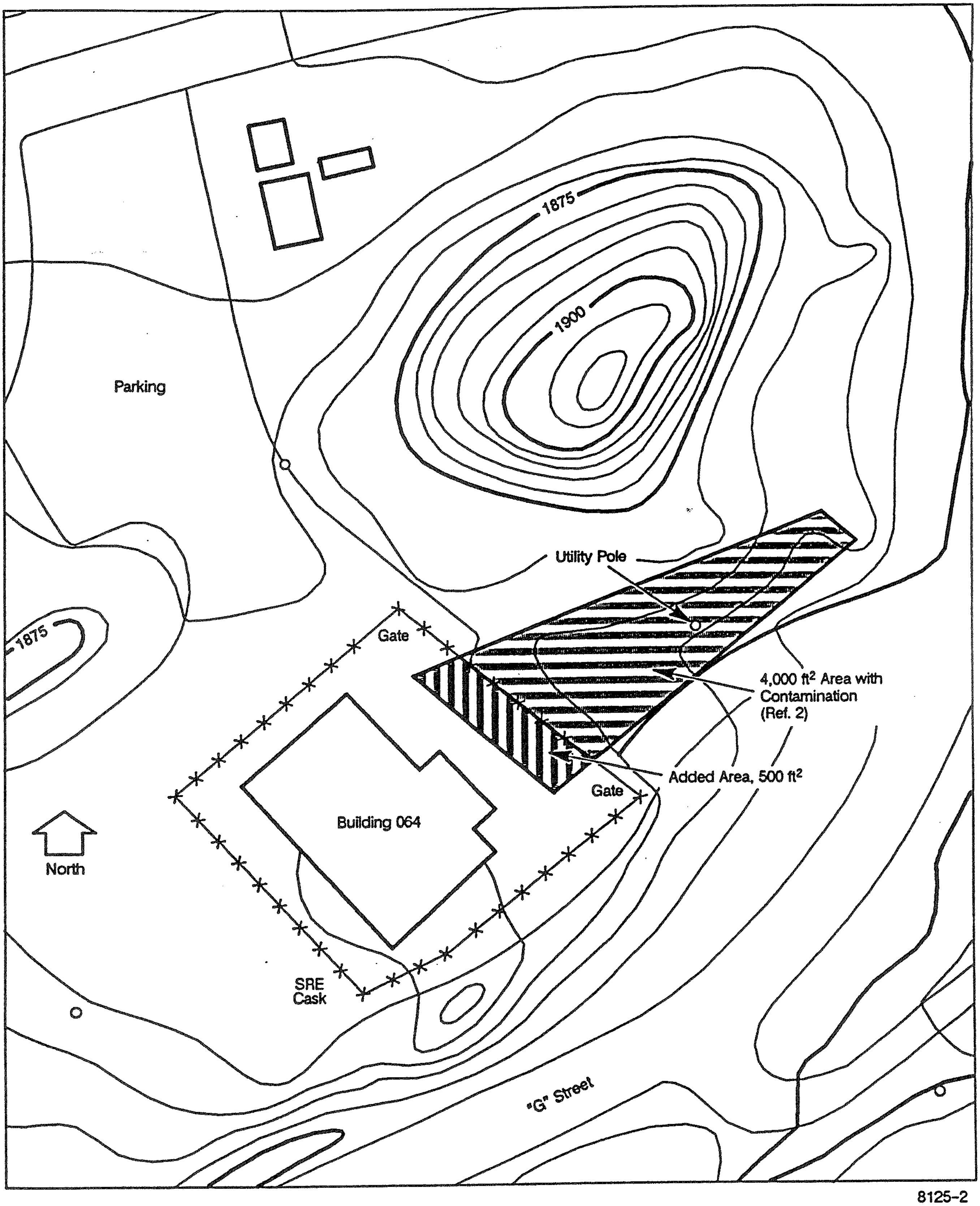

Figure 3. Building T064 Side Yard

The 1988 survey report recommended remedial action in the 4000-ft^2 area. Accordingly, in 1989, the top layer material was removed from contaminated sections of the 4000-ft^2 area plus an additional 500 ft^2 area inside and bordering the east fence, as shown in Figure 3. This 4500-ft^2 area is designated the Building T064 Side Yard. Figure 4 is a detailed drawing depicting these areas and locations from which subsequent radiological measurements were obtained. The remedial efforts and results of the subsequent radiological survey are documented in the 1990 report.(3)

Based on results from both of these surveys, and favorable comparisons with acceptance limits established by DOE Orders, guides, and other regulatory agencies, the 1990 report concluded that the area identified as the Side Yard was suitable for release for unrestricted use.

2.4 THE 1992 ASSESSMENT SURVEY

The 1992 survey of the entire fenced-in yard, documented in this report, was performed as a more detailed and updated radiological assessment of that area. No radiologically significant activities have occurred in the assessed area to suspect any re-contamination since the previous surveys. Therefore, no new remedial actions were undertaken nor were new findings of significance anticipated. However, the building proper is undergoing remediation, including the removal between the 1988 and 1992 surveys of stored boxes of contaminated soil from several SSFL remediation operations. Some slightly contaminated building components were removed from the building interior following the 1992 survey, but they provided no opportunity for yard contamination because they were first packaged inside the building. All of these items were identified as part of the 1988 survey.

During the present assessment survey, new grid locations were established in the fenced-in yard. Measurements were made on these grid surfaces for fixed alpha and beta radioactivity, and for gamma exposure rates at 1-m elevations from the surface. Asphalt samples (or soil, as applicable) were collected from selected grid locations for analysis of radioactivity concentrations.

The procedures used in obtaining the above data were similar to those used previously. They are summarized in Section 3.

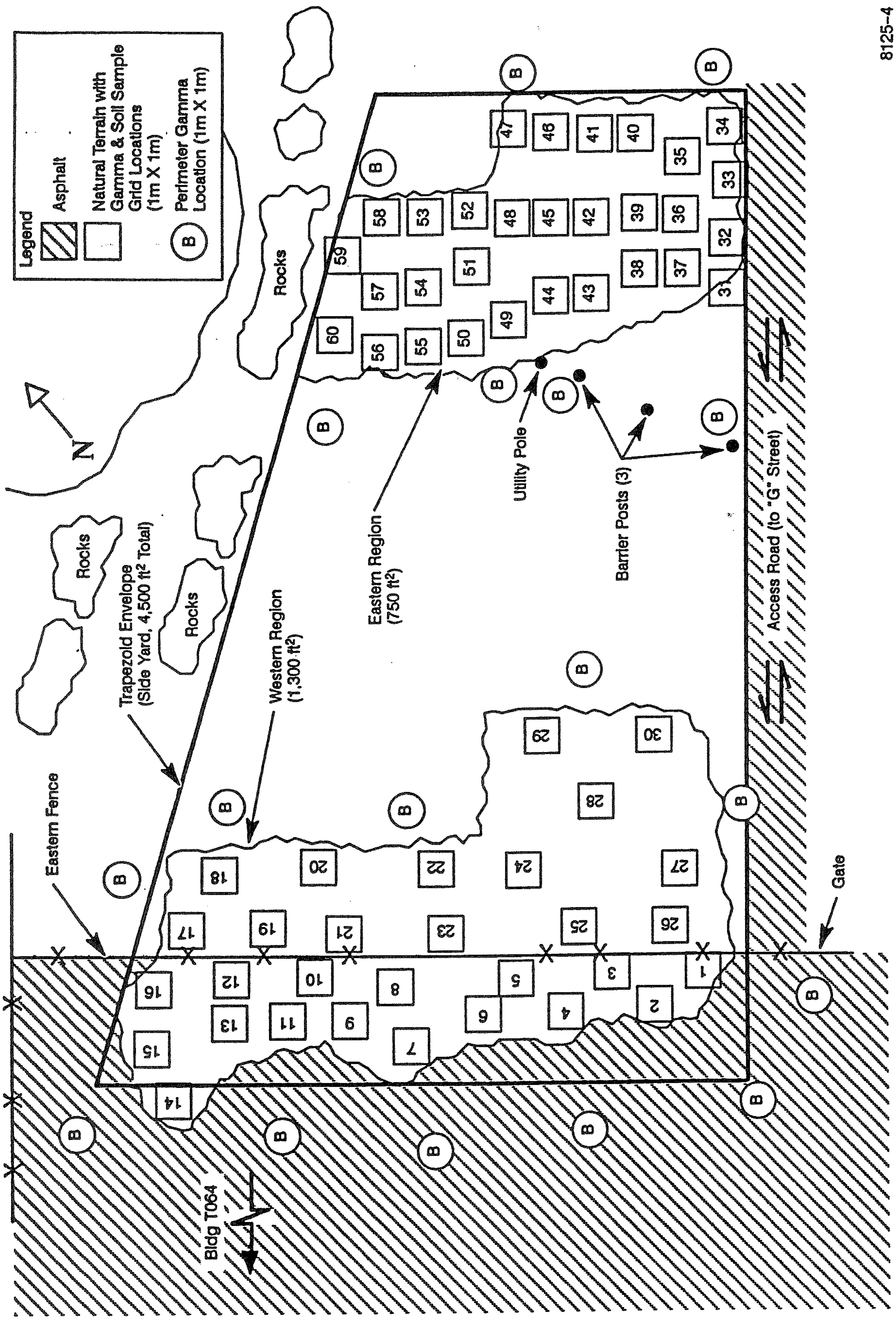

Figure 4. Building T064 Side Yard Decontamination and Survey Grid Locations

3. PROCEDURES

The survey area covered the entire 6580-ft^2 area of the fenced-in yard, following established procedures.[6] The survey grids, procedures, instrument calibration and checkouts, and data reduction and analyses are described below.

3.1 SURVEY GRID

A 3-m x 3-m grid pattern was established within the survey area, as shown in Figure 5. Measurements were made within the grid blocks to obtain alpha, beta, and gamma activity data. Asphalt and soil samples were subsequently collected from selected grid block locations for laboratory analyses of radioactivity. The grids covered mostly the asphaltic pavement, but also included concrete loading docks and a ramp, and soil surfaces from which the original asphalt had been removed by previous remediation activities, weathering, and erosion.

3.2 SURVEY PROCEDURES

3.2.1 Alpha and Beta Activity Measurements

Average alpha and beta surface activities were measured in a 1-m^2 area within each of the 9-m^2 grid blocks shown in Figure 5. As specified in DOE regulations,[7] this 1-m^2 area is the maximum area over which average measurements are to be made. The location of the 1-m^2 area within each grid block was left to the surveyor's judgment: it was to be selected as the area within the block most likely to have residual contamination. Such a selection procedure was expected to produce survey results biased toward the high end of the activity distribution over the survey area.

In order to facilitate the survey, the alpha and beta detectors were mounted on separate portable carts with the detector probe faces adjacent to the ground. Each selected square-meter survey area was scanned for alpha and beta activity, by moving each cart over the area for five minutes with a prescribed speed and survey pattern. These scans provided average 5-minute alpha and beta activity measurements over the 1-m^2 area. The detector, detector probe, date, and number of counts were recorded by location for each scan.

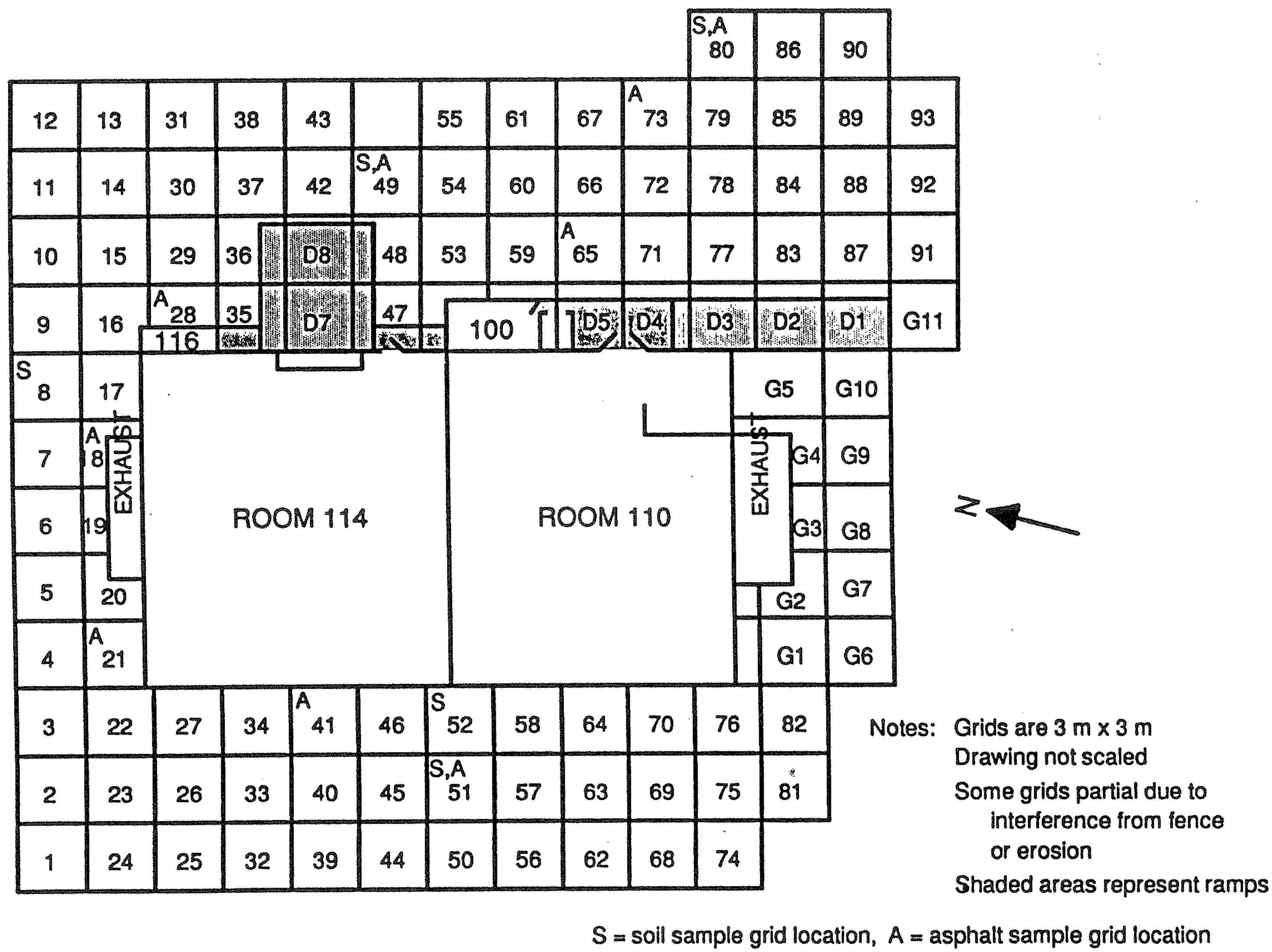

Figure 5. Fenced-In Yard Survey Grid Locations

The DOE regulations[7] also define limits for maximum allowable alpha and beta contamination, as described in Ref. 2. If a contamination spot is detected during the 5-minute scan for average activity, the surveyor typically performs an additional 5-minute stationary scan at that spot to check compliance with the regulatory limits, using the same equipment setup. In the present case, no such spots were detected.

3.2.2 Ambient Gamma Exposure Rate Measurements

A gamma exposure rate measurement was made 1 m from the surface in each of the 9-m^2 grid blocks shown in Figure 5. The particular location within the grid was chosen randomly. A tripod was used to support the gamma probe at the 1-m height. A 1-minute count was made at each location.

3.2.3 Surface Samples for Laboratory Analysis

Previous radiological survey procedures required that the surveyor obtain soil samples only if a gamma exposure rate measurement indicated radioactive contamination. Under such conditions, samples would be collected from that spot for analyses of gross alpha and beta activities using a 2-g sample, and for gamma spectrometry with a 450-ml sample. During the present survey, no such spots were indicated. However, for added conservatism, surface samples were collected for gamma spectrometry.

Samples of surface materials, collected to a depth of about 3 in. and weighing about 2 lb. each, were taken from 14 locations, as indicated in Figure 5. Most of the area is paved with asphalt, and 7 of these samples consisted of asphalt, 5 of soil, and two of a rock/soil mixture. Sample locations were identified and marked on the sample bags. The samples were crushed to smaller pieces as necessary and transferred to 450-ml Marinelli beakers for counting by gamma spectrometry. The samples were dry and thus were not subjected to the drying process usually required before spectrometry measurements.

3.3 INSTRUMENTS AND CALIBRATION

In general, the instruments used for this survey were the same as those used in previous surveys of this and other SSFL facilities. The instruments and the procedures used for their calibration are described in detail in previous survey reports (e.g., Ref. 2), and are summarized below.

3.3.1 Alpha and Beta Activity Measurements

Alpha contamination measurements were made using a Ludlum Model 43-1 alpha probe attached to a Ludlum Model 2220-ESG portable scaler. This large-diameter (9.5 cm) probe is sensitive only to alpha particles with energies exceeding about 1.5 MeV. The detector was calibrated using a ^{230}Th alpha source. The energy of ^{230}Th alpha particles (4.6 MeV) is similar to those of the isotopes handled in Building T064: ^{235}U, ^{234}U, and ^{238}U. A calibration check was performed three times daily using a ^{230}Th "check-source," and the background response of the detector was measured at the same time. The background measurements were made for both 1-minute and 5-minute counting periods, as specified in the instrument qualification report forms. The check-source response provided a measure of instrument stability during the survey period, and the daily average of the background response measurements was subtracted from the field measurements to obtain net alpha counts at the grid points.

The beta measurements were made using a Ludlum Model 44-9 beta probe attached to a Ludlum Model 2221-ESG portable scaler. The probe is a thin-window pancake Geiger-Müller tube. This detector is sensitive to both alpha and beta particles and is slightly sensitive to x rays and gamma rays, but is generally called a "beta detector" because it is used predominantly to measure beta activities. The detector was calibrated against a ^{99}Tc beta source. The energy of the ^{99}Tc beta particles (maximum 0.3 MeV) is close to those emitted by uranium daughter products. Use of this source for calibration will cause a slight overestimate of old mixed fission product activity. The measurements were made over the same areas used for the alpha surface activity measurements. Calibration checks and background measurements were obtained for the beta surveys in the same manner as for the alpha surveys.

3.3.2 Ambient Gamma Exposure Rate Measurements

The ambient gamma exposure rate measurements were made using a 1" x 1" NaI(Tl) scintillation crystal coupled to a photomultiplier tube, with pulse counting by a Ludlum Model 2220-ESG scaler. This detector assembly was mounted on a tripod such that the NaI(Tl) gamma detection volume was 1 meter from the yard surface. The detector is sensitive to nearly all directions (i.e., 4π geometry). The average "statistically significant activity" (SSA) detection limit (defined in Section 3.4.1 and discussed in Section 4.3) measured for this instrument during the survey period was 1.7 μR/h, which is well below the 5-μR/h acceptance limit adopted for this facility (Section 3.4.2).

The expression of the gamma counting results in units of μR/h for comparison to regulatory limits required a conversion from detector counts per minute (cpm) to exposure rate (μR/h). A conversion factor of 215 cpm = 1 μR/h was established for this detector by comparison with a Reuter Stokes High Pressure Ion Chamber. The instrument response is adjusted quarterly using a ^{137}Cs calibration source in the mR/h range. This instrument response was also checked three times daily during the survey using a ^{40}K check-source. The background detector response was also measured three times daily, for 1-minute and 5-minute counting periods.

3.3.3 Gamma Spectrometry of Soil Samples

Each 450-ml soil sample was placed in a Marinelli beaker and counted on a Canberra Industries, Inc. Series 80 Multichannel Analyzer (MCA). The MCA is an energy-sensitive spectrometer whose results can be used to determine the presence and quantities of specific radionuclides, including (but not limited to) ^{238}U, ^{235}U, ^{232}Th, ^{40}K and the characteristic fission and activation products ^{137}Cs, ^{60}Co, and ^{152}Eu. The spectrometer is calibrated routinely for both energy definition and counting efficiency. This calibration was performed using a Marinelli Beaker Standard Source and procedures described in the Canberra Operator's Manual, and encompassed a wide energy range.

A detailed description of the MCA is given in Appendix A of Ref. 2, and the calibration procedures are documented in Ref. 8.

3.4 DATA REDUCTION AND ANALYSES

3.4.1 Data Reduction

Procedures used for the reduction of raw data obtained from the survey are essentially the same as those used in previous surveys. They are summarized below for completeness.

The detector data obtained from the alpha and beta contamination surveys are total detector counts recorded over a 5-minute period at each location. Each total count was converted to a total count rate (counts per minute or cpm), by dividing it by the counting time for each measurement. The net (background-corrected) cpm was then obtained by subtracting the daily average background cpm derived from the corresponding background measurements. The net cpm was converted to disintegrations per minute (dpm) by multiplying it by an efficiency factor for the detector. Finally, the dpm was converted to dpm/100 cm^2 by multiplying it by the ratio of 100 cm^2 to the area of the detector probe (71 cm^2 for the alpha probe and 20 cm^2 for the beta probe). The quantity dpm/100 cm^2, determined for each grid location, is the conventional unit of measure for total average alpha and beta contamination. The efficiency factors used to convert the alpha and beta activity data to dpm/100 cm^2 for the individual measurements are included in the spreadsheet calculations appended to this report (Appendix A). They were typically about 7 dpm/cpm for the alpha probes and 8 dpm/cpm for the beta probes.

The raw data for the 1-minute gamma survey measurements were recorded as ambient gamma exposure counts. These total counts were converted to total exposure rates in μR/h using the calibration-derived relationship 215 cpm = 1 μR/h. The net (background-subtracted) gamma exposure rates were then obtained by subtracting a 15.3-μR/h background from the ambient values. This 15.3-μR/h background value was previously established as a best estimate for the SSFL, as documented in Ref. 2. Separate calculations were also performed to derive net gamma exposure rates using the background measurements performed in conjunction with the survey. In that case a net exposure count rate was determined for each location by subtracting the average background count rate for the day of the measurement from the total count rate. This net count rate was then converted to a net exposure rate by dividing by 215.

Specific concentrations of radionuclides in the asphalt/soil samples were converted from MCA counts to pCi/g following procedures outlined in Ref. 2.

One of the statistical tests employed to determine whether activity measurements indicate the presence of contamination or are part of the natural background distribution is a detection limit test known as "statistically significant activity" (SSA). This test compares the net (background-subtracted) activity with the SSA limit, which is defined mathematically as follows:[9]

$$SSA = \frac{1.645 \sqrt{2}\, \sigma_B}{T} .$$

Here σ_B is the standard deviation of the background count, T is the count time (in minutes), and the factor 1.645 is the normal deviate corresponding to the one-sided 95% confidence level. The parameter SSA is then expressed in cpm units. A conservative (lower-limit) estimate of the SSA can be obtained from a single background measurement by approximating σ_B with $\sqrt{B}$, where B is the number of background counts. If the net measured activity is greater than the SSA, that measurement is greater than 95% of the expected distribution of background measurements. The SSA thus provides guidance for judging whether a given measurement is background or background plus a contaminant.

The SSA also provides a measure of the counting instrument response in the presence of background, and can be used to judge the suitability of the instrument for a given application. For example, the instrument's SSA must be well below the regulatory acceptance limit for facility release in order for the instrument to be an appropriate selection for final survey measurements.

3.4.2 Comparison with Regulatory Limits

The data in each measurement category (alpha, beta, gamma, and soil radioactivity) were examined separately to determine whether any of the measured values exceeded regulatory acceptance limits. These limits, as adopted for this work, are summarized in Table 1 and discussed individually below.

Table 1. Regulatory Acceptance Limits Adopted for this Work

Parameter	Acceptance Limit	Reference
Total average alpha activity	5000 dpm/100 cm^2 above background	10
Total average beta activity	5000 dpm/100 cm^2 above background	10
Gamma exposure rate (at 1 m from surface)	5 μR/h above background	11, 3
Soil activity concentration	3.2 pCi/g each for ^{137}Cs and ^{90}Sr (for residential use, including drinking water from wells)	12

The alpha and beta limits are taken from DOE Order 5400.5.[10] This guideline specifies allowable average total residual surface contamination limits of 5000 dpm/cm^2 each for (a) ^{nat}U, ^{235}U, ^{238}U, and associated decay products and alpha emitters, and (b) mixed fission product beta-gamma emitters.

For the gamma exposure rate, DOE guidelines[7,10] recommend a limit of 20 μR/h above background, based originally on facility screening applications. In contrast, the NRC Dismantling Order for the decommissioning of the Rockwell L-85 reactor required a limit of 5 μR/h above background.[11] For conservatism, Rocketdyne adopted the NRC 5 μR/h above-background limit for this and previous[3] survey applications. Note that this limit is an increase of only about 1/3 over the average background value (15.3 μR/h) for the SSFL site.

Generic limits are generally not available for radionuclide concentrations in soil, and a pathway analysis calculation is required to set limits on a site- and nuclide-specific basis. A pathway analysis was performed for the present work using the computer code RESRAD,[12] as used previously for the Building T064 side yard and described in some detail in that report.[3] For the present case, a residential land use scenario was assumed, with a radionuclide contamination area defined as the area of the fenced-in yard plus Building T064, and extending to a depth of 1 meter. The assumption of an infinite contamination depth produced no change in the results. The analysis was used to calculate allowed ^{137}Cs and ^{90}Sr single-radionuclide concentration limits for which the annual effective dose equivalent received by a plausible future user of the site would not exceed 10 mrem. The 10 mrem/y limit was adopted as an achievable goal and is lower than the DOE guideline of 100 mrem/y.[10]

The soil guideline is not a spot limit, but provides guidance for cleanup and serves as a basis for calculating the allowable maximum ("hot spot") contamination. The allowable hot spot contamination, in areas smaller than 25 m^2, is calculated as $\sqrt{100/A}$*G, where A is the hot spot area in m^2 and G is the guideline value. This adjusted guideline should not exceed 30*G.

The results of the RESRAD analysis gave single-radionuclide limits of 3.24 pCi/g for ^{137}Cs and 362 pCi/g for ^{90}Sr. If it is assumed that equal concentrations of these two radionuclides are present, the concentration limit for each radionuclide is 3.2 pCi/g in order to meet the 10 mrem/y limit. This value was adopted for the present work.

The survey data were analyzed statistically by methods used previously in final release surveys.[3] Cumulative probability plots were generated and a test statistic (TS) was obtained and compared with the above acceptance limit for each radiological parameter. The probability plot provides a comparison between the data distribution and a normal (Gaussian) distribution whose parameters are derived from the data. Overlaying the data with the normal distribution (represented by a straight, solid line on the plot) readily identifies "outlier" data values.

The test statistic is defined as follows:

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

where $\bar{x}$ is the mean of the measurement distribution and s is the estimated standard deviation. The value of k is determined from the sample size and two other statistical sampling coefficients that are related to the risk of accepting a lot, given that a fraction of the lot has rejectable items in it. The values chosen for these coefficients for the present survey correspond to assuring, with 90% confidence, that 90% of the area has residual contamination below 100% of the applicable limit (i.e., a 90/90/100 test). The test statistic typically corresponds to a cumulative probability of about 93%, depending upon the number of data points. This value is indicated on the cumulative probability plot as a dashed vertical line. For a survey data set to be accepted, the normal distribution (solid) line on the plot must pass below the intersection of the test statistic probability line and a horizontal line representing the acceptance limit for the measurements.

Results from this survey are presented and discussed in the next section. Detailed data generated using spreadsheet calculations are included in Appendix A. A list of survey records is included in Appendix B.

4. RESULTS AND DISCUSSION

The results of the Building T064 fenced-in yard assessment survey are summarized in Table 2. In general, the survey data show that residual radioactivity in the fenced-in yard corresponds to background levels. The data and their analysis are discussed in more detail below.

4.1 ALPHA ACTIVITY

Total alpha activities were measured in 101 grid locations, averaged over a 1-m^2 surface area at each location. Based on these measurements, the average measured activity was determined to be 3.4 ± 12.0 dpm/100 cm^2 above the 30.3 ± 12.3 dpm/100 cm^2 background, with a maximum of 51 dpm/100 cm^2. These values are negligible in comparison with the 5000-dpm/100 cm^2 acceptance limit.

Comparisons between the individual background-subtracted activity measurements and the daily SSA values, calculated conservatively as the square root of the daily average of the background measurements, indicate that 7 of the 101 measurements are above the SSA limit (Appendix A). Three of those measurements are above the 28.6 dpm/100 cm^2 average SSA calculated from the standard deviation of the full set of 5-minute background counts. The average SSA is significantly higher than the daily values, as it accounts for several other measurement variability factors (instrument drift, etc.) besides $\sqrt{B}$ counting statistics. Even this average SSA may be conservative, as the alpha and beta background counts were made at a single outdoor location. The SSA limits and all of the alpha activity measurements are two orders of magnitude below the acceptance limit, and one can conclude that the alpha detector is appropriate for these measurements and that the fenced-in yard is acceptably clean of alpha activity.

A cumulative probability plot for the total background-corrected alpha activity data is shown in Figure 6, where the vertical scale was chosen to include the 5000-dpm/100 cm^2 acceptance limit. All of the data and the test statistic corresponding to their distribution (TS = 21.0 dpm/100 cm^2) are shown graphically to have negligible values relative to this limit.

Figure 7 replots the same data with an expanded vertical (activity) axis to show the distribution in more detail. This figure shows that the data are consistent with a normal distribution with the exception of three to six outlier data points, all of which were flagged by the SSA comparisons. The highest four data points (and five of the highest six) are from locations on the Building T064

Table 2. Summary of Data from the Building T064 Fenced-In Yard Assessment Survey

Measurement (Units)	Number of Measurements[a]	Average	Standard Deviation	Minimum	Maximum	Test Statistic	Acceptance Limit
Total Average Alpha Activity (dpm/100 cm^2)	101	3.4	12.0	-19.8	51	21.0	5000
Total Average Beta Activity (dpm/100 cm^2)	112	239	328	-655	1209	717	5000
Gamma Exposure Rate above Background (μR/h) @ 1 m Above Surface							
(1) for 15.3-μR/h average SSFL background	112	-1.11	1.11	-4.74	3.47	0.50	5.00
(2) for daily background measurements[b]	112	1.17	1.23	-2.51	4.56	2.96	5.00
Soil Radionuclide Concentration (pCi/g)							
^{40}K	14	19.3	2.2	22.3	14.3	23.4	---
^{137}Cs	14	0.41	0.83	0.02	3.12	1.96	3.2
^{235}U	14	0.04	0.02	0.02	0.07	0.07	0.27

(a) See Appendix A for individual measurements and corresponding survey locations
(b) See background discussion in text (Section 4.3)

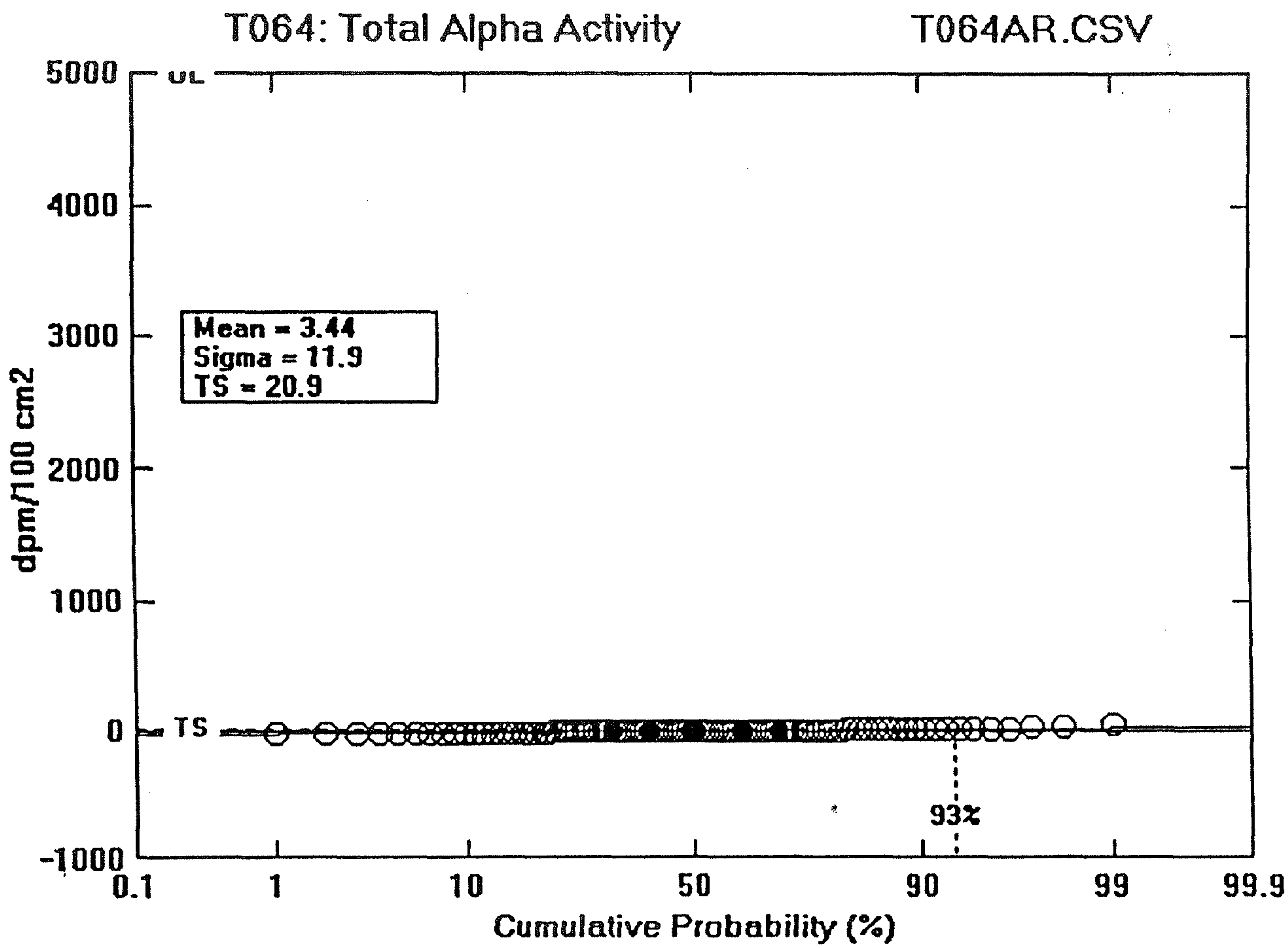

Figure 6. **Cumulative Probability Plot of Total Background-Corrected Alpha Activity Measurements in the Fenced-In Yard, with the Acceptance Limit as Maximum Ordinate**

ramp. Chapman observed similar outliers correlated with cement ramp locations during his 1988 survey of the building interior.[2] He attributed that increased activity to the possibility of naturally-occurring radionuclides in the concrete used for the ramps. The present data show that, with the exception of one grid location on the ramp (Location D7; see Appendix A), the alpha activities measured at the ramps are all slightly above the average, consistent with Chapman's observations.

4.2 BETA ACTIVITY

Total beta activities were measured in 112 locations. They were also averaged over a 1-m^2 surface area at each location, where the 1-m^2 area was generally the same as that used for the alpha measurements. The average background-subtracted beta activity was found to be 239 ± 328 dpm/100 cm^2, with a maximum of 1209 dpm/cm^2. All values were well below the 5000-dpm/cm^2 acceptance limit, indicating that the fenced-in yard is acceptably clean of beta activity.

Comparisons were also made between the individual background-subtracted beta activity measurements and the daily SSA values, the latter calculated as the square root of the daily average of the background measurements. The results indicate that 41 (37%) of the 112 measurements are above this conservative SSA limit (Appendix A), although significantly below the acceptance limit. A separate analysis of the background measurements taken during the survey (at a single location) gave an average background that is equivalent to a beta activity of 3336 ± 362 dpm/100 cm^2, and an average SSA of 842 dpm/100 cm^2 (above background). Only four values exceed this SSA limit. This average SSA is also well below the acceptance limit, validating the acceptability of the beta detector for these measurements.

A cumulative probability plot for the background-corrected beta activity data is shown in Figure 8, with the vertical scale chosen to include the 5000-dpm/cm^2 acceptance limit as the upper boundary. All of the data and the calculated test statistic (TS = 717 dpm/100 cm^2) are shown graphically to be well below this limit. The data are replotted in Figure 9 with an expanded vertical axis. These data behave as a normal distribution, with the exception of two to five outliers. These outliers, which were also flagged by comparisons with the average SSA limit, do not correspond to any specific type of location, in contrast to observations for the outlier alpha activities.

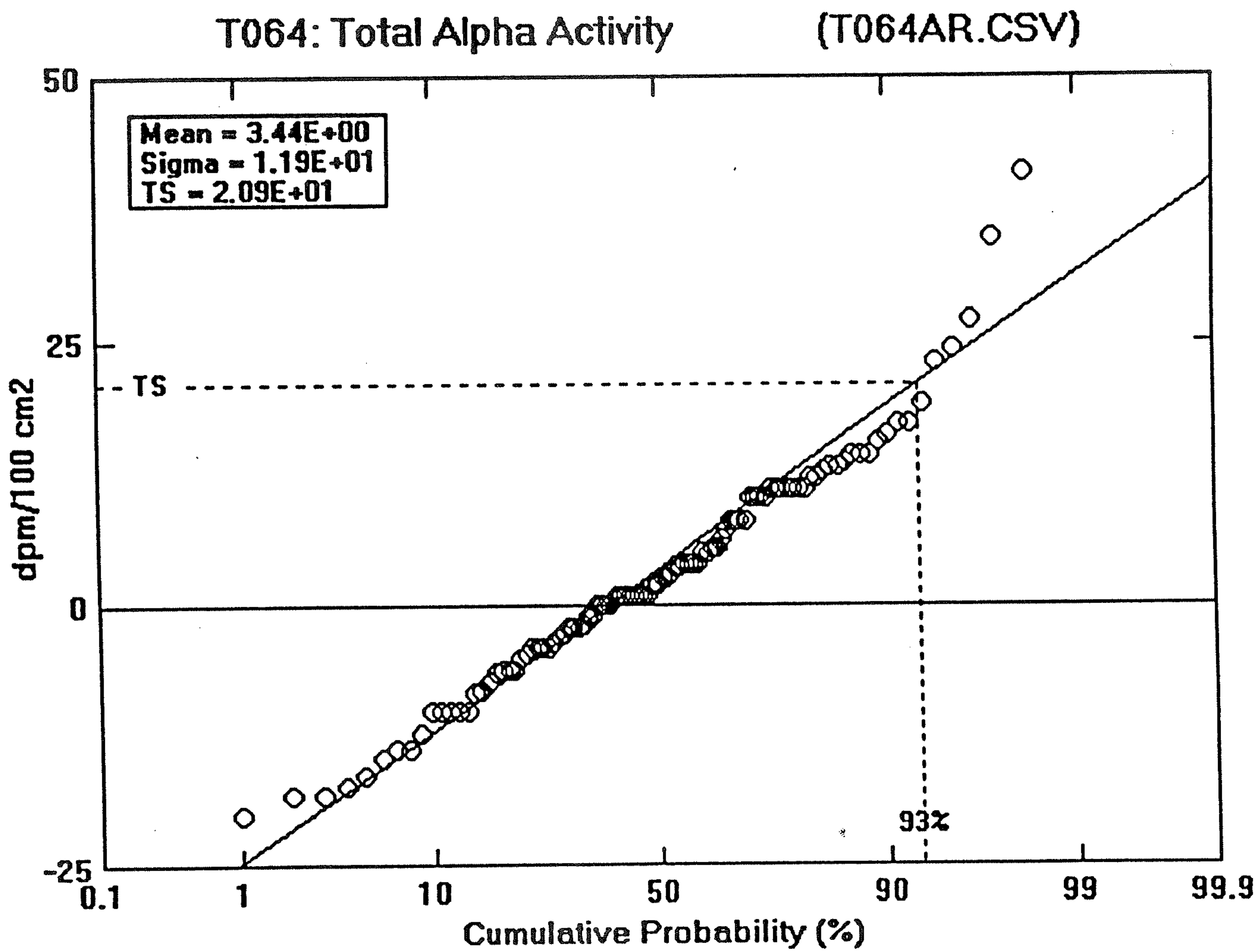

Figure 7. **Cumulative Probability Plot of Total Background-Corrected Alpha Activity Measurements in the Fenced-In Yard, with Expanded Ordinate Scale**

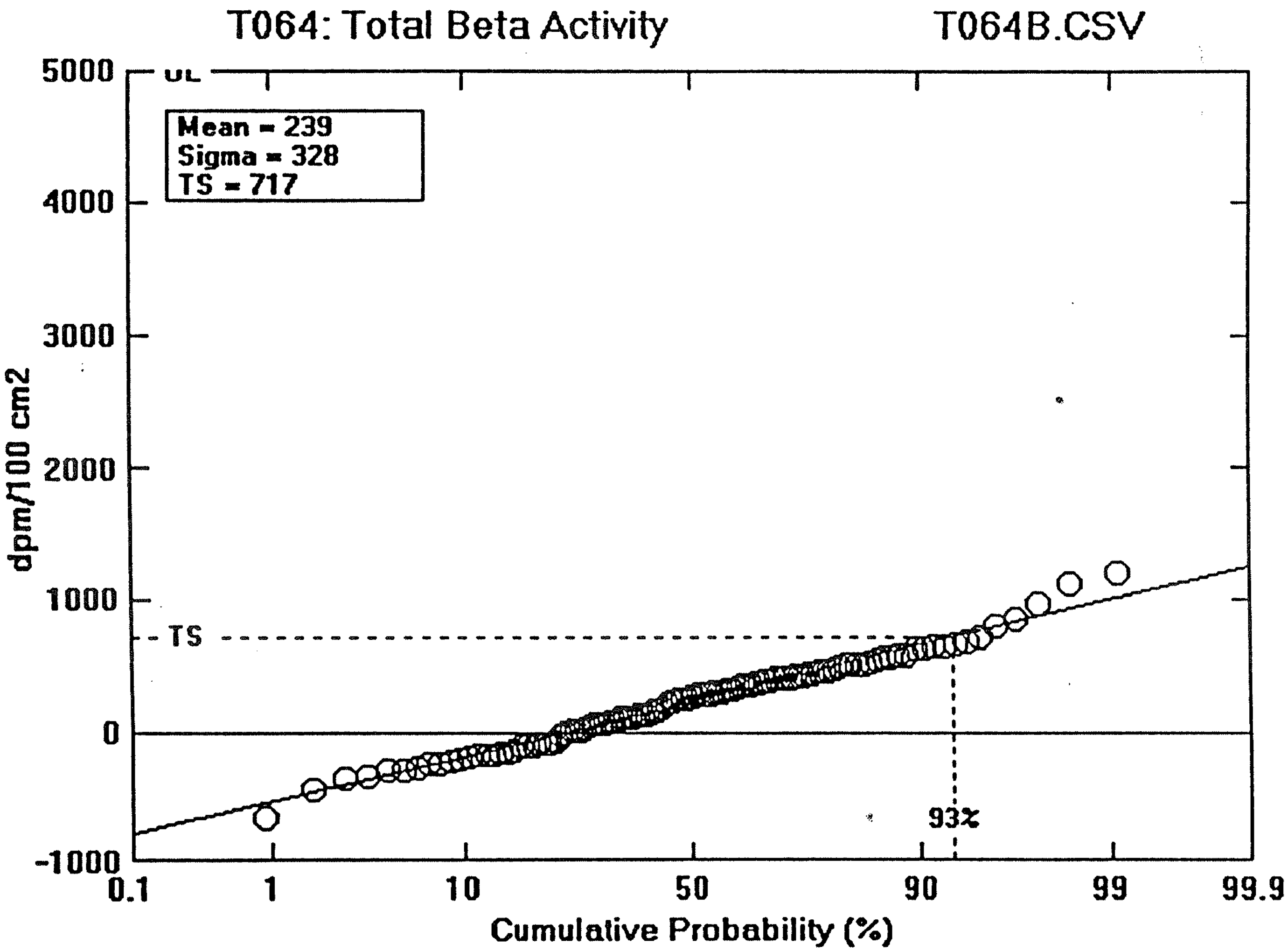

Figure 8. **Cumulative Probability Plot of Total Background-Corrected Beta Activity Measurements in the Fenced-In Yard, with the Acceptance Limit as Maximum Ordinate**

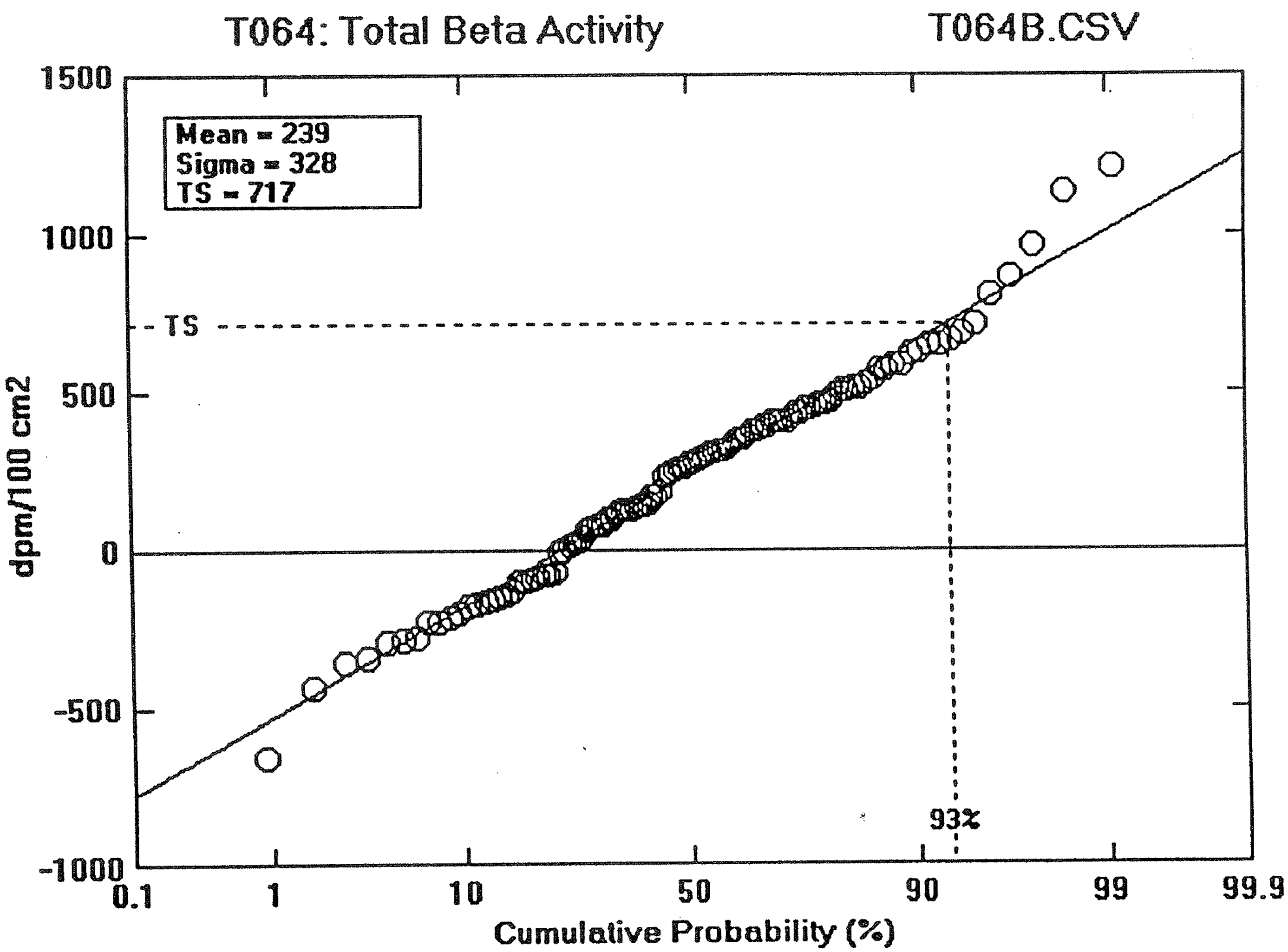

Figure 9. **Cumulative Probability Plot of Total Background-Corrected Beta Activity Measurements in the Fenced-In Yard, with Expanded Ordinate Scale**

4.3 GAMMA EXPOSURE RATES

Gamma exposure rate data were obtained from 112 locations. The background-corrected exposure rate at each location was determined by calculating the total exposure rate and then subtracting an average background value of 15.3 μR/h. This provided an average net exposure rate of -1.11 ± 1.11 μR/h and a maximum value of 3.47 μR/h. The corresponding cumulative probability plot is shown in Figure 10, and includes a calculated test statistic of TS = 0.50 μR/h. The exposure rate values and the test statistic are all below the 5 μR/h acceptance limit.

The 15.3-μR/h background used for these calculations was based on an average of previous measurements made at three different SSFL locations.[2,13] Such background measurements have shown a wide variation in exposure rate, depending upon location. For example, Chapman[2,13] noted during his 1988 survey that the background values measured in the Building 309 Area had a range of 3.4 μR/h, which approaches the adopted NRC limit of 5 μR/h. Because of this observed variability, the Building T064 Side Yard survey[3] established a background based on data from a portion of the surrounding 2-acre area that most closely matched the survey area physically and topographically. That background value (15.5 ± 0.8 μR/h) is consistent with the 15.3-μR/h value used here.

The present survey included three-times-daily background gamma measurements that were performed as instrument checks. Those measurements were all performed at a single location outside of, but in the vicinity of, the fenced-in yard that was known to be free of contamination. The analysis of those measurements gave an average background value of 12.8 ± 0.7 μR/h and an average SSA value of 1.7 μR/h. This background value is significantly lower than (but within the variation of) the established area average, which may be due to the use of a single, lower-activity counting location. SSA comparisons based on these lower-background measurements indicated that 80 (71%) of the activity measurements exceeded the daily SSA values and 37 (33%) exceeded the average SSA. One conclusion that could be made based on the average SSA is that the gamma detector performance is acceptable for this survey. An average net gamma exposure rate was also calculated using these background data, by subtracting the daily background readings from the individual survey measurements before converting to exposure rates. This yielded an average net exposure rate of 1.17 ± 1.23 μR/h. The individual net exposure rates are shown as a cumulative probability plot in Figure 11. Although the net calculated exposure rates are higher using these background data, they are all below the 5-μR/h acceptance limit.

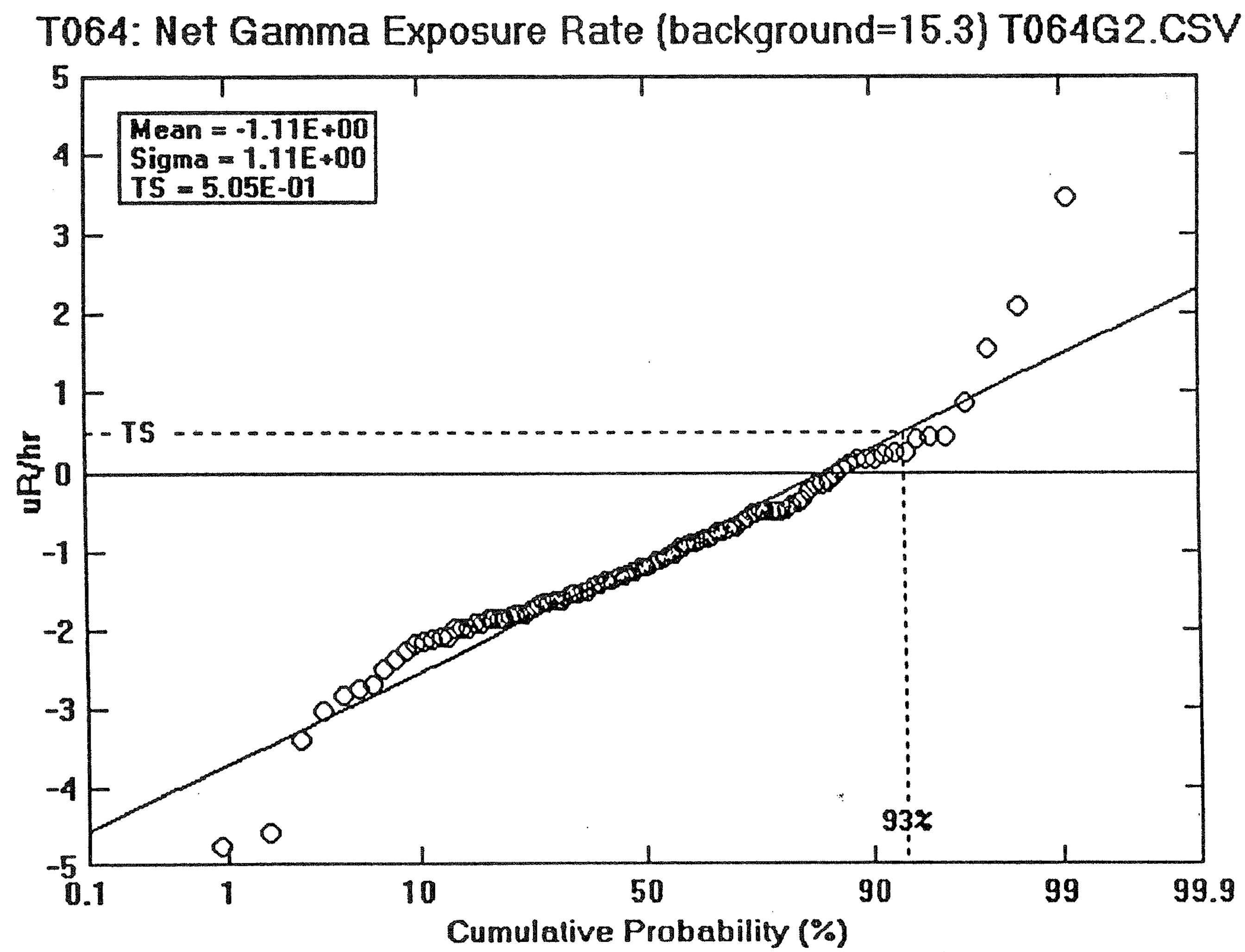

Figure 10. **Cumulative Probability Plot of Background-Subtracted Gamma Exposure Rates in the Fenced-In Yard, for Background = 15.3 μR/h**

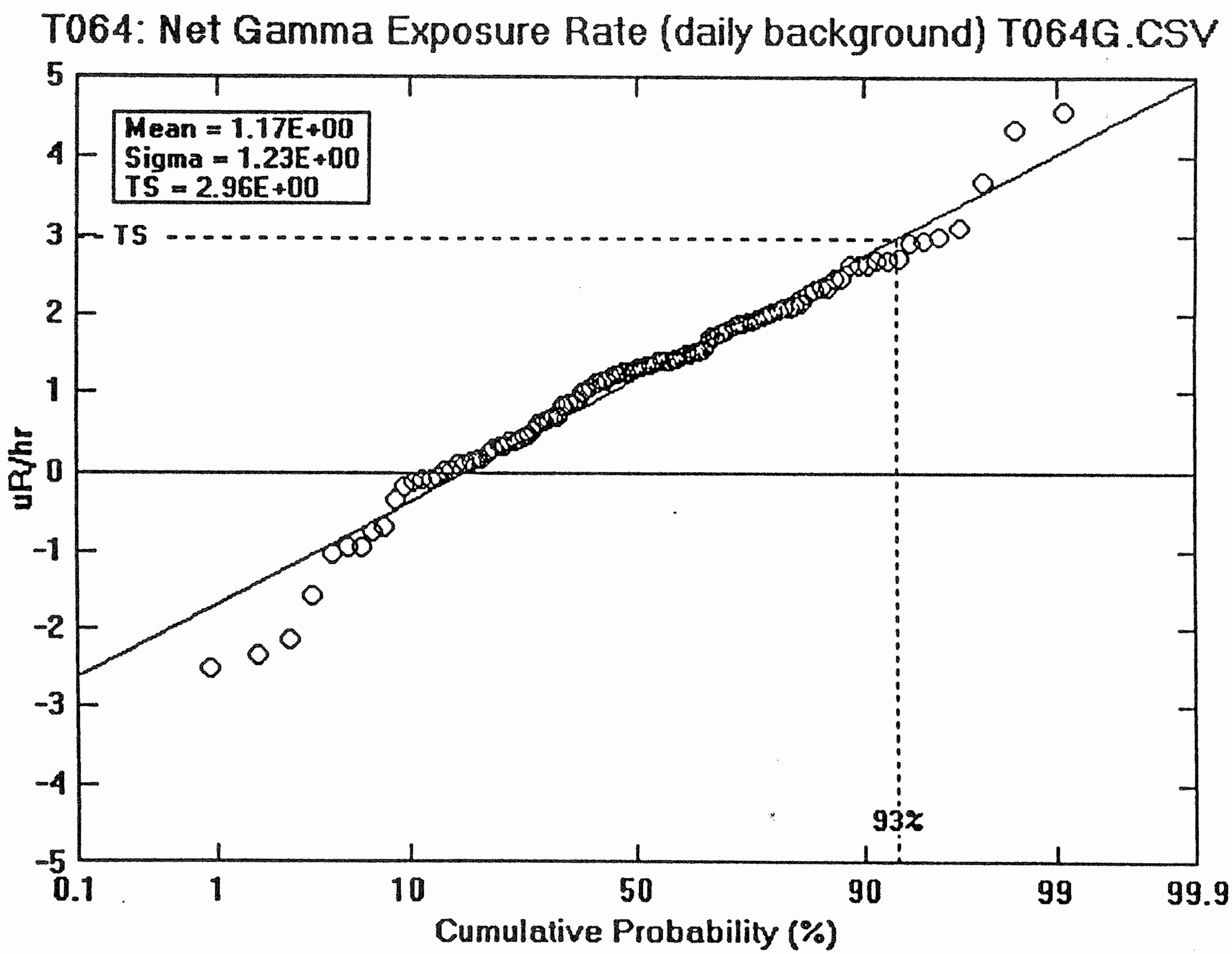

Figure 11. **Cumulative Probability Plot of Background-Subtracted Gamma Exposure Rates in the Fenced-In Yard, Using Daily Background Measurements**

The net exposure rates calculated using the adopted 15.3-μR/h average facility background were examined in more detail to look for possible trends. The probability plot in Figure 10 shows three outlier exposure values, at grid locations 17, 18, and G11 (see Figure 5). Two of the locations (17 and 18) were near a slightly contaminated building filter plenum(2) that was packaged and removed since the survey. The third location (G11) is in the vicinity of a rain gutter that may have accumulated some fallout material that settled on the building roof and was washed down by precipitation. All three values are below acceptance limits and no further action is warranted.

Comparisons between the other gamma activity measurements and previous site survey measurements(2) show that the present data are consistent with previous results.

4.4 RESIDUAL RADIOACTIVITY IN SOIL/ASPHALT

The fourteen soil and asphalt samples were analyzed for 18 specific radionuclides by gamma spectrometry. The net activity measurements for those radionuclides were consistent with natural background activities with the exception of a few slightly elevated ^{137}Cs activities. The average measured ^{137}Cs activity was 0.41 ± 0.83 pCi/g, and all values were below the adopted 3.2 pCi/g acceptance limit.

The radiological activity measurements for the three radionuclides ^{40}K, ^{137}Cs, and ^{235}U are summarized in Appendix A and plotted in Figure 12. ^{40}K was the only significant activity measured (19.3 ± 2.2 pCi/g), and that activity is due to natural potassium in the soil. Figure 13 replots the ^{137}Cs and ^{235}U results with an expanded activity scale and provides a comparison with the ^{137}Cs acceptance criterion. This figure shows graphically that the soil activity concentration criterion is met for all ^{137}Cs measurements.

Cumulative probability plots for the ^{40}K, ^{137}Cs, and ^{235}U data are shown in Figures 14, 15, and 16, respectively. These plots indicate that the ^{40}K and ^{235}U (0.04 ± 0.02 pCi/g) activities generally follow normal probability distributions, as expected from naturally distributed radionuclides. The ^{137}Cs probability distribution flags as outliers the three elevated data points in Figure 13, but these values and the test statistic calculated for the distribution (1.96 pCi/g) meet the adopted acceptance criterion.

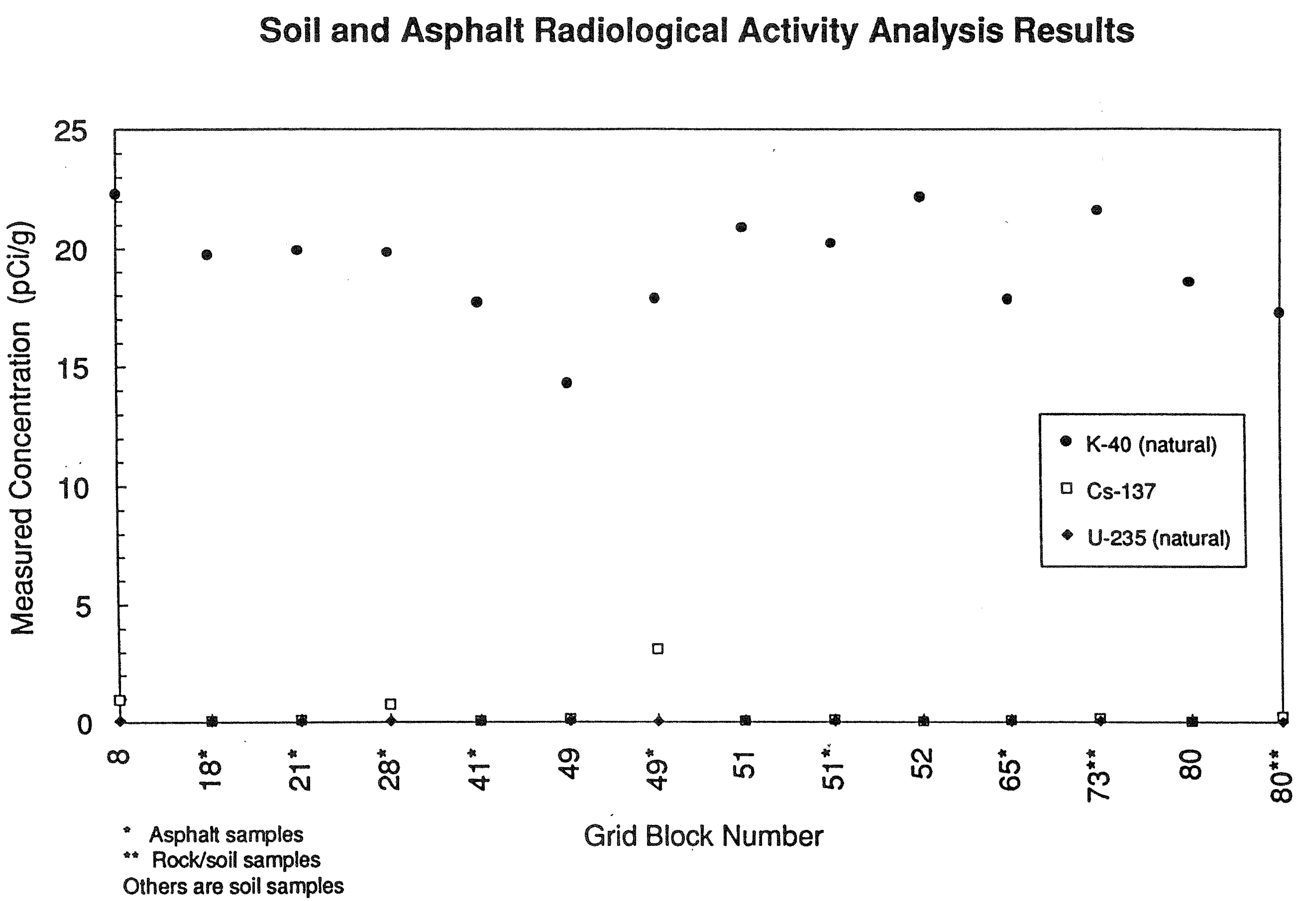

Figure 12. ^{40}K, ^{137}Cs, and ^{235}U **Activity Measurements for the Soil and Asphalt Samples from the Fenced-In Yard**

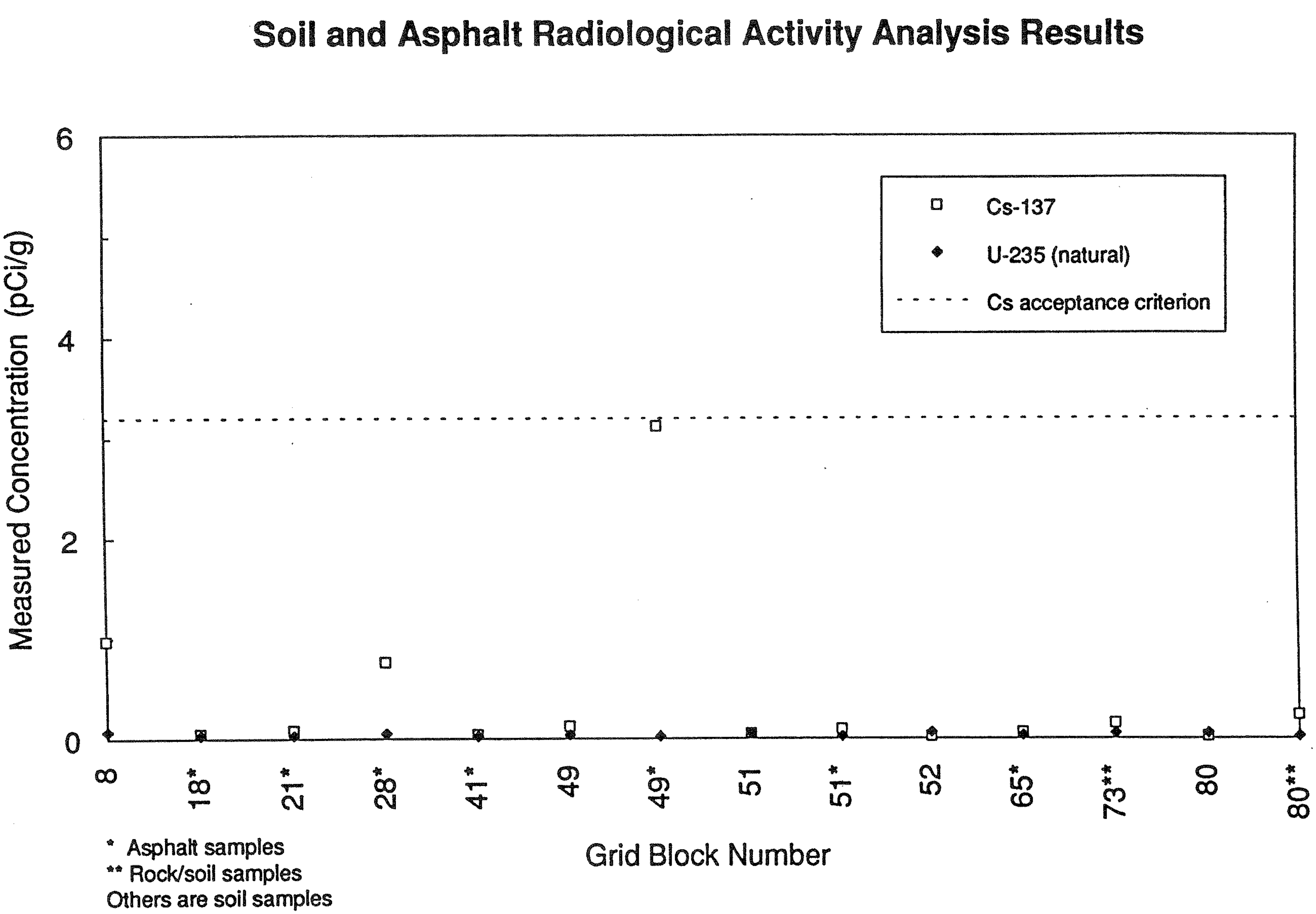

Figure 13. ^{137}Cs and ^{235}U Activity Measurements from the Soil and Asphalt Samples from the Fenced-In Yard, Overlaid with the ^{137}Cs Acceptance Criterion

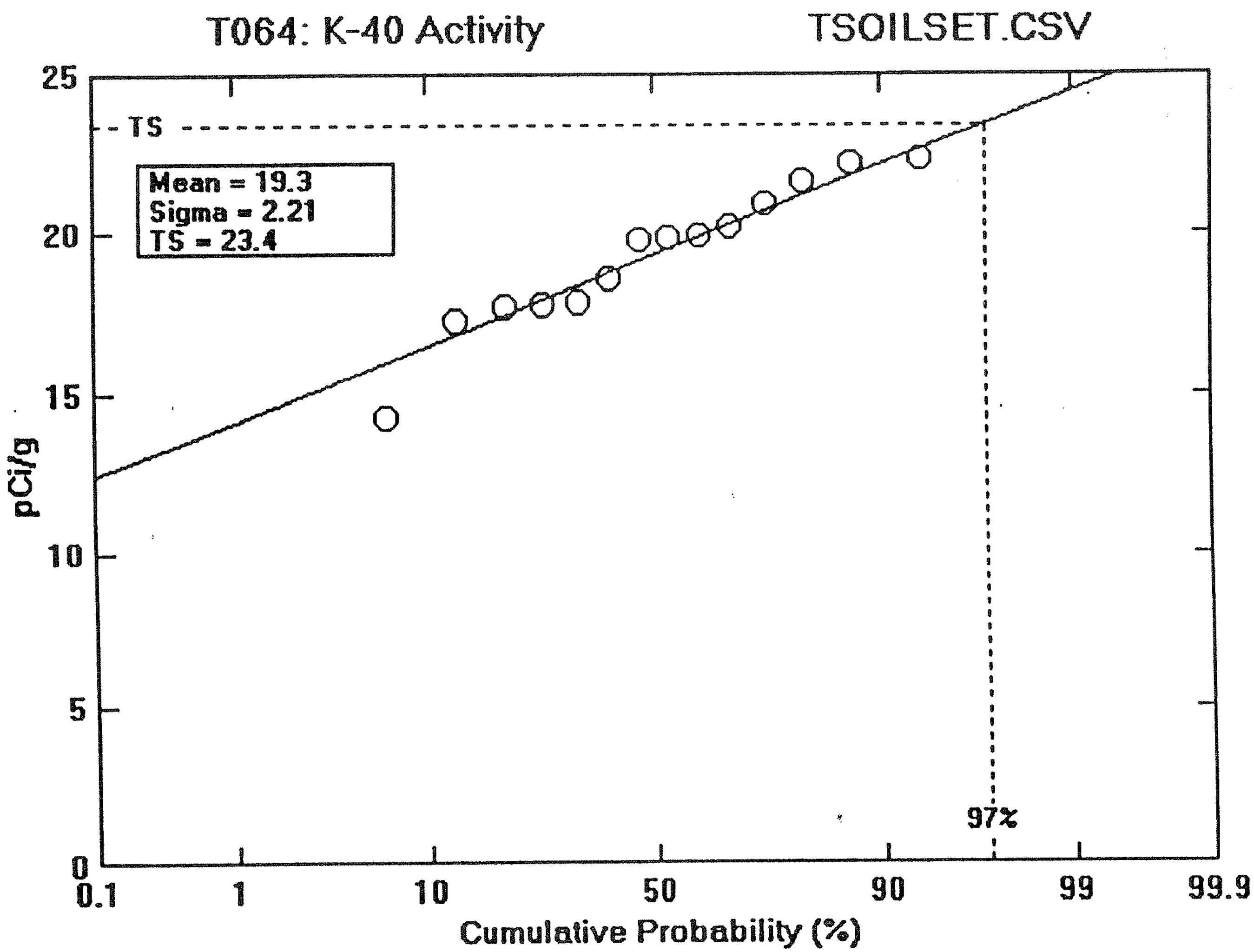

Figure 14. Cumulative Probability Plot of ^{40}K Activity Measurements from the Fenced-In Yard Soil and Asphalt Samples

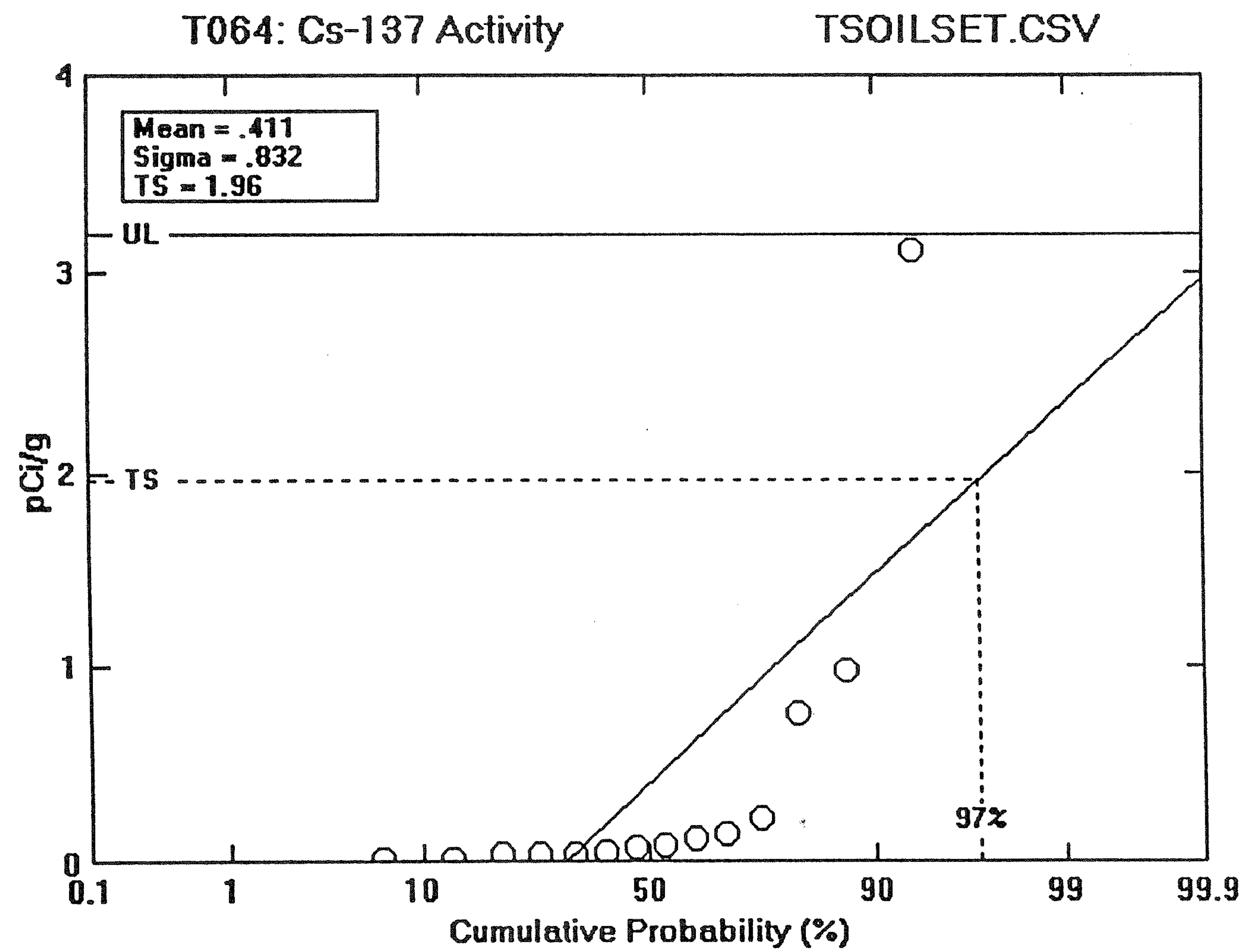

Figure 15. **Cumulative Probability Plot of ^{137}Cs Activity Measurements from the Fenced-In Yard Soil and Asphalt Samples**

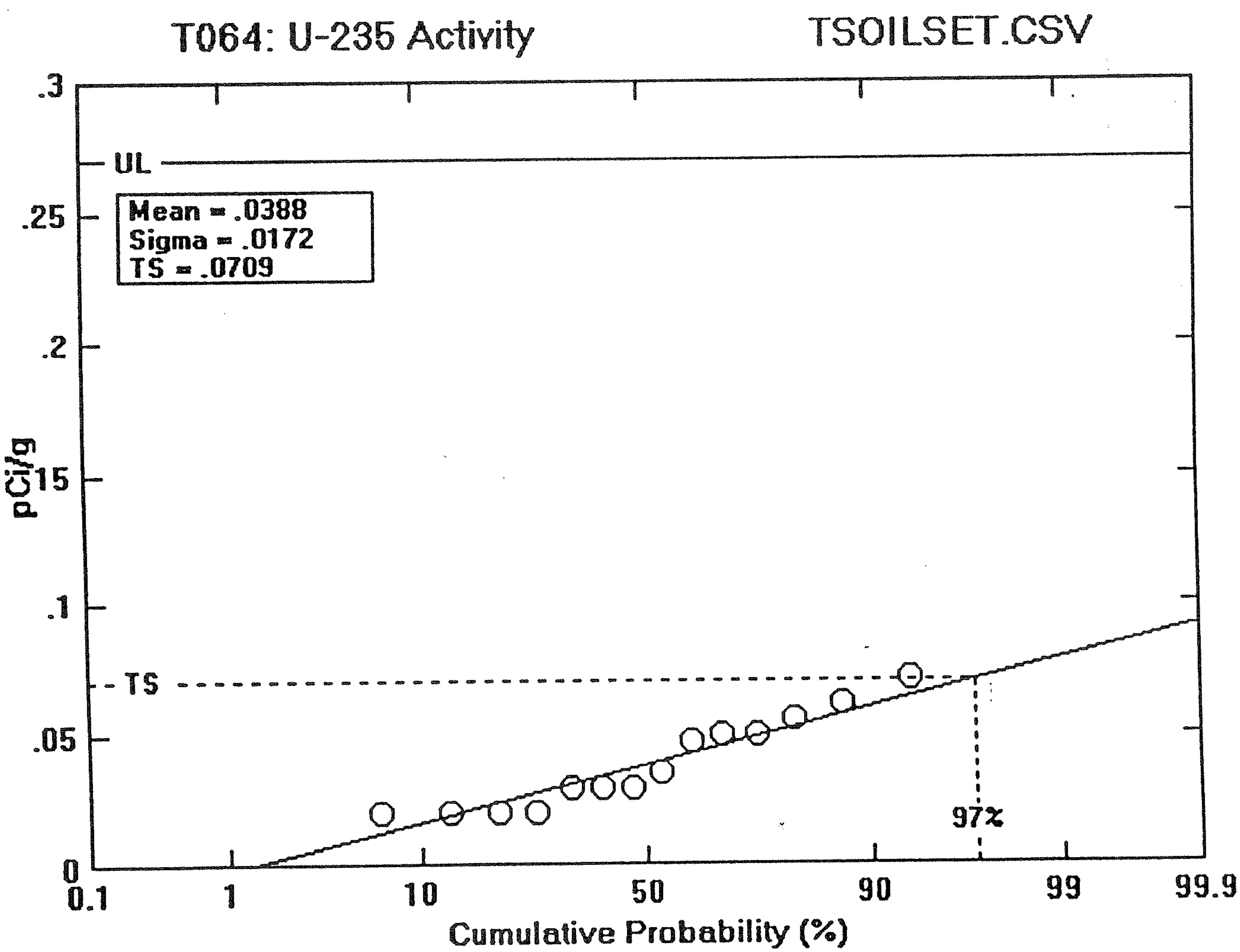

Figure 16. **Cumulative Probability Plot of ^{235}U Activity Measurements from the Fenced-In Yard Soil and Asphalt Samples**

Since ^{235}U, as measured by gamma spectrometry, is an indicator of ^{234}U and ^{238}U, depending upon enrichment of the possible contaminant, an equivalent acceptance limit must be developed to recognize these other radionuclides. The guideline for ^{235}U in highly enriched uranium (HEU, 93% ^{235}U by mass) is 0.27 pCi $^{235}U/g$. This is about five times the activity concentration in natural soil due to the natural uranium, and so is readily detected. For normal uranium, the ^{235}U guideline is 0.50 pCi $^{235}U/g$. Since HEU could have been a contaminant here, the lower guideline is applied.

5. CONCLUSIONS

The 6580 ft^2 area comprising the fenced-in yard that surrounds SSFL Building T064 was surveyed to assess its present radiological condition. The area was divided into grid blocks, alpha activity, beta activity, and gamma exposure rate measurements were made, and samples of soil and asphalt were taken for laboratory analysis to measure concentration levels of man-made residual radioactivity.

The resulting analysis data were compared with acceptance limits for facility release and with previous data where possible. The specific and general conclusions from this work follow.

5.1 SPECIFIC CONCLUSIONS

1. The average value for the 101 1-m^2-averaged, background-subtracted alpha surface activity measurements in the fenced-in yard is 3.4 ± 12.0 dpm/100 cm^2, the maximum measured area-averaged value is 51 dpm/100 cm^2, and the test statistic for the distribution is 21.0 dpm/100 cm^2. All values are well below the acceptance limit of 5000 dpm/100 cm^2.

2. The average value for the 112 1-m^2-averaged, background-subtracted beta surface activity measurements in the fenced-in yard is 239 ± 328 dpm/cm^2, the maximum measured area-averaged value is 1209 dpm/100 cm^2, and the test statistic for the distribution is 717 dpm/100 cm^2. All values are well below the acceptance limit of 5000 dpm/100 cm^2.

3. The average measured value for the background-subtracted gamma exposure rate is -1.11 ± 1.11 µR/h, based on an assumed background rate of 15.3 µR/h for the SSFL facility. The maximum measured gamma exposure rate (3.47 µR/h) and the test statistic for the measured exposure rate distribution (0.50 µR/h) are both below the 5-µR/h acceptance limit for facility release. Reanalyzing the data using the lower background rates obtained from daily instrument checks at a single location raises the calculated background-subtracted exposure rates, but those values are also all below the acceptance limit.

4. The measured soil concentrations of 18 specific radionuclides in the 14 soil and asphalt samples are consistent with natural background concentrations with the exception of a few slightly elevated ^{137}Cs measurements. The average measured ^{137}Cs activity is 0.41 ± 0.83 pCi/g, and all values are below the adopted 3.2 pCi/g acceptance limit.

5.2 OVERALL CONCLUSION

The fenced-in yard remains acceptably clean of radioactive contamination, and meets the criteria for release for unrestricted use.

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APPENDIX A

SURVEY DATA SPREADSHEETS

The following spreadsheet tables provide the input data for the individual survey measurements, the calculations performed to derive background-corrected exposure rates (gamma) and radiological activity levels (alpha, beta), and a summary of the soil/asphalt radiological concentration measurements for ^{40}K, ^{137}Cs, and ^{235}U. Also included are the spreadsheet tables used to derive average gamma, alpha, and beta background values from the individual background counts performed during the survey period.

Alpha Activity Data T064R2.xls 2/18/93

Detector area (Aalpha) = 71 cm^2

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
1	2/18/92	20	4.0	4.3	2.2	LTD*	-0.3	6.4	-2.7	36.1
2	2/18/92	21	4.2	4.3	2.2	LTD	-0.1	6.4	-0.9	37.9
3/1	2/18/92	29	5.8	4.3	2.2	LTD	1.5	6.4	13.5	52.3
3/2	2/18/92	23	4.6	4.3	2.2	LTD	0.3	6.4	2.7	41.5
4	2/18/92	11	2.2	4.2	2.2	LTD	-2.0	6.4	-18.0	19.8
5	2/18/92	17	3.4	4.2	2.2	LTD	-0.8	6.4	-7.2	30.6
6	2/18/92	19	3.8	4.2	2.2	LTD	-0.4	6.4	-3.6	34.3
7	2/18/92	13	2.6	4.2	2.2	LTD	-1.6	6.4	-14.4	23.4
8	2/18/92	20	4.0	4.2	2.2	LTD	-0.2	6.4	-1.8	36.1
9	2/18/92	21	4.2	4.2	2.2	LTD	0.0	6.4	0.0	37.9
10	2/18/92	10	2.0	4.2	2.2	LTD	-2.2	6.4	-19.8	18.0
11	2/19/92	25	5.0	4.9	2.2	LTD	0.1	6.4	0.9	45.1
12	2/19/92	17	3.4	4.9	2.2	LTD	-1.5	6.4	-13.5	30.6
13	2/19/92	15	3.0	4.9	2.2	LTD	-1.9	6.4	-17.1	27.0
14	2/19/92	33	6.6	4.9	2.2	LTD	1.7	6.4	15.3	59.5
15	2/19/92	22	4.4	4.9	2.2	LTD	-0.5	6.4	-4.5	39.7
16	2/19/92	17	3.4	4.9	2.2	LTD	-1.5	6.4	-13.5	30.6
17	2/19/92	23	4.6	4	2.2	LTD	0.6	6.4	5.4	41.5
18	2/19/92	26	5.2	4	2.2	LTD	1.2	6.4	10.8	46.9
19	2/19/92	26	5.2	4	2.2	LTD	1.2	6.4	10.8	46.9
20	2/19/92	23	4.6	4	2.2	LTD	0.6	6.4	5.4	41.5
21	2/19/92	22	4.4	4	2.2	LTD	0.4	6.4	3.6	39.7
22	2/19/92	26	5.2	4	2.2	LTD	1.2	6.4	10.8	46.9
23	2/19/92	27	5.4	4	2.2	LTD	1.4	6.4	12.6	48.7
24	2/19/92	22	4.4	4	2.2	LTD	0.4	6.4	3.6	39.7
25	4/22/92	15	3.0	2.8	1.8	LTD	0.2	7.1	2.0	30.0
26	4/22/92	9	1.8	2.8	1.8	LTD	-1.0	7.1	-10.0	18.0
27	4/22/92	16	3.2	2.8	1.8	LTD	0.4	7.1	4.0	32.0
28	4/16/92	30	6.0	5.3	2.4	LTD	0.7	6.4	6.3	54.1
29	4/16/92	36	7.2	5.3	2.4	LTD	1.9	6.4	17.1	64.9
30	4/16/92	28	5.6	5.3	2.4	LTD	0.3	6.4	2.7	50.5
31	4/16/92	27	5.4	5.3	2.4	LTD	0.1	6.4	0.9	48.7
32	4/22/92	6	1.2	2.8	1.8	LTD	-1.6	7.1	-16.0	12.0
33	4/22/92	12	2.4	2.8	1.8	LTD	-0.4	7.1	-4.0	24.0
34	4/22/92	5	1.0	2.8	1.8	LTD	-1.8	7.1	-18.0	10.0
35	4/16/92	40	8.0	5.3	2.4	0.3	2.7	6.4	24.3	72.1
36	4/16/92	37	7.4	5.3	2.4	LTD	2.1	6.4	18.9	66.7
37	4/16/92	27	5.4	5.3	2.4	LTD	0.1	6.4	0.9	48.7
38	4/16/92	23	4.6	5.3	2.4	LTD	-0.7	6.4	-6.3	41.5
39	4/22/92	11	2.2	2.8	1.8	LTD	-0.6	7.1	-6.0	22.0
40	4/22/92	9	1.8	2.8	1.8	LTD	-1.0	7.1	-10.0	18.0
41	4/22/92	8	1.6	2.8	1.8	LTD	-1.2	7.1	-12.0	16.0
42	4/16/92	27	5.4	5.3	2.4	LTD	0.1	6.4	0.9	48.7
43	4/16/92	22	4.4	5.3	2.4	LTD	-0.9	6.4	-8.1	39.7
44	4/22/92	11	2.2	2.8	1.8	LTD	-0.6	7.1	-6.0	22.0
45	4/22/92	21	4.2	2.8	1.8	LTD	1.4	7.1	14.0	42.0

Alpha Activity Data/2

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
46	4/22/92	19	3.8	2.8	1.8	LTD	1.0	7.1	10.0	38.0
47	4/16/92	27	5.4	5.3	2.4	LTD	0.1	6.4	0.9	48.7
48	4/17/92	11	2.2	2	1.6	LTD	0.2	7.1	2.0	22.0
49	4/17/92	17	3.4	2	1.6	LTD	1.4	7.1	14.0	34.0
50	4/22/92	14	2.8	2.8	1.8	LTD	0.0	7.1	0.0	28.0
51	4/22/92	13	2.6	2.8	1.8	LTD	-0.2	7.1	-2.0	26.0
52	4/22/92	9	1.8	2.8	1.8	LTD	-1.0	7.1	-10.0	18.0
53	4/17/92	14	2.8	2	1.6	LTD	0.8	7.1	8.0	28.0
54	4/17/92	15	3.0	2	1.6	LTD	1.0	7.1	10.0	30.0
56	4/22/92	9	1.8	2.8	1.8	LTD	-1.0	7.1	-10.0	18.0
57	4/22/92	11	2.2	2.8	1.8	LTD	-0.6	7.1	-6.0	22.0
58	4/22/92	9	1.8	2.8	1.8	LTD	-1.0	7.1	-10.0	18.0
59	4/17/92	18	3.6	2	1.6	LTD	1.6	7.1	16.0	36.0
60	4/17/92	14	2.8	2	1.6	LTD	0.8	7.1	8.0	28.0
61	4/17/92	16	3.2	2	1.6	LTD	1.2	7.1	12.0	32.0
62	4/22/92	14	2.8	2.8	1.8	LTD	0.0	7.1	0.0	28.0
63	4/23/92	9	1.8	2	1.4	LTD	-0.2	7.1	-2.0	18.0
64	4/23/92	8	1.6	2	1.4	LTD	-0.4	7.1	-4.0	16.0
65	4/17/92	8	1.6	2	1.6	LTD	-0.4	7.1	-4.0	16.0
66	4/17/92	15	3.0	2	1.6	LTD	1.0	7.1	10.0	30.0
67	4/17/92	12	2.4	2	1.6	LTD	0.4	7.1	4.0	24.0
68	4/23/92	11	2.2	2	1.4	LTD	0.2	7.1	2.0	22.0
69	4/23/92	14	2.8	2	1.4	LTD	0.8	7.1	8.0	28.0
70	4/23/92	9	1.8	2	1.4	LTD	-0.2	7.1	-2.0	18.0
71	4/17/92	6	1.2	2	1.6	LTD	-0.8	7.1	-8.0	12.0
72	4/17/92	12	2.4	2	1.6	LTD	0.4	7.1	4.0	24.0
73	4/20/92	12	2.4	1.7	1.4	LTD	0.7	7.1	7.0	24.0
74	4/23/92	17	3.4	2	1.4	LTD	1.4	7.1	14.0	34.0
75	4/23/92	8	1.6	2	1.4	LTD	-0.4	7.1	-4.0	16.0
76	4/23/92	15	3.0	2	1.4	LTD	1.0	7.1	10.0	30.0
77	4/20/92	8	1.6	1.7	1.4	LTD	-0.1	7.1	-1.0	16.0
78	4/20/92	14	2.8	1.7	1.4	LTD	1.1	7.1	11.0	28.0
79	4/20/92	14	2.8	1.7	1.4	LTD	1.1	7.1	11.0	28.0
80	4/20/92	14	2.8	1.7	1.4	LTD	1.1	7.1	11.0	28.0
81	4/23/92	14	2.8	2	1.4	LTD	0.8	7.1	8.0	28.0
82	4/23/92	12	2.4	2	1.4	LTD	0.4	7.1	4.0	24.0
83	4/20/92	6	1.2	1.7	1.4	LTD	-0.5	7.1	-5.0	12.0
84	4/20/92	9	1.8	1.7	1.4	LTD	0.1	7.1	1.0	18.0
85	4/20/92	15	3.0	1.7	1.4	LTD	1.3	7.1	13.0	30.0
86	4/20/92	11	2.2	1.7	1.4	LTD	0.5	7.1	5.0	22.0
87	4/20/92	10	2.0	1.7	1.4	LTD	0.3	7.1	3.0	20.0
88	4/20/92	7	1.4	1.7	1.4	LTD	-0.3	7.1	-3.0	14.0
89	4/20/92	11	2.2	1.7	1.4	LTD	0.5	7.1	5.0	22.0
90	4/20/92	9	1.8	1.7	1.4	LTD	0.1	7.1	1.0	18.0
91	4/20/92	17	3.4	1.7	1.4	0.3	1.7	7.1	17.0	34.0
92	4/20/92	9	1.8	1.7	1.4	LTD	0.1	7.1	1.0	18.0
93	4/20/92	15	3.0	1.7	1.4	LTD	1.3	7.1	13.0	30.0
D1	4/21/92	29	5.8	1.7	1.4	2.7	4.1	7.1	41.0	58.0

Alpha Activity Data/3

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
D2	4/21/92	22	4.4	1.7	1.4	1.3	2.7	7.1	27.0	44.0
D3	4/21/92	34	6.8	1.7	1.4	3.7	5.1	7.1	51.0	68.0
D4	4/21/92	26	5.2	1.7	1.4	2.1	3.5	7.1	35.0	52.0
D5	4/21/92	14	2.8	1.7	1.4	LTD	1.1	7.1	11.0	28.0
D6	4/21/92	20	4.0	1.7	1.4	0.9	2.3	7.1	23.0	40.0
D7	4/23/92	10	2.0	2	1.4	LTD	0.0	7.1	0.0	20.0
D8	4/23/92	16	3.2	2	1.4	LTD	1.2	7.1	12.0	32.0
								ave =	3.44	32.00
								std dev =	11.95	13.71

* LTD = "Less Than Detectable" (below SSA limit)

Alpha Counter Background Response:

Date	Total counts/shift time Start	Mid	End	Total Ct. Time (m)	Bkgd cpm	Convers. dpm/cpm	dpm/ 100 cm2	
4/16/92	42	34	35	21	5.3	6.4	47.65	Group ave:
4/17/92	16	11	16	21	2.0	7.1	20.48	6.84
4/20/92	12	10	13	21	1.7	7.1	16.67	dpm/100 cm2
4/21/92	11	13		14	1.7	7.1	17.14	
4/22/92	24	16	19	21	2.8	7.1	28.10	
4/23/92	13	16	14	21	2.0	7.1	20.48	
2/18/92	24	19	23	15	4.4	6.4	39.66	
2/18/92 A	24	19		10	4.3			
2/18/92 P		19	23	10	4.2			
2/19/92	26	23	17	15	4.4	6.4	39.66	
2/19/92 A	26	23		10	4.9			
2/19/92P		23	17	10	4.0			

Alpha Individual Background Counting Data T064BKR2.xls 2/19/93

Detector Area (Aalpha) = 71 cm^2

Date	Period	Counts	Time (min)	Ct. Rate (cpm)	Convers. dpm/cpm	dpm/ 100 cm2
2/18/92	am	24	5	4.8	6.4	43.3
2/18/92	mid	19	5	3.8	6.4	34.3
2/18/92	pm	23	5	4.6	6.4	41.5
2/19/92	am	26	5	5.2	6.4	46.9
2/19/92	mid	23	5	4.6	6.4	41.5
2/19/92	pm	17	5	3.4	6.4	30.6
4/16/92	am	33	5	6.6	6.4	59.5
4/16/92	mid	26	5	5.2	6.4	46.9
4/16/92	pm	21	5	4.2	6.4	37.9
4/17/92	am	13	5	2.6	7.1	26.0
4/17/92	mid	10	5	2	7.1	20.0
4/17/92	pm	13	5	2.6	7.1	26.0
4/20/92	am	9	5	1.8	7.1	18.0
4/20/92	mid	8	5	1.6	7.1	16.0
4/20/92	pm	11	5	2.2	7.1	22.0
4/21/92	am	8	5	1.6	7.1	16.0
4/21/92	mid	11	5	2.2	7.1	22.0
4/22/92	am	20	5	4	7.1	40.0
4/22/92	mid	12	5	2.4	7.1	24.0
4/22/92	pm	14	5	2.8	7.1	28.0
4/23/92	am	7	5	1.4	7.1	14.0
4/23/92	mid	11	5	2.2	7.1	22.0
4/23/92	pm	10	5	2	7.1	20.0

ave =	16.0	***ave alpha =***	30.27
std. dev. =	7.2	***std dev =***	12.27
ave/minute =	3.2	***SSA =***	28.55
SSA =	3.4		

Daily Average 5-Minute Count SSAs (for Individual Data Comparisons):

Date	Ave 5-min Count	SSA (cpm)
2/18/92	22.00	2.2
2/19/92	22.00	2.2
4/16/92	26.67	2.4
4/17/92	12.00	1.6
4/20/92	9.33	1.4
4/21/92	9.50	1.4
4/22/92	15.33	1.8
4/23/92	9.33	1.4

Beta Activity Data

Detector area (Abeta) = 20 cm^2

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
1	2/18/92	386	77.2	84	9.5	LTD	-6.8	8.4	-286	3242
2	2/18/92	422	84.4	84	9.5	LTD	0.4	8.4	17	3545
3/1	2/18/92	393	78.6	84	9.5	LTD	-5.4	8.4	-227	3301
3/2	2/18/92	368	73.6	84	9.5	LTD	-10.4	8.4	-437	3091
4	2/18/92	403	80.6	84	9.5	LTD	-3.4	8.4	-143	3385
5	2/18/92	440	88	84	9.5	LTD	4	8.4	168	3696
6	2/18/92	409	81.8	84	9.5	LTD	-2.2	8.4	-92	3436
7	2/18/92	425	85	84	9.5	LTD	1	8.4	42	3570
8	2/18/92	453	90.6	84	9.5	LTD	6.6	8.4	277	3805
9	2/18/92	423	84.6	84	9.5	LTD	0.6	8.4	25	3553
10	2/18/92	405	81	84	9.5	LTD	-3	8.4	-126	3402
11	2/19/92	417	83.4	82	9.7	LTD	1.4	8.4	59	3503
12	2/19/92	425	85	82	9.7	LTD	3	8.4	126	3570
13	2/19/92	418	83.6	82	9.7	LTD	1.6	8.4	67	3511
14	2/19/92	427	85.4	82	9.7	LTD	3.4	8.4	143	3587
15	2/19/92	448	89.6	82	9.7	LTD	7.6	8.4	319	3763
16	2/19/92	441	88.2	82	9.7	LTD	6.2	8.4	260	3704
17	2/19/92	421	84.2	88	9.7	LTD	-3.8	8.4	-160	3536
18	2/19/92	475	95	88	9.7	LTD	7	8.4	294	3990
19	2/19/92	416	83.2	88	9.7	LTD	-4.8	8.4	-202	3494
20	2/19/92	510	102	88	9.7	4.3	14	8.4	588	4284
21	2/19/92	487	97.4	88	9.7	LTD	9.4	8.4	395	4091
22	2/19/92	362	72.4	88	9.7	LTD	-15.6	8.4	-655	3041
23	2/19/92	419	83.8	88	9.7	LTD	-4.2	8.4	-176	3520
24	2/19/92	407	81.4	88	9.7	LTD	-6.6	8.4	-277	3419
25	4/21/92	395	79	81	9.5	LTD	-2	7.9	-79	3121
26	4/21/92	450	90	81	9.5	LTD	9	7.9	356	3555
27	4/21/92	447	89.4	81	9.5	LTD	8.4	7.9	332	3531
28	4/17/92	449	89.8	78	9.1	2.7	11.8	7.9	466	3547
29	4/17/92	442	88.4	78	9.1	1.3	10.4	7.9	411	3492
30	4/17/92	423	84.6	78	9.1	LTD	6.6	7.9	261	3342
31	4/17/92	428	85.6	78	9.1	LTD	7.6	7.9	300	3381
32	4/21/92	446	89.2	81	9.5	LTD	8.2	7.9	324	3523
33	4/21/92	404	80.8	81	9.5	LTD	-0.2	7.9	-8	3192
34	4/21/92	415	83	81	9.5	LTD	2	7.9	79	3279
35	4/17/92	438	87.6	78	9.1	0.5	9.6	7.9	379	3460
36	4/17/92	420	84	78	9.1	LTD	6	7.9	237	3318
37	4/17/92	390	78	78	9.1	LTD	0	7.9	0	3081
38	4/17/92	402	80.4	78	9.1	LTD	2.4	7.9	95	3176
39	4/21/92	437	87.4	81	9.5	LTD	6.4	7.9	253	3452
40	4/21/92	428	85.6	81	9.5	LTD	4.6	7.9	182	3381
41	4/21/92	457	91.4	81	9.5	0.9	10.4	7.9	411	3610
42	4/17/92	411	82.2	78	9.1	LTD	4.2	7.9	166	3247
43	4/17/92	440	88	78	9.1	0.9	10	7.9	395	3476
44	4/22/92	470	94	78	9.1	6.9	16	7.9	632	3713
45	4/22/92	472	94.4	78	9.1	7.3	16.4	7.9	648	3729

Beta Activity Data/2

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
46	4/22/92	462	92.4	78	9.1	5.3	14.4	7.9	569	3650
47	4/17/92	436	87.2	78	9.1	0.1	9.2	7.9	363	3444
48	4/17/92	445	89	78	9.1	1.9	11	7.9	435	3516
49	4/17/92	533	106.6	78	9.1	19.5	28.6	7.9	1130	4211
50	4/22/92	442	88.4	78	9.1	1.3	10.4	7.9	411	3492
51	4/22/92	444	88.8	78	9.1	1.7	10.8	7.9	427	3508
52	4/22/92	454	90.8	78	9.1	3.7	12.8	7.9	506	3587
53	4/17/92	429	85.8	78	9.1	LTD	7.8	7.9	308	3389
54	4/17/92	445	89	78	9.1	1.9	11	7.9	435	3516
56	4/22/92	449	89.8	78	9.1	2.7	11.8	7.9	466	3547
57	4/22/92	450	90	78	9.1	2.9	12	7.9	474	3555
58	4/22/92	492	98.4	78	9.1	11.3	20.4	7.9	806	3887
59	4/17/92	512	102.4	78	9.1	15.3	24.4	7.9	964	4045
60	4/17/92	455	91	78	9.1	3.9	13	7.9	514	3595
61	4/17/92	480	96	78	9.1	8.9	18	7.9	711	3792
62	4/22/92	454	90.8	78	9.1	3.7	12.8	7.9	506	3587
63	4/23/92	441	88.2	81	9.4	LTD	7.2	7.9	284	3484
64	4/23/92	442	88.4	81	9.4	LTD	7.4	7.9	292	3492
65	4/17/92	402	80.4	78	9.1	LTD	2.4	7.9	95	3176
66	4/17/92	472	94.4	78	9.1	7.3	16.4	7.9	648	3729
67	4/17/92	543	108.6	78	9.1	21.5	30.6	7.9	1209	4290
68	4/23/92	440	88	81	9.4	LTD	7	7.9	277	3476
69	4/23/92	457	91.4	81	9.4	1	10.4	7.9	411	3610
70	4/23/92	434	86.8	81	9.4	LTD	5.8	7.9	229	3429
71	4/17/92	455	91	78	9.1	3.9	13	7.9	514	3595
72	4/17/92	469	93.8	78	9.1	6.7	15.8	7.9	624	3705
73	4/20/92	442	88.4	91	10.1	LTD	-2.6	7.9	-103	3492
74	4/23/92	415	83	81	9.4	LTD	2	7.9	79	3279
75	4/23/92	462	92.4	81	9.4	2	11.4	7.9	450	3650
76	4/23/92	462	92.4	81	9.4	2	11.4	7.9	450	3650
77	4/20/92	445	89	91	10.1	LTD	-2	7.9	-79	3516
78	4/20/92	436	87.2	91	10.1	LTD	-3.8	7.9	-150	3444
79	4/20/92	426	85.2	91	10.1	LTD	-5.8	7.9	-229	3365
80	4/20/92	446	89.2	91	10.1	LTD	-1.8	7.9	-71	3523
81	4/23/92	479	95.8	81	9.4	5.4	14.8	7.9	585	3784
82	4/23/92	445	89	81	9.4	LTD	8	7.9	316	3516
83	4/20/92	428	85.6	91	10.1	LTD	-5.4	7.9	-213	3381
84	4/20/92	433	86.6	91	10.1	LTD	-4.4	7.9	-174	3421
85	4/20/92	410	82	91	10.1	LTD	-9	7.9	-356	3239
86	4/20/92	471	94.2	91	10.1	LTD	3.2	7.9	126	3721
87	4/20/92	518	103.6	91	10.1	2.5	12.6	7.9	498	4092
88	4/20/92	434	86.8	91	10.1	LTD	-4.2	7.9	-166	3429
89	4/20/92	471	94.2	91	10.1	LTD	3.2	7.9	126	3721
90	4/20/92	473	94.6	91	10.1	LTD	3.6	7.9	142	3737
91	4/20/92	469	93.8	91	10.1	LTD	2.8	7.9	111	3705
92	4/20/92	474	94.8	91	10.1	LTD	3.8	7.9	150	3745
93	4/20/92	442	88.4	91	10.1	LTD	-2.6	7.9	-103	3492
D1	4/21/92	407	81.4	81	9.5	LTD	0.4	7.9	16	3215

Beta Activity Data/3

Grid Point	Meas. Date	Total Cts. (5 min)	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Convers. dpm/cpm	dpm/ 100 cm2 (- bkgd)	dpm/ 100 cm2 (w/bkgd)
D2	4/21/92	489	97.8	81	9.5	7.3	16.8	7.9	664	3863
D3	4/21/92	422	84.4	81	9.5	LTD	3.4	7.9	134	3334
D4	4/21/92	420	84	81	9.5	LTD	3	7.9	119	3318
D5	4/21/92	362	72.4	81	9.5	LTD	-8.6	7.9	-340	2860
D6	4/21/92	368	73.6	81	9.5	LTD	-7.4	7.9	-292	2907
D7	4/23/92	394	78.8	81	9.4	LTD	-2.2	7.9	-87	3113
D8	4/23/92	474	94.8	81	9.4	4.4	13.8	7.9	545	3745
G1	4/24/92	453	90.6	81	9.5	0.1	9.6	7.9	379	3579
G2	4/24/92	477	95.4	81	9.5	4.9	14.4	7.9	569	3768
G3	4/24/92	463	92.6	81	9.5	2.1	11.6	7.9	458	3658
G4	4/24/92	492	98.4	81	9.5	7.9	17.4	7.9	687	3887
G5	4/24/92	436	87.2	81	9.5	LTD	6.2	7.9	245	3444
G6	4/24/92	449	89.8	81	9.5	LTD	8.8	7.9	348	3547
G7	4/24/92	514	102.8	81	9.5	12.3	21.8	7.9	861	4061
G8	4/24/92	450	90	81	9.5	LTD	9	7.9	356	3555
G9	4/24/92	472	94.4	81	9.5	3.9	13.4	7.9	529	3729
G10	4/24/92	444	88.8	81	9.5	LTD	7.8	7.9	308	3508
G11	4/24/92	454	90.8	81	9.5	0.3	9.8	7.9	387	3587
								ave =	238.55	3540.39
								std dev =	328.42	257.80

Beta Counter Background Response:

Date	Total counts/shift time Start	Mid	End	Total Ct. Time (m)	Bkgd cpm	Convers. dpm/cpm	dpm/ 100 cm2	
4/17/92	558	548	540	21	78	7.9	3096	Group ave:
4/20/92	764	557	589	21	91	7.9	3593	3313
4/21/92	555	558	583	21	81	7.9	3190	dpm/100 cm2
4/22/92	540	565	542	21	78	7.9	3098	
4/23/92	557	575	576	21	81	7.9	3213	
4/24/92	556		572	14	81	7.9	3183	
2/18/92	418	418	417	15	84	8.4	3508	
2/18/92 A	418	418		10	84			
2/18/92 P		418	417	10	84			
2/19/92	415	405	473	15	86	8.4	3620	
2/19/92 A	415	405		10	82			
2/19/92P		405	473	10	88			

Beta Individual Background Counting Data

Detector Area (Abeta) = 20 cm^2

Date	Period	Counts	Time (min)	Ct. Rate (cpm)	Convers. dpm/cpm	dpm/ 100 cm2
2/18/92	am	418	5	83.6	8.4	3511
2/18/92	mid	418	5	83.6	8.4	3511
2/18/92	pm	417	5	83.4	8.4	3503
2/19/92	am	415	5	83	8.4	3486
2/19/92	mid	405	5	81	8.4	3402
2/19/92	pm	473	5	94.6	8.4	3973
4/17/92	am	385	5	77	7.9	3042
4/17/92	mid	390	5	78	7.9	3081
4/17/92	pm	377	5	75.4	7.9	2978
4/20/92	am	587	5	117.4	7.9	4637
4/20/92	mid	402	5	80.4	7.9	3176
4/20/92	pm	418	5	83.6	7.9	3302
4/21/92	am	417	5	83.4	7.9	3294
4/21/92	mid	409	5	81.8	7.9	3231
4/21/92	pm	424	5	84.8	7.9	3350
4/22/92	am	392	5	78.4	7.9	3097
4/22/92	mid	383	5	76.6	7.9	3026
4/22/92	pm	378	5	75.6	7.9	2986
4/23/92	am	402	5	80.4	7.9	3176
4/23/92	mid	404	5	80.8	7.9	3192
4/23/92	pm	406	5	81.2	7.9	3207
4/24/92	am	412	5	82.4	7.9	3255
4/24/92	pm	420	5	84	7.9	3318
	ave =	415.3		*ave beta =*		3336
	std. dev. =	42.5		*std dev =*		362
	ave/minute =	83.1		*SSA =*		842
	SSA =	19.8				

Daily Average 5-Minute Count SSAs (for Individual Data Comparisons):

Date	Ave 5-min Count	SSA (cpm)
2/18/92	417.67	9.5
2/19/92	431.00	9.7
4/17/92	384.00	9.1
4/20/92	469.00	10.1
4/21/92	416.67	9.5
4/22/92	384.33	9.1
4/23/92	404.00	9.4
4/24/93	416.00	9.5

Gamma Exposure Rate Data

conversion=1/kgam
kgam = 215

* Indiv. bkgd subtraction

** Ave. bkgd (bgam) subtraction, bgam = 15.3 µR/h

Grid Point	Meas. Date	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Net Rate * (µR/h)	Total Rate (µR/h)	Net Rate** (µR/h)
1	2/18/92	2564	2901	127.5	LTD	-337	-1.57	11.93	-3.37
2	2/18/92	2864	2901	127.5	LTD	-37	-0.17	13.32	-1.98
3/1	2/18/92	2822	2901	127.5	LTD	-79	-0.37	13.13	-2.17
3/2	2/18/92	2880	2901	127.5	LTD	-21	-0.10	13.40	-1.90
4	2/18/92	2914	3065	127.5	LTD	-151	-0.70	13.55	-1.75
5	2/18/92	3085	3065	127.5	LTD	20	0.09	14.35	-0.95
6	2/18/92	3048	3065	127.5	LTD	-17	-0.08	14.18	-1.12
7	2/18/92	3136	3065	127.5	LTD	71	0.33	14.59	-0.71
8	2/18/92	3386	3065	127.5	193.5	321	1.49	15.75	0.45
9	2/18/92	2843	3065	127.5	LTD	-222	-1.03	13.22	-2.08
10	2/18/92	2864	3065	127.5	LTD	-201	-0.93	13.32	-1.98
11	2/19/92	3214	2903	128.1	182.9	311	1.45	14.95	-0.35
12	2/19/92	2936	2903	128.1	LTD	33	0.15	13.66	-1.64
13	2/19/92	2983	2903	128.1	LTD	80	0.37	13.87	-1.43
14	2/19/92	2937	2903	128.1	LTD	34	0.16	13.66	-1.64
15	2/19/92	3039	2903	128.1	7.9	136	0.63	14.13	-1.17
16	2/19/92	3183	2903	128.1	151.9	280	1.30	14.80	-0.50
17	2/19/92	3622	3098	128.1	395.9	524	2.44	16.85	1.55
18	2/19/92	4035	3098	128.1	808.9	937	4.36	18.77	3.47
19	2/19/92	3104	3098	128.1	LTD	6	0.03	14.44	-0.86
20	2/19/92	3099	3098	128.1	LTD	1	0.00	14.41	-0.89
21	2/19/92	3185	3098	128.1	LTD	87	0.40	14.81	-0.49
22	2/19/92	2893	3098	128.1	LTD	-205	-0.95	13.46	-1.84
23	2/19/92	2937	3098	128.1	LTD	-161	-0.75	13.66	-1.64
24	2/19/92	2641	3098	128.1	LTD	-457	-2.13	12.28	-3.02
25	4/21/92	2877	2810	122.2	LTD	67	0.31	13.38	-1.92
26	4/21/92	2994	2810	122.2	61.8	184	0.86	13.93	-1.37
27	4/21/92	3239	2810	122.2	306.8	429	2.00	15.07	-0.23
28	4/16/92	3009	2600	118.4	290.6	409	1.90	14.00	-1.30
29	4/16/92	2867	2600	118.4	148.6	267	1.24	13.33	-1.97
30	4/16/92	2892	2600	118.4	173.6	292	1.36	13.45	-1.85
31	4/16/92	2981	2600	118.4	262.6	381	1.77	13.87	-1.43
32	4/21/92	2941	2810	122.2	8.8	131	0.61	13.68	-1.62
33	4/21/92	3111	2810	122.2	178.8	301	1.40	14.47	-0.83
34	4/21/92	3376	2810	122.2	443.8	566	2.63	15.70	0.40
35	4/16/92	2889	2600	118.4	170.6	289	1.34	13.44	-1.86
36	4/16/92	2703	2600	118.4	LTD	103	0.48	12.57	-2.73
37	4/16/92	2684	2600	118.4	LTD	84	0.39	12.48	-2.82
38	4/16/92	2904	2600	118.4	185.6	304	1.41	13.51	-1.79
39	4/21/92	2959	2810	122.2	26.8	149	0.69	13.76	-1.54
40	4/21/92	3113	2810	122.2	180.8	303	1.41	14.48	-0.82
41	4/21/92	3296	2810	122.2	363.8	486	2.26	15.33	0.03
42	4/16/92	2900	2600	118.4	181.6	300	1.40	13.49	-1.81
43	4/16/92	2898	2600	118.4	179.6	298	1.39	13.48	-1.82
44	4/22/92	2963	2679	120.0	164	284	1.32	13.78	-1.52
45	4/22/92	3324	2679	120.0	525	645	3.00	15.46	0.16

Gamma Exposure Rate Data/2

Grid Point	Meas. Date	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Net Rate * (µR/h)	Total Rate (µR/h)	Net Rate** (µR/h)
46	4/22/92	3344	2679	120.0	545	665	3.09	15.55	0.25
47	4/16/92	2715	2600	118.4	LTD	115	0.53	12.63	-2.67
48	4/17/92	2954	2777	121.6	55.4	177	0.82	13.74	-1.56
49	4/17/92	3186	2777	121.6	287.4	409	1.90	14.82	-0.48
50	4/22/92	3141	2679	120.0	342	462	2.15	14.61	-0.69
51	4/22/92	3255	2679	120.0	456	576	2.68	15.14	-0.16
52	4/22/92	3473	2679	120.0	674	794	3.69	16.15	0.85
53	4/17/92	2756	2777	121.6	LTD	-21	-0.10	12.82	-2.48
54	4/17/92	3021	2777	121.6	122.4	244	1.13	14.05	-1.25
56	4/22/92	3129	2679	120.0	330	450	2.09	14.55	-0.75
57	4/22/92	3055	2679	120.0	256	376	1.75	14.21	-1.09
58	4/22/92	3308	2679	120.0	509	629	2.93	15.39	0.09
59	4/17/92	2831	2777	121.6	LTD	54	0.25	13.17	-2.13
60	4/17/92	3180	2777	121.6	281.4	403	1.87	14.79	-0.51
61	4/17/92	3143	2777	121.6	244.4	366	1.70	14.62	-0.68
62	4/22/92	3131	2679	120.0	332	452	2.10	14.56	-0.74
63	4/23/92	3160	2759	123.4	277.6	401	1.87	14.70	-0.60
64	4/23/92	3258	2759	123.4	375.6	499	2.32	15.15	-0.15
65	4/17/92	3062	2777	121.6	163.4	285	1.33	14.24	-1.06
66	4/17/92	3016	2777	121.6	117.4	239	1.11	14.03	-1.27
67	4/17/92	3095	2777	121.6	196.4	318	1.48	14.40	-0.90
68	4/23/92	3032	2759	123.4	149.6	273	1.27	14.10	-1.20
69	4/23/92	3164	2759	123.4	281.6	405	1.88	14.72	-0.58
70	4/23/92	3182	2759	123.4	299.6	423	1.97	14.80	-0.50
71	4/17/92	2921	2777	121.6	22.4	144	0.67	13.59	-1.71
72	4/17/92	2956	2777	121.6	57.4	179	0.83	13.75	-1.55
73	4/20/92	3111	2743	121.5	246.5	368	1.71	14.47	-0.83
74	4/23/92	3068	2759	123.4	185.6	309	1.44	14.27	-1.03
75	4/23/92	3093	2759	123.4	210.6	334	1.55	14.39	-0.91
76	4/23/92	3208	2759	123.4	325.6	449	2.09	14.92	-0.38
77	4/20/92	2934	2743	121.5	69.5	191	0.89	13.65	-1.65
78	4/20/92	2893	2743	121.5	28.5	150	0.70	13.46	-1.84
79	4/20/92	2958	2743	121.5	93.5	215	1.00	13.76	-1.54
80	4/20/92	3176	2743	121.5	311.5	433	2.01	14.77	-0.53
81	4/23/92	3030	2679	123.4	227.6	351	1.63	14.09	-1.21
82	4/23/92	3180	2679	123.4	377.6	501	2.33	14.79	-0.51
83	4/20/92	2926	2743	121.5	61.5	183	0.85	13.61	-1.69
84	4/20/92	2805	2743	121.5	LTD	62	0.29	13.05	-2.25
85	4/20/92	2992	2743	121.5	127.5	249	1.16	13.92	-1.38
86	4/20/92	3130	2743	121.5	265.5	387	1.80	14.56	-0.74
87	4/20/92	3015	2743	121.5	150.5	272	1.27	14.02	-1.28
88	4/20/92	2966	2743	121.5	101.5	223	1.04	13.80	-1.50
89	4/20/92	3067	2743	121.5	202.5	324	1.51	14.27	-1.03
90	4/20/92	2974	2743	121.5	109.5	231	1.07	13.83	-1.47
91	4/20/92	3050	2743	121.5	185.5	307	1.43	14.19	-1.11
92	4/20/92	3005	2743	121.5	140.5	262	1.22	13.98	-1.32
93	4/20/92	3001	2743	121.5	136.5	258	1.20	13.96	-1.34
D1	4/21/92	2833	2810	122.2	LTD	23	0.11	13.18	-2.12

Gamma Exposure Rate Data/3

Grid Point	Meas. Date	Total (T) cpm	Bkgd (B) cpm	Daily SSA	SSA Test (T-B-SSA)	Net cpm (T - B)	Net Rate * (μR/h)	Total Rate (μR/h)	Net Rate** (μR/h)
D2	4/21/92	2839	2810	122.2	LTD	29	0.13	13.20	-2.10
D3	4/21/92	2780	2810	122.2	LTD	-30	-0.14	12.93	-2.37
D4	4/21/92	2902	2810	122.2	LTD	92	0.43	13.50	-1.80
D5	4/21/92	2305	2810	122.2	LTD	-505	-2.35	10.72	-4.58
D6	4/21/92	2271	2810	122.2	LTD	-539	-2.51	10.56	-4.74
D7	4/23/92	3029	2759	123.4	146.6	270	1.26	14.09	-1.21
D8	4/23/92	2997	2759	123.4	114.6	238	1.11	13.94	-1.36
G1	4/23/92	3283	2759	123.4	400.6	524	2.44	15.27	-0.03
G2	4/23/92	3322	2759	123.4	439.6	563	2.62	15.45	0.15
G3	4/23/92	3085	2759	123.4	202.6	326	1.52	14.35	-0.95
G4	4/23/92	3174	2759	123.4	291.6	415	1.93	14.76	-0.54
G5	4/23/92	3324	2759	123.4	441.6	565	2.63	15.46	0.16
G6	4/23/92	3200	2759	123.4	317.6	441	2.05	14.88	-0.42
G7	4/23/92	3381	2759	123.4	498.6	622	2.89	15.73	0.43
G8	4/23/92	3341	2759	123.4	458.6	582	2.71	15.54	0.24
G9	4/23/92	3337	2759	123.4	454.6	578	2.69	15.52	0.22
G10	4/23/92	3262	2759	123.4	379.6	503	2.34	15.17	-0.13
G11	4/23/92	3740	2759	123.4	857.6	981	4.56	17.40	2.10
						ave =	1.17	14.19	
						std dev =	1.23	1.11	

Gamma Counter Background Response:

Date	Total counts/shift time Start	Mid	End	Total Ct. Time (m)	Bkgd cpm
4/16/92	17633	18403	18558	21	2600
4/17/92	19805		19069	14	2777
4/20/92	19281	19204	19128	21	2743
4/21/92	19681	19664	19656	21	2810
4/22/92	18354	18961	18938	21	2679
4/23/92	19561	19085	19300	21	2759
2/18/92	2886	2916	3214	3	3005
2/18/92 A	2886	2916		2	2901
2/18/92 P		2916	3214	2	3065
2/19/92	2901	2904	3291	3	3032
2/19/92 A	2901	2904		2	2903
2/19/92P		2904	3291	2	3098

Gamma Individual Background Counting Data

Conversion Factor (kgam) = 215

Date	Period	Total Counts	Time (min)	Ct. Rate (cpm)	Exp. Rate (µR/h)
2/18/92	am	2886	1	2886	13.42
2/18/92	mid	2916	1	2916	13.56
2/18/92	pm	3214	1	3214	14.95
2/19/92	am	2901	1	2901	13.49
2/19/92	mid	2904	1	2904	13.51
2/19/92	pm	3291	1	3291	15.31
4/16/92	am	2530	1	2530	11.77
4/16/92	am	2527	1	2527	11.75
4/16/92	mid	2659	1	2659	12.37
4/16/92	mid	2578	1	2578	11.99
4/16/92	pm	2614	1	2614	12.16
4/16/92	pm	2626	1	2626	12.21
4/17/92	am	2832	1	2832	13.17
4/17/92	am	2748	1	2748	12.78
4/17/92	pm	2722	1	2722	12.66
4/17/92	pm	2626	1	2626	12.21
4/20/92	am	2723	1	2723	12.67
4/20/92	am	2728	1	2728	12.69
4/20/92	mid	2737	1	2737	12.73
4/20/92	mid	2736	1	2736	12.73
4/20/92	pm	2687	1	2687	12.50
4/20/92	pm	2743	1	2743	12.76
4/21/92	am	2719	1	2719	12.65
4/21/92	am	2791	1	2791	12.98
4/21/92	mid	2756	1	2756	12.82
4/21/92	mid	2681	1	2681	12.47
4/21/92	pm	2798	1	2798	13.01
4/21/92	pm	2802	1	2802	13.03
4/22/92	am	2713	1	2713	12.62
4/22/92	am	2568	1	2568	11.94
4/22/92	mid	2579	1	2579	12.00
4/22/92	mid	2693	1	2693	12.53
4/22/92	pm	2732	1	2732	12.71
4/22/92	pm	2683	1	2683	12.48
4/23/92	am	2906	1	2906	13.52
4/23/92	am	2795	1	2795	13.00
4/23/92	mid	2772	1	2772	12.89
4/23/92	mid	2785	1	2785	12.95
4/23/92	pm	2835	1	2835	13.19
4/23/92	pm	2790	1	2790	12.98
	ave =	2758		*avegam =*	12.83
	std dev =	153		*std dev =*	0.71
	SSA =	357		*SSA =*	1.66

Gamma Individual Background Counting Data/2

Daily Average 5-Minute Count SSAs (for Individual Data Comparisons):

Date	Ave 1-min Count	SSA (cpm)
2/18/92	3005	127.5
2/19/92	3032	128.1
4/16/92	2589	118.4
4/17/92	2732	121.6
4/20/92	2726	121.5
4/21/92	2758	122.2
4/22/92	2661	120.0
4/23/92	2814	123.4

Summary of Soil/Asphalt Radiological Concentration Measurements T-SOIL2.xls 3/12/93

Grid Location	Sample Type	Measured Activity	2-Sigma Uncertainty	Analytical Background	SSA	Net Activity	
40K Activity (pCi/g):							
8	soil	22.46	0.27	0.17	0.04	22.29	
49	soil	14.45	0.32	0.15	0.06	14.30	
51	soil	21.08	0.15	0.19	0.03	20.89	
52	soil	22.37	0.40	0.21	0.07	22.16	
80	soil	18.70	0.39	0.17	0.07	18.53	
18	asphalt	19.89	0.36	0.15	0.08	19.74	
21	asphalt	20.09	0.42	0.16	0.10	19.93	
28	asphalt	19.98	0.48	0.15	0.11	19.83	
41	asphalt	17.83	0.36	0.16	0.09	17.67	
49	asphalt	17.99	0.45	0.15	0.11	17.84	
51	asphalt	20.38	0.49	0.17	0.13	20.21	Average:
65	asphalt	17.98	0.58	0.17	0.15	17.81	19.29
73	rock/soil	21.76	0.41	0.17	0.10	21.59	Std. Dev.:
80	rock/soil	17.41	0.52	0.16	0.14	17.25	2.21
137Cs Activity (pCi/g):							
8	soil	0.97	0.02	0.00	0.00	0.97	
49	soil	0.12	0.01	0.00	0.00	0.12	
51	soil	0.05	0.01	0.00	0.00	0.05	
52	soil	0.02	0.01	0.00	0.00	0.02	
80	soil	0.02	0.01	0.00	0.01	0.02	
18	asphalt	0.05	0.01	0.00	0.01	0.05	
21	asphalt	0.08	0.02	0.00	0.01	0.08	
28	asphalt	0.76	0.03	0.00	0.01	0.76	
41	asphalt	0.04	0.01	0.00	0.01	0.04	
49	asphalt	3.12	0.05	0.00	0.01	3.12	
51	asphalt	0.09	0.02	0.00	0.01	0.09	Average:
65	asphalt	0.06	0.02	0.00	0.01	0.06	0.41
73	rock/soil	0.15	0.02	0.00	0.01	0.15	Std. Dev.:
80	rock/soil	0.23	0.02	0.00	0.01	0.23	0.83
235U Activity (pCi/g):							
8	soil	0.08	0.007	0.01	0.00	0.071	
49	soil	0.04	0.006	0.00	0.00	0.036	
51	soil	0.06	0.006	0.01	0.00	0.056	
52	soil	0.07	0.009	0.01	0.00	0.062	
80	soil	0.05	0.008	0.01	0.00	0.048	
18	asphalt	0.04	0.01	0.01	0.01	0.03	
21	asphalt	0.04	0.02	0.01	0.01	0.03	
28	asphalt	0.06	0.10	0.01	0.01	0.05	
41	asphalt	0.03	0.01	0.01	0.01	0.02	
49	asphalt	0.03	0.01	0.01	0.01	0.02	
51	asphalt	0.03	0.01	0.01	0.01	0.02	Average:
65	asphalt	0.04	0.02	0.01	0.01	0.03	0.04
73	rock/soil	0.06	0.01	0.01	0.01	0.05	Std. Dev.:
80	rock/soil	0.03	0.01	0.01	0.01	0.02	0.02

APPENDIX B

LIST OF ITEMS IN THE BUILDING T064 FENCED-IN YARD RADIOLOGICAL SURVEY FILE

The following table provides an annotated list of the records generated during this survey and maintained in the Building T064 decontamination and decommissioning files.

ITEMS IN THE BUILDING T064 FENCED-IN YARD RADIOLOGICAL SURVEY FILE

1. Richards, C. D., "Building 064 Radiologic Survey and Sampling," Energy Technology Engineering Center, Report SSWA-SOP-0001 (February 28, 1992). *(The procedures and sampling plan used for this fenced-in yard survey.)*

2. Original radiation survey report forms (Form 732-A, Rev 1-91) used to record the fenced-in yard alpha, beta, and gamma survey counting measurements.

3. Radiation Protection and Health Physics Services Daily Instrument Qualification reports that record the daily instrument checks and background measurements performed during the survey periods.

4. Copies of the Building 064 Operations Log pages that document personnel activities during the February 1992 survey measurement period.

5. MicroSoft EXCEL spreadsheets that tabulate the survey data and perform the analyses converting the measurements to activity and exposure rate units.

6. Data records documenting the soil and asphalt radionuclide concentration measurements.

7. D. W. Kneff, R. J. Tuttle, and G. Subbaramań, "Radiological Assessment of the Building T064 Fenced-In Yard," Rockwell International, Rocketdyne Division Supporting Document N704SRR990035 (December 1993). *(This final survey report.)*

FORWARD

The purpose of this Docket is to document the successful decontamination & decommissioning of Facility 4064, along with its surroundings, 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 4064 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 4064 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 4064 without Radiological Restrictions at 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 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.

ETEC 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 4064.

Building 4064, was a facility used for the storage of non-irradiated uranium, fuel material, and fuel elements manufactured at the De Soto and Santa Susana Field Laboratories. Equipment and containers of radioactive material were periodically stored in the building's side yard. In 1989, operations at the facility were terminated. In 1993, the building was emptied of all contents, both radioactive and non-radioactive. Then the facility was decontaminated and the area was surveyed. In 1996 the building was approved for demoltion by the Department of Energy and the Californiat Department of Health Services.

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education (ORISE) completed an independent verification of the building in 1994 and the sidyard in 1998.

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: 0 5 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/

(06-93)

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

SEP 1996 RECEIVED

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

Printed on recycled paper

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LIST OF TABLES

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

	Gamma Shielding Factor	
Radial Location	**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 $DCGL_W$s (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 Default
	Industrial	Wilderness	Residential	
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
	Industrial	Wilderness	Residential	Default
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
	Industrial	Wilderness	Residential	Default
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 4064 IN AREA IV AT SSFL

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

January 25, 1999

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

SUBJECT: SECOND ADDENDUM TO THE VERIFICATION SURVEY OF THE BUILDING T064 SIDE YARD, SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA (ORISE 1993 AND 1995)

Dear Mr. Gupta:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) recently completed the third verification of the Building T064 (now known as 4054) Side Yard at the Santa Susana Field Laboratory (SSFL) 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 U.S. 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.

One of these SSFL facilities, the Building T064 Side Yard (Figure 2), was occasionally used for storage of recoverable uranium scrap, irradiated fuel elements, and miscellaneous radioactive wastes. In the early 1960's, the drain plug of a lead-pig cask containing irradiated "Seawolf" fuel and contaminated water failed and allowed the contaminated water to leak into the side yard. A 65 m^2 area was excavated immediately following the incident. However, a 1988 comprehensive radiological survey of the area around Building T064 identified elevated soil concentrations of Cs-137 (and an assumed equivalent amount of Sr-90). Further investigations determined that a 47 m^2 area of contamination was located within the northeast fence line and extended in the northeast direction past the fence line over an additional area of 370 m^2. A Cs-137 guideline was developed and the top 41 cm of soil was, subsequently, excavated from the area and a post-remedial action survey performed and documented. However, ESSAP verification surveys performed in 1992, and then again in 1995, identified the presence of contamination in excess of the guideline (ORISE 1993, and 1995). Further remedial activities in 1996 included the removal of additional soils and a septic tank and its leach field. The additional soil excavated from the side yard extended southeast under G street to an area approximately 45 meters in diameter on the south side of the street. After these areas were decontaminated by Rocketdyne/Boeing, core sampling was performed to document the final radiological status of the area (Boeing 1998).

On September 29, 1998, ESSAP performed a reverification survey of the Building T064 Side Yard and the additional remediated land areas. The survey was conducted in accordance with a DOE approved site-specific survey plan (ORISE 1998). Survey procedures included gamma surface scans using NaI scintillation detectors coupled to ratemeters with audible indicators, exposure rate measurements using a microrem meter, and soil sampling.

ESSAP's surface scans of the area identified elevated direct gamma radiation in an area due west of the location where Building T064 formerly stood and outside of the project remediation boundary (Figure 2). Surface scans of the remaining excavated area did not identify any locations of elevated direct radiation. Soil samples were collected from 19 locations—four of which represented samples from the area of elevated direct gamma radiation detected by surface scans and the remaining 15 were from randomly selected locations (Figure 3). Exposure rate measurements were performed at one meter above each sampling location. Rocketdyne/Boeing personnel were notified that contamination was suspected in the area of elevated direct gamma radiation and they elected to perform additional remediation while ESSAP was on-site. ESSAP personnel then collected two post-remedial action samples.

Samples were analyzed by gamma spectroscopy at ESSAP's laboratory in Oak Ridge, Tennessee. Analytical results are provided in Table 1. Cesium-137 concentrations in soil samples from random locations ranged from less than 0.06 to 2.9 pCi/g and those collected from the area of elevated direct gamma radiation ranged from 23.4 to 80.6 pCi/g. The Cs-137 concentrations in the two post-remedial action samples were 0.4 and 0.6 pCi/g. Exposure rates ranged from 9 to 13 μR/h.

The verification survey results were compared with the guidelines established for the SSFL (DOE 1996 and State of California 1996). The site-specific criterion for Cs-137 is 9.2 pCi/g (Table 2). After the additional remediation, Cs-137 concentrations were within this criterion. The DOE exposure rate guideline is 20 μR/h above background (DOE 1990). However, Rocketdyne/Boeing has elected to use a more conservative criterion of 5 μR/h above background. Exterior background exposure rates for the SSFL average 14 μR/h. The T064 Side Yard exposure rates ranged from 9 to 13 μR/h and therefore, satisfy this criterion.

In summary, ESSAP's verification survey supports Rocketdyne/Boeing's conclusion that the T064 Side Yard satisfies the criteria for release for unrestricted use. However, it is ESSAP's opinion that the source of the contaminated area that ESSAP identified outside of the project area should be investigated and addressed by Rocketdyne/Boeing.

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

Sincerely,

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

TJV:dkh

Enclosure

cc: M. Lopez, DOE/OAK
H. Joma, DOE/OAK
W. Beck, ORISE/ESSAP
E. Abelquist, ORISE/ESSAP
Files/357 and 402

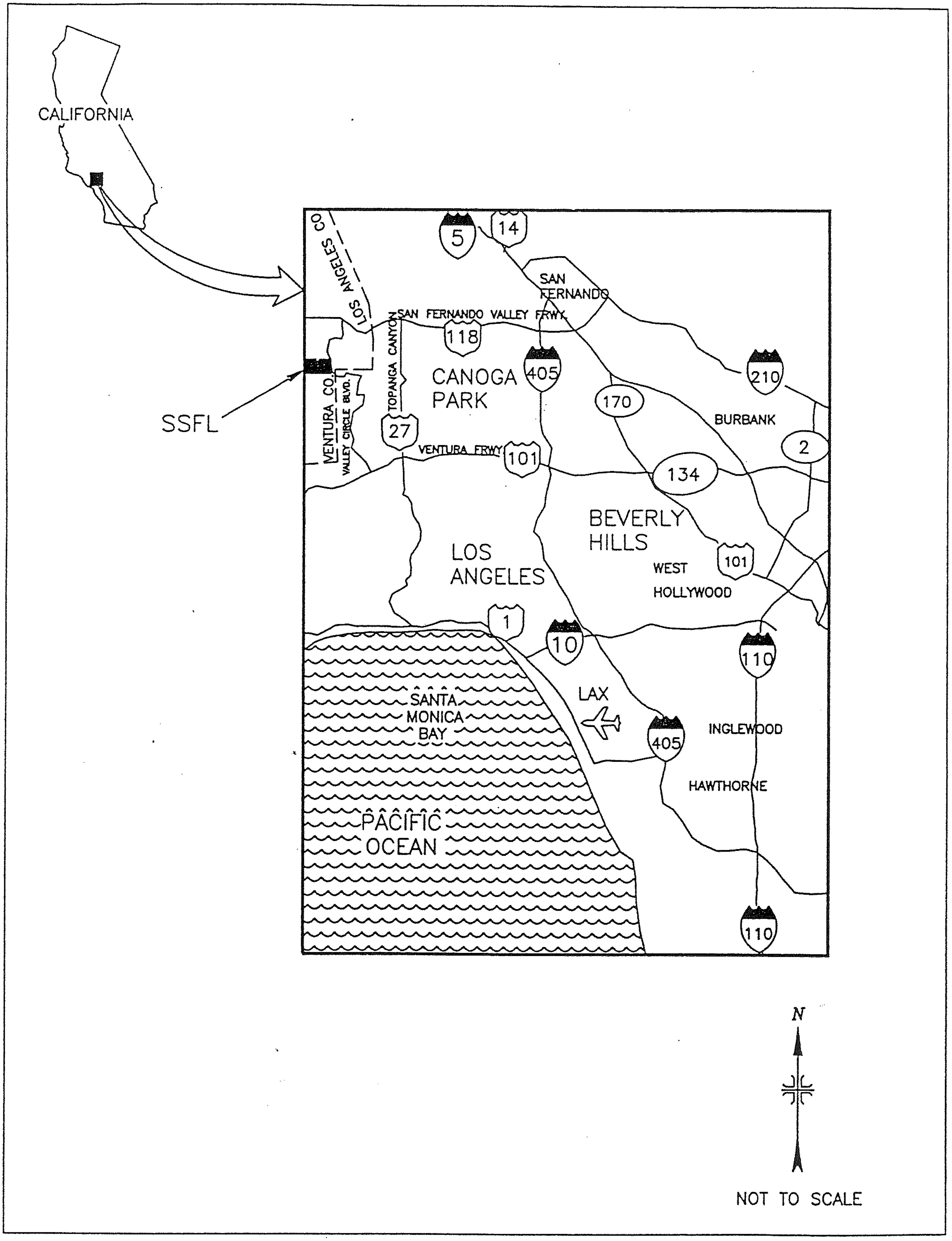


FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

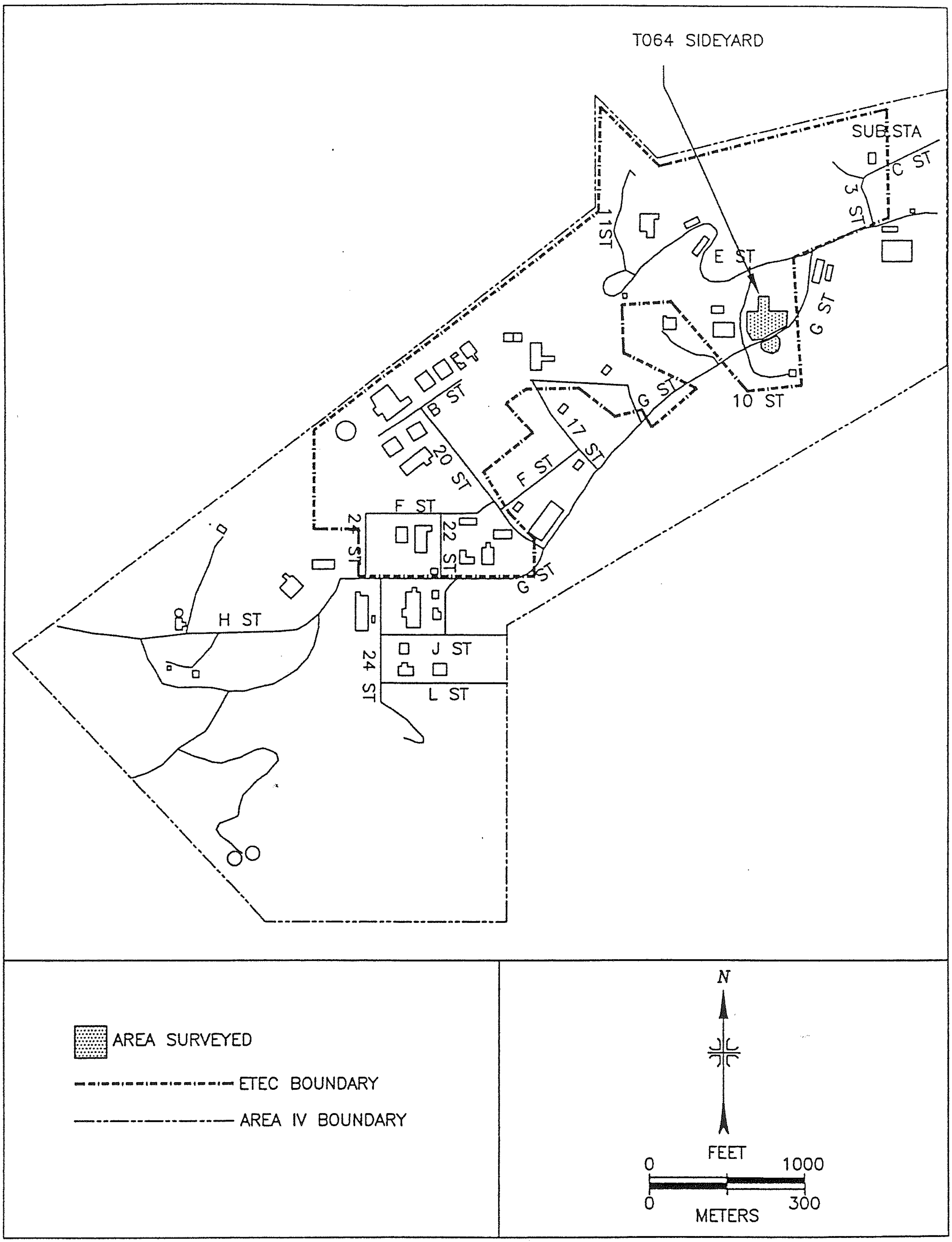
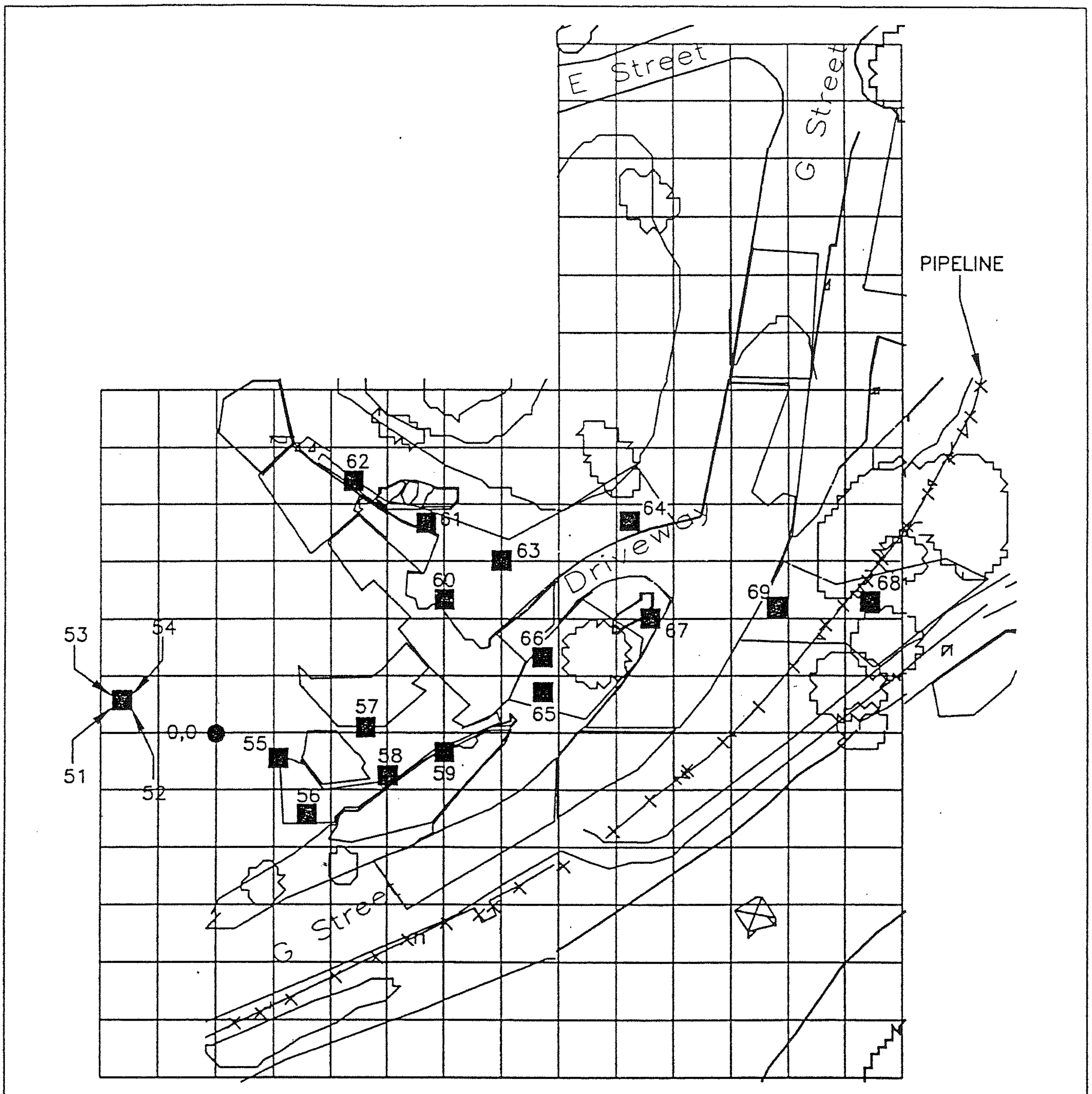


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Building T064 Side Yard



MEASUREMENT/SAMPLING LOCATIONS

■ # SURFACE SOIL

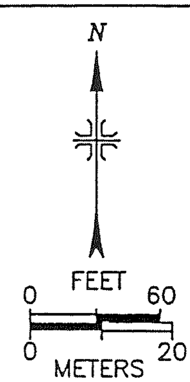


FIGURE 3: Building T064 Side Yard – Measurement and Sampling Locations

TABLE 1

CS-137 CONCENTRATIONS IN SOIL AND EXPOSURE RATES
BUILDING T064 SIDE YARD
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rates at 1 m (μR/h)	Cs-137 Concentration (pCi/g)
51	11	27.75 ± 0.28[b]
52	11	80.63 ± 0.44
53	13	23.38 ± 0.22
54	13	55.61 ± 0.13
70 (Post-Remedial Action from Locations 51-54)	9	0.37 ± 0.03
71 (Post-Remedial Action from Locations 51-54)	9	0.57 ± 0.07
55	10	<0.05
56	11	1.83 ± 0.12
57	11	0.07 ± 0.03
58	13	0.50 ± 0.05
59	12	<0.06
60	11	0.57 ± 0.07
61	12	0.49 ± 0.06
62	12	0.35 ± 0.04
63	11	0.07 ± 0.03
64	12	0.10 ± 0.03
65	12	<0.04
66	11	0.47 ± 0.04
67	11	0.13 ± 0.04
68	12	<0.04
69	12	2.93 ± 0.17

[a]Refer to Figure 3.
[b]Uncertainties are total propogated uncertainties at the 95% confidence level.

TABLE 2

SITE-WIDE LIMITS FOR SOIL AND WATER
(REFERENCE N001SRR140127)[a]
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

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[b]
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[d] and 15[d]	4.1
Sr-90	36.0	8[b]
Th-228	5[d] and 15[d]	6.8
Th-232	5[d] and 15[d]	2.0
U-234	30[c]	---
U-235	30[c]	total uranium 20[b]
U-238	35[c]	---
Gross alpha (not including radon and uranium)	---	15[b]
Gross beta	---	50[b]

[a]Reference taken from Rocketdyne/Boeing 96ETEC-DRF-0374, Enclosure A, June 28, 1996.
[b]State of California Maximum Contaminant Levels, CCR Title 22.
[c]Generally more conservative NRC limits for uranium isotopes are proposed.
[d]DOE Order 5400.5 limits are proposed (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).

REFERENCES

Boeing North American (Boeing). Soil Sampling Results for Building 064 Area at SSFL Canoga Park, California; September 9, 1998.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; October 1993.

Oak Ridge Institute for Science and Education. Additional Surveys of the Building T064 Side Yard, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; October 23, 1995.

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.

State of California, Department of Health Services. Authorized Site-Wide Radiological Guidelines for Release of Unrestricted Use. August 9, 1996.

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

U.S. Department of Energy. Memorandum from S. Robinson to R. Liddle, "Sitewide Limits for Release of Facilities Without Radiological Restrictions", September 17, 1996.

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

ENERGY/ENVIRONMENT SYSTEMS DIVISION

October 23, 1995

Mr. Don Williams
U. S. Department of Energy
EM-421
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: ADDITIONAL SURVEYS OF THE BUILDING T064 SIDE YARD, SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

Dear Mr. Williams:

In June 1992, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed a verification survey of the Building T064 Side Yard located at the Santa Susana Field Laboratory and identified several areas of residual Cs-137 soil contamination. Rockwell personnel later performed remediation in two of the three areas ESSAP had identified. At the request of the U. S. Department of Energy, ESSAP performed a follow up survey of the subject area during the week of September 11, 1995 in order to determine whether the areas had been adequately remediated.

Rockwell cleared the brush from the area and ESSAP then performed gamma surface scans using NaI scintillation detectors coupled to ratemeters with audible indicators. In addition to the unexcavated hot spot that ESSAP initially identified in 1992 (location A on Figure 1), two additional locations of elevated direct radiation where identified during the September 1995 survey. Both locations were contiguous to the other two hot spots previously identified in 1992 (locations B and C on Figure 1). Surface (0 to 15 centimeters) soil samples were collected from six locations in and around the areas of elevated direct gamma radiation (locations 1 through 6 on Figure 1). In addition a subsurface (15 to 30 centimeters) soil sample was collected from sampling location # 1.

The samples were analyzed by gamma spectrometry at ESSAP's laboratory in Oak Ridge, Tennessee. Analytical results are provided in Table 1. Cs-137 activity concentration levels ranged from 0.6 to 72.1 pCi/g for surface samples. The single subsurface sample contained 8.1 pCi/g of Cs-137. Six of the eight samples collected contain Cs-137 activity concentration levels in excess of the 7.08 pCi/g cleanup criteria that Rockwell has used for the Side Yard area. There were no other gamma emitting radionuclides identified in samples, other than those that are naturally occurring.

Please contact me at (423) 576-5073 or W. L. (Jack) Beck at (423) 576-5031 should you have any questions or we may provide additional information.

Sincerely,

Timothy J. Vitkus
Environmental Project Leader
Environmental Survey and
Site Assessment Program

cc. A. Kluk, DOE/HQ
W. Beck, ORISE/ESSAP
File/357

TJV:cds

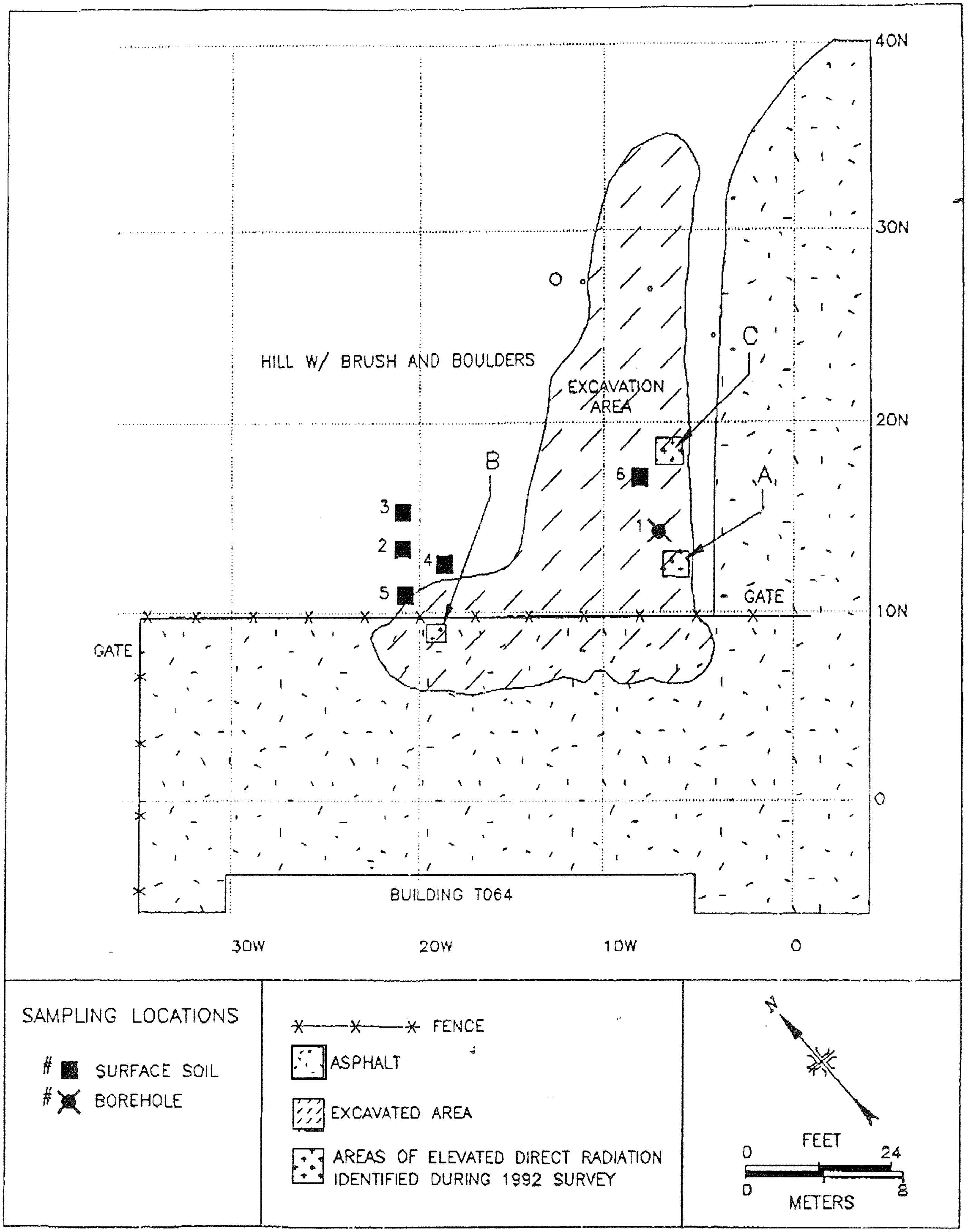


FIGURE 1: Building T064 Side Yard – Soil Sampling Locations and Locations of Previously Identified Areas of Elevated Direct Radiation

TABLE 1
CS-137 CONCENTRATIONS IN SOIL
BUILDING T064 SIDE YARD
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

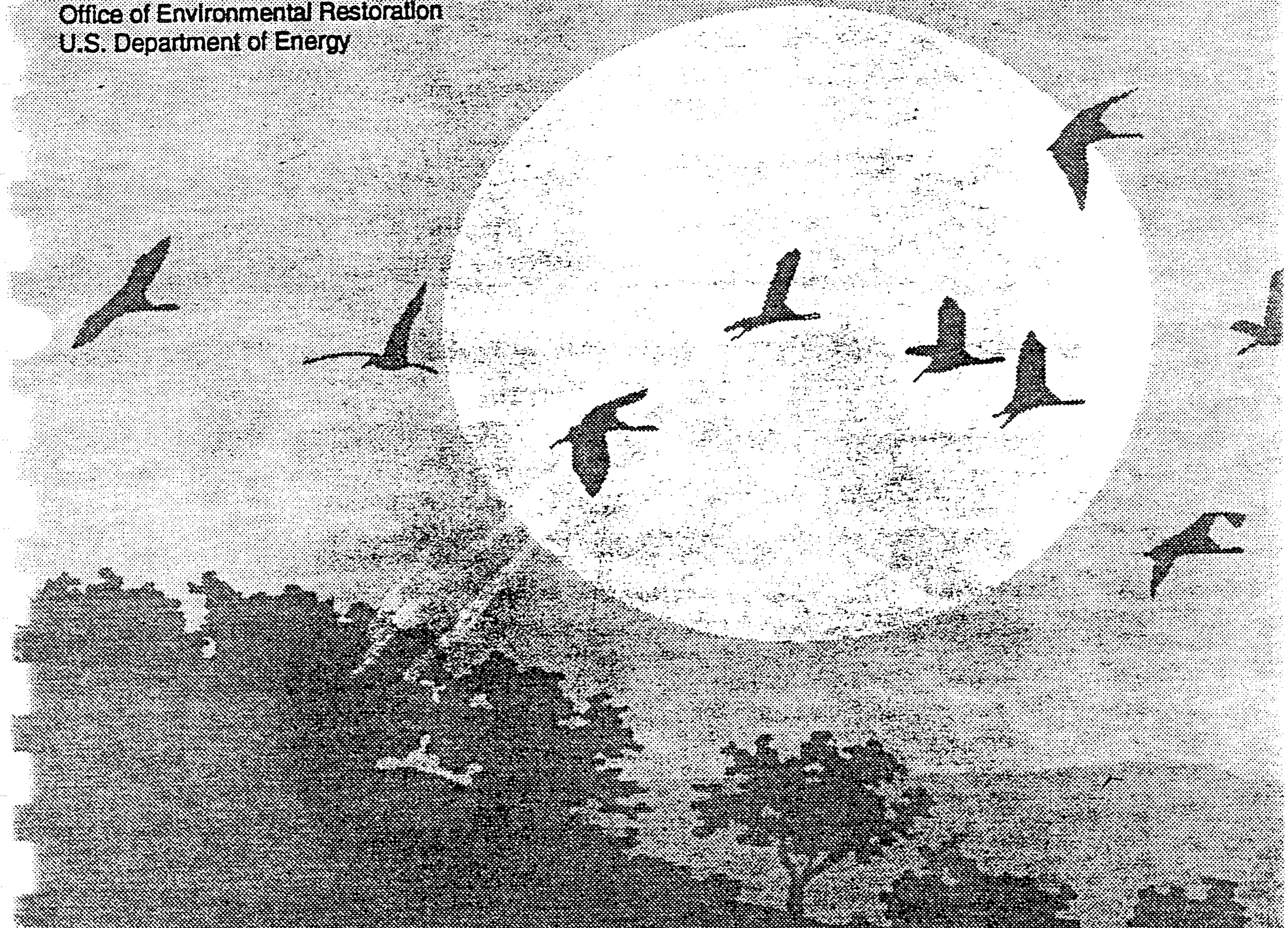
Location[a]		Cs-137 Concentration (pCi/g)
1	(0-15 cm)	50.5 ± 0.8[b]
1	(15-30 cm)	8.1 ± 0.3
2	(0-15 cm)	29.9 ± 0.6
3	(0-15 cm)	15.3 ± 0.4
4	(0-15 cm)	1.4 ± 0.2
5	(0-15 cm)	0.6 ± 0.1
6	(0-15 cm)	72.1 ± 0.1

[a]Refer to Figure 1.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

VERIFICATION SURVEY OF BUILDINGS 005, 023, AND 064 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T.J. VITKUS

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
Energy/Environment Systems Division

VERIFICATION SURVEY OF BUILDINGS 005, 023, AND 064 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by

T. J. Vitkus

Environmental Survey and Site Assessment Program
Energy/Environmental Systems Division
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

OCTOBER 1994

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

ACKNOWLEDGEMENTS

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

FIELD STAFF

T. D. Herrera
E. H. Montalvo
J. R. Morton

LABORATORY STAFF

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

CLERICAL STAFF

D. A. Cox
R. D. Ellis

ILLUSTRATOR

T. D. Herrera

VERIFICATION SURVEY
OF BUILDINGS 005, 023, AND 064
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Prepared by: Timothy J. Vitkus ______ Date: 10/26/94
T. J. Vitkus, Project Leader
Environmental Survey and Site Assessment Program

Reviewed by: Mark Laudeman ______ Date: 10/31/94
M. J. Laudeman, Radiochemistry Laboratory Supervisor
Environmental Survey and Site Assessment Program

Reviewed by: Ann T. Payne ______ Date: 11/3/94
A. T. Payne, Quality Assurance Officer
Environmental Survey and Site Assessment Program

Reviewed by: W L Beck ______ Date: 11/3/94
W. L. Beck, Acting Program Director
Environmental Survey and Site Assessment Program

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
cm^2	square centimeter
cpm	counts per minute
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurement Laboratory
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
ha	hectare
GM	Geiger-Mueller
kg	kilogram
km	kilometer
m	meter
m^2	square meter
MDA	minimum detectable activity
mi	mile
mm	millimeter
NaI	sodium iodide
NIST	National Institute of Standards and Technology
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
SSFL	Santa Susana Field Laboratory
ZnS	zinc sulfide
μR/h	microroentgens per hour

VERIFICATION SURVEY
OF BUILDINGS 005, 023, AND 064
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.

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, americium-241, fission products (primarily cesium-137 and strontium-90), activation products (cobalt-60, europium-152, nickel-63, promethium-147, and tantalum-182), and tritium. Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater.

Decontamination and decommissioning of facilities began in the late 1960's and continues as other DOE sponsored projects are phased out and transitioned to EM-40. Rockwell/Rocketdyne has recently completed the decommissioning and final status radiological surveys of three SSFL facilities. These facilities are Buildings 005, 023, and 064.

Building 005 was built in the late 1950's for testing proposed coolants for the Organic Moderated Reactor Experiment and Piqua reactors. There was no radiological material use in the facility during this period; however, the facility was later converted for uranium carbide fuel fabrication. Fuel fabrication activities were performed from 1966 to 1967. At the conclusion of the fuel fabrication project, uranium contaminated equipment and surfaces were either removed or decontaminated to permit non-radiological use of the building. Additional facility decontamination was initiated during 1978 and completed in phases, ending in 1992. Decontamination activities included cleaning and/or removal of contaminated floors, equipment, duct work, drain pipes, and storage tanks. Rockwell/Rocketdyne performed the final radiological survey in 1993.

Studies of radioactive contamination transport in a sodium loop were performed in the portions of Building 023 constructed in 1962 (referred to as Old Building 023). A second section, 023A, was added on to the building in 1976. There were two fires documented within the facility that involved the sodium loop. Contaminants involved were Cs-137, Mn-54, and Co-60. In addition, the facility was also used to store a Dew-Point meter containing a Ra-226 source. Plans called for the disassembly of the meter; however, the disassembly was not attempted and the intact meter was removed from the facility. Most of the contamination identified in the building involved the radioactive liquid holdup tank and the associated drain lines and sink. Facility decontamination included the removal of the sodium loop, holdup tank, drain lines, sink, a fume hood and the ventilation exhaust system, and remediation of an area of the floor where the sodium loop was previously located. Rockwell/Rocketdyne's final radiological survey was conducted in 1993.

The third building, Building 064, was constructed in 1958 (a second bay was added on in 1963) to serve as a storage and repackaging facility for special nuclear and source radioactive material. Source and special nuclear material, including processed natural uranium, depleted uranium, enriched uranium, uranium-233, thorium, and plutonium, were stored in the building until 1980. Most recently, packaged soil contaminated with Cs-137 was stored in the facility. Exterior yard areas were occasionally used for storage of recoverable uranium scrap, irradiated fuel elements, and miscellaneous radioactive wastes. Interior surfaces were determined to be contaminated from the uranium repackaging process. Initial facility decommissioning involved removal of equipment and fixtures, and finally, removal of the contaminated soil. Rockwell/Rocketdyne then performed the final radiological surveys of the interior and exterior grounds of the building.

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 guidelines and that the documentation accurately and adequately describes the post-remedial action radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has been designated as the organization responsible for this task at SSFL.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California approximately 47 km (29 mi) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1090 hectares (2700 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. The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha. The Area IV plot plan is provided in Figure 2 and indicates the locations of Buildings 005, 023, and 064.

Building 005 is located within the central portion of Area IV and is bordered on the north and northeast by B Street, to the southwest by 17th Street, and to the southeast by the Old Coal Storage Yard and G Street (Figure 3). The facility is a tilt-up concrete structure with Butler aluminum siding and has approximately 430 m^2 of floor space. A number of concrete pads are located on the east end of the building. These pads formerly held equipment used in the Molten Salt Oxidation Project and the filter plenums from the fuel fabrication project. The building interior is subdivided into an administration area, change rooms, chemistry laboratories, storage rooms, and a high-bay area. Figure 4 shows those rooms that were included in the radiological control area.

Building 023 is located in the central section of Area IV. Facility boundaries are 12th Street to the north, B Street to the south and east and Building 032 to the west (Figure 5). Building 023 is a single story structure with galvanized steel walls and roof and a concrete slab floor. The sodium test loop was located in the western, or "old", portion of the building. The "new" building section held an analytical chemistry laboratory and a storage and set-up room. The waste holdup tank was formerly located in an exterior sub-grade vault at the east end of the building (Figure 6).

Building 064 is located in the northeast quadrant of Area IV. Facility boundaries include paved yard areas to the north, and west, "G" Street to the south, and a paved area and the Side-Yard to the east (Figure 7). This Side-Yard includes an excavated area from which the Cs-137 contaminated soil, previously stored in Building 064, originated. ESSAP performed the verification of the Side-Yard during a previous survey.[1] The 410 m^2 building is constructed of reinforced concrete with two large open bays, Rooms 110 and 114. Other rooms include a material handling area (Room 116), office and supply and storage space (Room 120), and a rest room (Figure 8).

OBJECTIVES

The objectives of the verification surveys were to provide independent document reviews and measurement and sampling data for use by the DOE in determining the radiological status of each facility and whether or not the facility meets the guideline requirements for release to unrestricted use.

DOCUMENT REVIEW

ESSAP reviewed Rockwell's radiological survey, decontamination and decommissioning, and final status survey reports for Buildings 005, 023, and 064.[2-12] Procedures and methods used by Rockwell were reviewed for adequacy and appropriateness. The post-remedial action data was reviewed for adequacy, completeness, and compliance with guidelines.

PROCEDURES

A survey team from ESSAP visited the SSFL during the period July 18 through 21, 1994 and performed visual inspections and independent measurements and sampling inside building structures as well as exterior areas. Survey activities were conducted in accordance with a site specific survey plan submitted to and approved by the DOE.[13] Additional information regarding major instrumentation and survey and analytical procedures may be found in Appendices A and B.

REFERENCE GRID

ESSAP used the 1 m × 1 m grid system established by Rockwell, where intact, for referencing measurement and sampling locations. Survey locations on upper walls, ceilings, or other ungridded surfaces were referenced to the floor or lower wall grid or to prominent building features. Survey references of exterior areas were made to either the existing grid or to prominent site features.

SURFACE SCANS

Interior surface scans for alpha, beta, and gamma activity were performed on floors, lower walls, upper walls, and ceilings of each building, and on portions of concrete exterior surfaces (ramps, walkways, and a tank vault). Exterior soil and paved areas, and the Building 005 and 064 roofs were scanned for gamma activity. Scans were performed using gas proportional, ZnS, GM, and/or NaI detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Scan coverage, with the exception of upper walls and ceilings, ranged from 25% in rooms or areas without a radiological use history, up to 100% for radiological use areas. Approximately 5% of accessible upper wall and ceiling surfaces were scanned. Locations of elevated direct radiation identified by surface scans were marked for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Direct measurements to determine total alpha and total beta surface activity levels were performed in 68 floor and lower wall grid blocks. Grid blocks selected for survey were chosen either randomly or as a result of elevated direct radiation detected by surface scans. One set of five direct measurements was obtained from each grid block with measurements performed at the center and four points equidistant from the center and grid block corners. Since the time of the radioactive material use in Building 005, new tile had been placed over most of the original floor. Rather than addressing these areas with grid block measurements, tiles were removed from 10 randomly selected locations within 4 rooms (Rooms 108, 110, 113, and 114) associated with the fuel fabrication work and single-point measurements performed. An additional 165 single-point alpha and beta direct measurements were performed on floor, lower wall, upper wall and ceiling surfaces, as well as equipment, exterior paved areas around each building, the attic area in Building 005, and the tank vault outside of Building 023. All measurements were made using ZnS and GM detectors coupled to ratemeter-scalers. A smear sample for determining removable alpha and beta activity was collected from the location within each grid block that corresponded to the highest total direct measurement, and from each single-point measurement location. Figures 9 through 28 show measurement and sampling locations.

EXPOSURE RATE MEASUREMENTS

Quantitative site exposure rate measurements, at 1 m above the surface, were made at 7 locations within Building 005, 6 locations within Building 064, and at two soil sampling locations (Figures 20 and 21 and 26 through 28) using a pressurized ionization chamber (PIC). Exposure rates in all remaining areas were determined qualitatively and were based on gamma surface scan data. Rockwell/Rocketdyne developed background exposure rate data, which was used by ESSAP for data comparisons.

SOIL SAMPLING

With the exception of the southeast side of Building 064, all exterior areas around the buildings were paved. One surface (0 to 15 cm) soil sample was collected from the southeast side of Building 064 and 2 samples were collected, through cores previously made by Rockwell, from beneath the asphalt to the northeast of Building 005. Figures 20 and 28 show sampling locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ESSAP's Oak Ridge, Tennessee laboratory for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. Spectrum were reviewed for uranium and gamma-emitting activation and fission products (primarily Cs-137). Results were reported in picocuries per gram (pCi/g). Smear samples were analyzed for gross alpha and gross beta activity using a low background proportional counter. These results were reported together with direct measurement data in units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2). Exposure rates were reported in microroentgens per hour (μR/h).

Results were compared to the DOE guidelines which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP identified a number of areas in the documentation submitted by Rockwell/Rocketdyne, principally related to guideline selection, survey methodology, and final status documentation where clarification or additional information was necessary. ESSAP provided these comments to the DOE in March 22 and April 4, 1994 correspondences.[14,15] Rockwell/Rocketdyne subsequently issued a response to each comment in a June 2, 1994 correspondence.[16]

SURFACE SCANS

Alpha, beta, and gamma scans of the interior and exterior areas of each building identified 4 locations of elevated direct beta radiation requiring additional investigation. One location, measuring less than 15 cm^2, was in Building 064 Room 114 grid block F,8 (Figure 26). The second location was in Building 005 Room 105/112 grid block Q,19 (Figure 10). The remaining two locations were identified in the Control Room of Building 023. One area was contiguous with the area which Rockwell/Rocketdyne had previously remediated (grid blocks D,1 and D,2 Figure 22). The second location measured less than 15 cm^2 and was located in grid block B,5 (Figure 22). The location in Building 064 Room 114 and the small area of contamination in grid block B,5 of Building 023 Control Room were decontaminated by Rockwell/Rocketdyne. ESSAP personnel performed post-remedial action surface scans at each location and found the beta surface activity to be comparable to background levels. Additional investigation of the residual activity detected in Building 005 Room 105/112 grid block Q,19 and Building 023 Control Room grid blocks D,1 and D,2 determined that the activity could be averaged over 1 m^2 for guideline comparison.

SURFACE ACTIVITY LEVELS

Surface activity levels for each of the buildings surveyed are summarized in Table 1. Total activity levels for the interior of Building 005 ranged from less than 66 to 360 dpm/100 cm^2 for alpha and less than 1,500 to 7,100 dpm/100 cm^2 for beta. The average activity in 1 m^2 grid blocks was less than 66 dpm/100 cm^2 for alpha and less than 1,500 to 2,100 dpm/100 cm^2 for beta. Total activity levels for the exterior areas of Building 005 ranged from less than 66 to 360 dpm/100 cm^2 and less than 1,500 to 1,900 dpm/100 cm^2 for alpha and beta, respectively.

Final survey results for total surface activity levels inside of Building 023, listed in Table 1, were less than 66 to 400 dpm/100 cm^2 for alpha and less than 1,400 to 6,700 dpm/100 cm^2 for beta. The average activity in 1 m^2 grid blocks was less than 66 dpm/100 cm^2 for alpha and less than 1,400 to 2,400 dpm/100 cm^2 for beta. The activity levels on exterior surfaces, including the holdup waste tank vault, were less than 66 dpm/100 cm^2 to 120 dpm/100 cm^2 for alpha and less than 1,500 to 1,600 dpm/100 cm^2 for beta. Prior to remediation, the activity level of the "hot spot" in the Control Room was 20,000 dpm/100 cm^2. Post-remedial activity was less than 1,400 dpm/100 cm^2.

Building 064 final survey results for total activity, provided in Table 1, ranged from less than 66 to 290 dpm/100 cm^2 for alpha and less than 1,500 to 2,400 dpm/100 cm^2 for beta. The 1 m^2 grid block averages were less than 66 dpm/100 cm^2 and less than 1,500 dpm/100 cm^2 for alpha and beta, respectively. Exterior surface activity levels were less than 66 dpm/100 cm^2 for alpha and ranged from less than 1,400 to 2,200 dpm/100 cm^2 for beta. The beta activity level of the "hot spot" in Room 114 was 46,000 dpm/100 cm^2 prior to additional remediation, and 1,500 dpm/100 cm^2 after decontamination.

Removable activity levels for all measurement locations, summarized in Table 1, were less than the minimum detectable activities of the procedure which were 12 dpm/100 cm^2 for gross alpha and 16 dpm/100 cm^2 for gross beta.

EXPOSURE RATES

Background exposure rates as measured by Rockwell/Rocketdyne were 8 μR/h (in Building 038 for comparison with Buildings 005 and 023), 15 μR/h (in Building 445 for comparison with Building 064), and 15 μR/h for exterior areas. Building and exterior exposure rates are summarized in Table 2. Exposure rates ranged from 10 to 11 μR/h and 14 to 17 μR/h for the interiors of Buildings 005 and 064, respectively. Exterior exposure rates ranged from 12 to 14 μR/h. Qualitative verification exposure rates in Building 023 were comparable to background levels.

RADIONUCLIDE CONCENTRATIONS IN SOIL

The radionuclide concentrations in the soil samples collected from Buildings 005 and 064 are summarized in Table 3. Concentration ranges were as follows: Cs-137, less than 0.1 to 2.7 pCi/g; U-235, 0.1 to 0.5 pCi/g; and U-238, 0.7 to 3.8 pCi/g. There were no other gamma-emitting radionuclides of significance, other than naturally occurring radionuclides.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each of the three buildings were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5. These guidelines are summarized in Appendix C. The applicable guidelines for Building 005 and 064 are those for uranium which 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

The guidelines for Building 023 are those for beta-gamma emitters which 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 uranium guidelines noted above specify alpha activity. However, because rough, dirty, damp, or porous materials may selectively attenuate the alpha radiation emitted by uranium, the beta radiation (emitted by the uranium daughters) was also measured, in addition to alpha activity, and used for guideline comparison. Alpha to beta decay ratios range from 1:1 for natural and low-enriched (<1%) uranium to as high as 9:1 for the reported 12.67% enriched uranium used in the fuel fabrication project. ESSAP previously requested additional information from Rockwell/Rocketdyne that would define the expected alpha-to-beta decay ratios for the various isotopic uranium compositions used in the facility.[14] Based on Rockwell/Rocketdyne's response, a 1:1 alpha to beta activity ratio was used for comparing beta surface activity levels, as well as the alpha surface activity levels, to the alpha guidelines for this survey.[16] All of the final ESSAP independent measurements were below both sets of guideline levels.

Soil concentration guidelines for uranium and Cs-137 are developed on a site-specific basis using the RESRAD computer code developed for that process. The Cs-137 guideline developed for the Building 064 Side Yard was 7.08 pCi/g average in a 100 m^2 area and a maximum "hot spot" concentration level of 70.8 pCi/g. Cesium-137 levels in verification samples were well below the average concentration guideline. Uranium levels in verification samples were comparable to expected background levels.

The DOE exposure rate guideline, identified in Appendix C, is 20 μR/h above background, at 1 m. However, Rockwell/Rocketdyne has elected to perform decommissioning work to meet a more restrictive exposure rate criteria of less than 5 μR/h above background. All exposure rates were below this guideline.

SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education has conducted verification activities for Buildings 005, 023, and 064 at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period July 18 through 21, 1994 ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, exposure rate measurements, and soil sampling.

ESSAP identified two small areas of above guideline contamination, one each in Buildings 023 and 064, during the verification survey. Rockwell/Rocketdyne personnel subsequently decontaminated both areas to below guideline levels. All remaining ESSAP measurements and sampling support Rockwell/Rocketdyne's conclusion that Building 005, 023, and 064 meet the DOE requirements for release to unrestricted use.

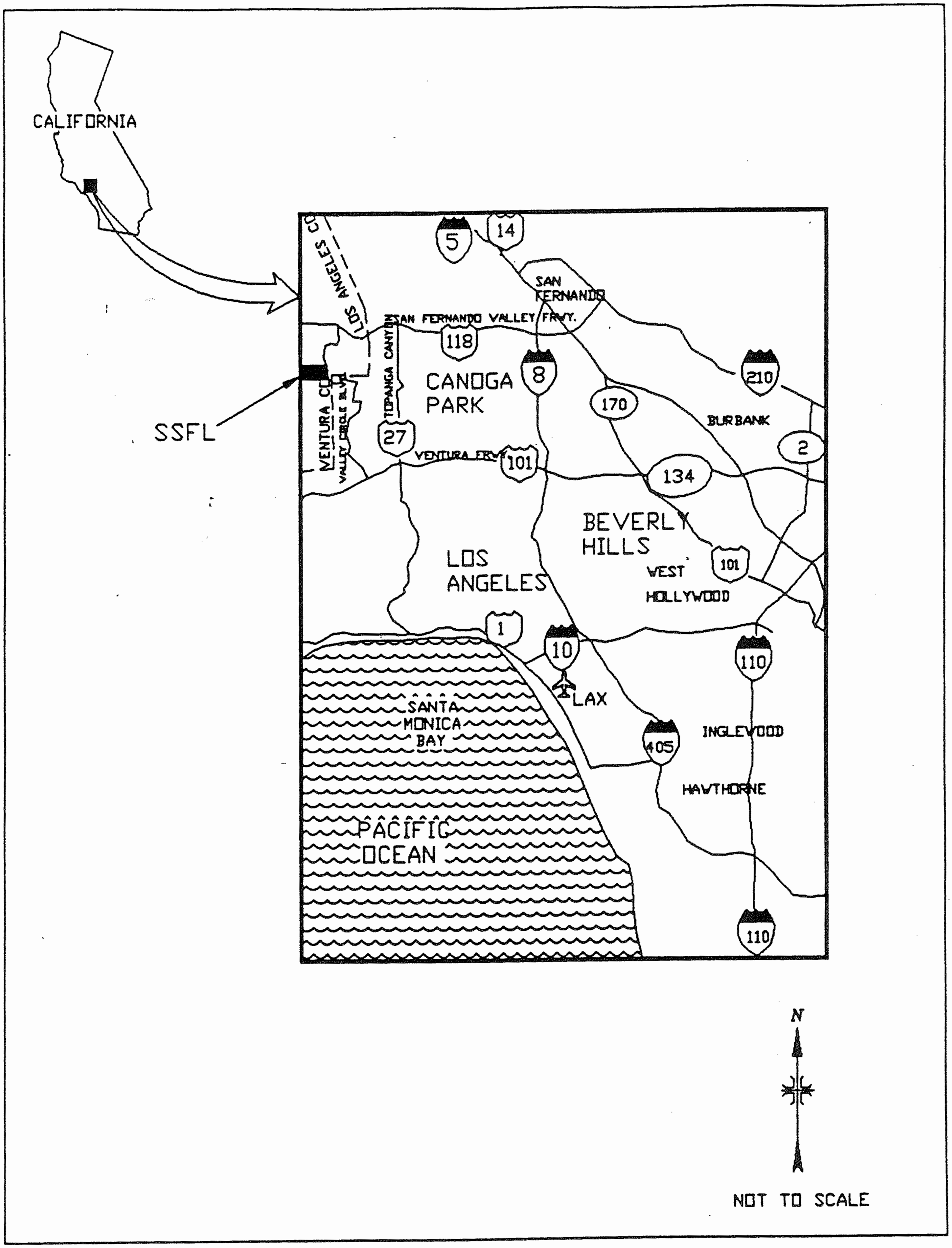

FIGURE 1: Los Angeles California Area - Location of Santa Susana Field Laboratory Site

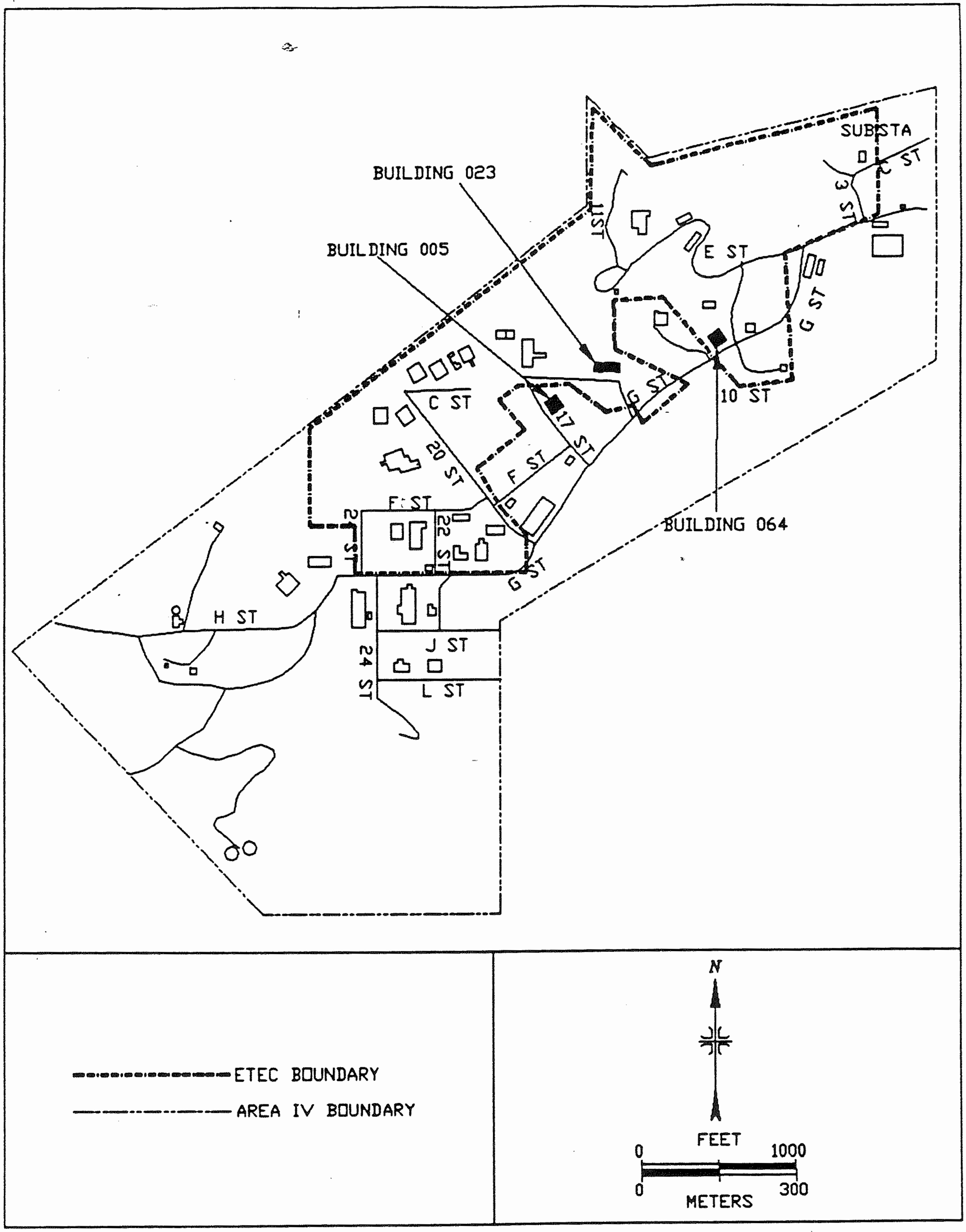

FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan - Locations of Buildings 005, 023, and 064

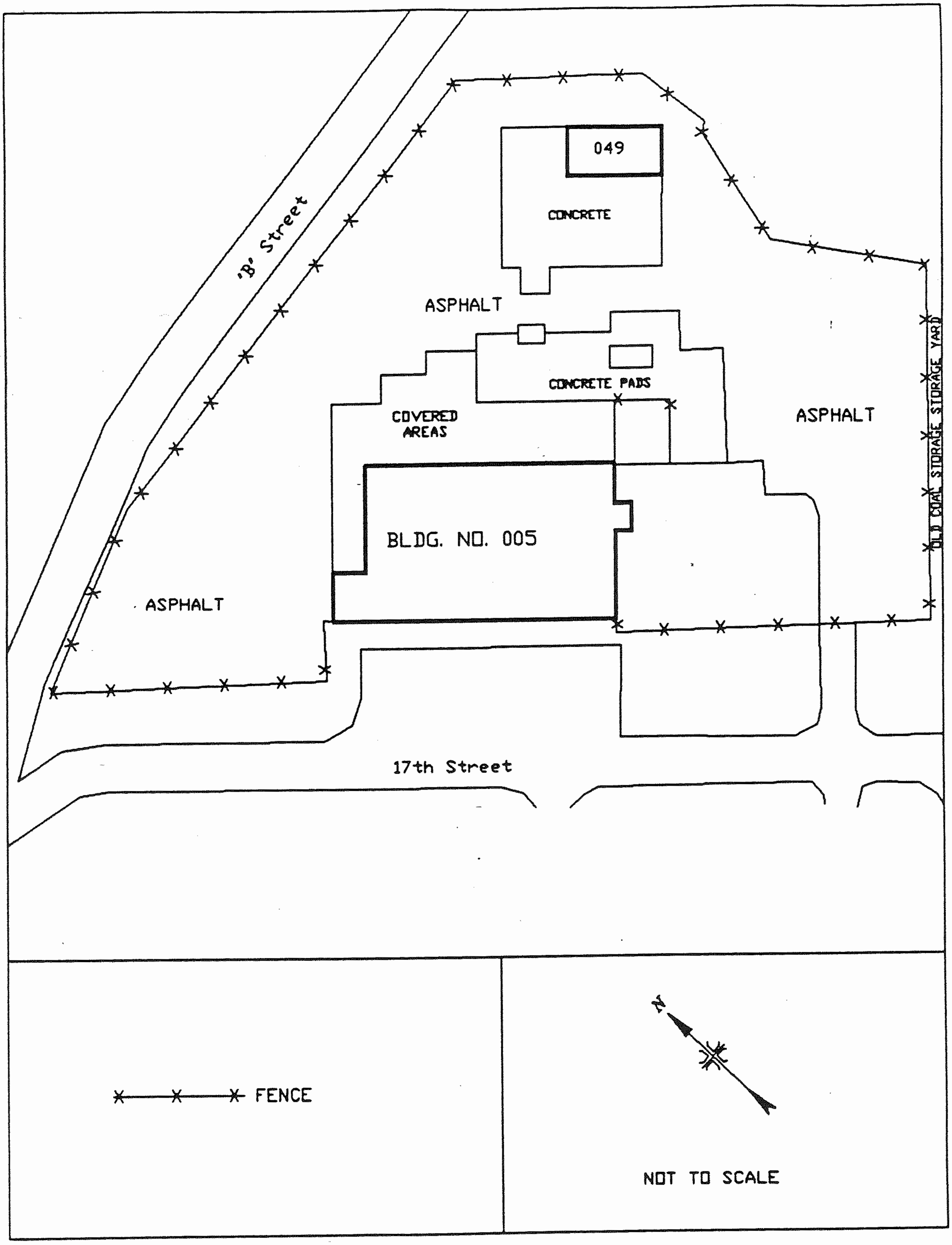

FIGURE 3: Building 005 - Plot Plan

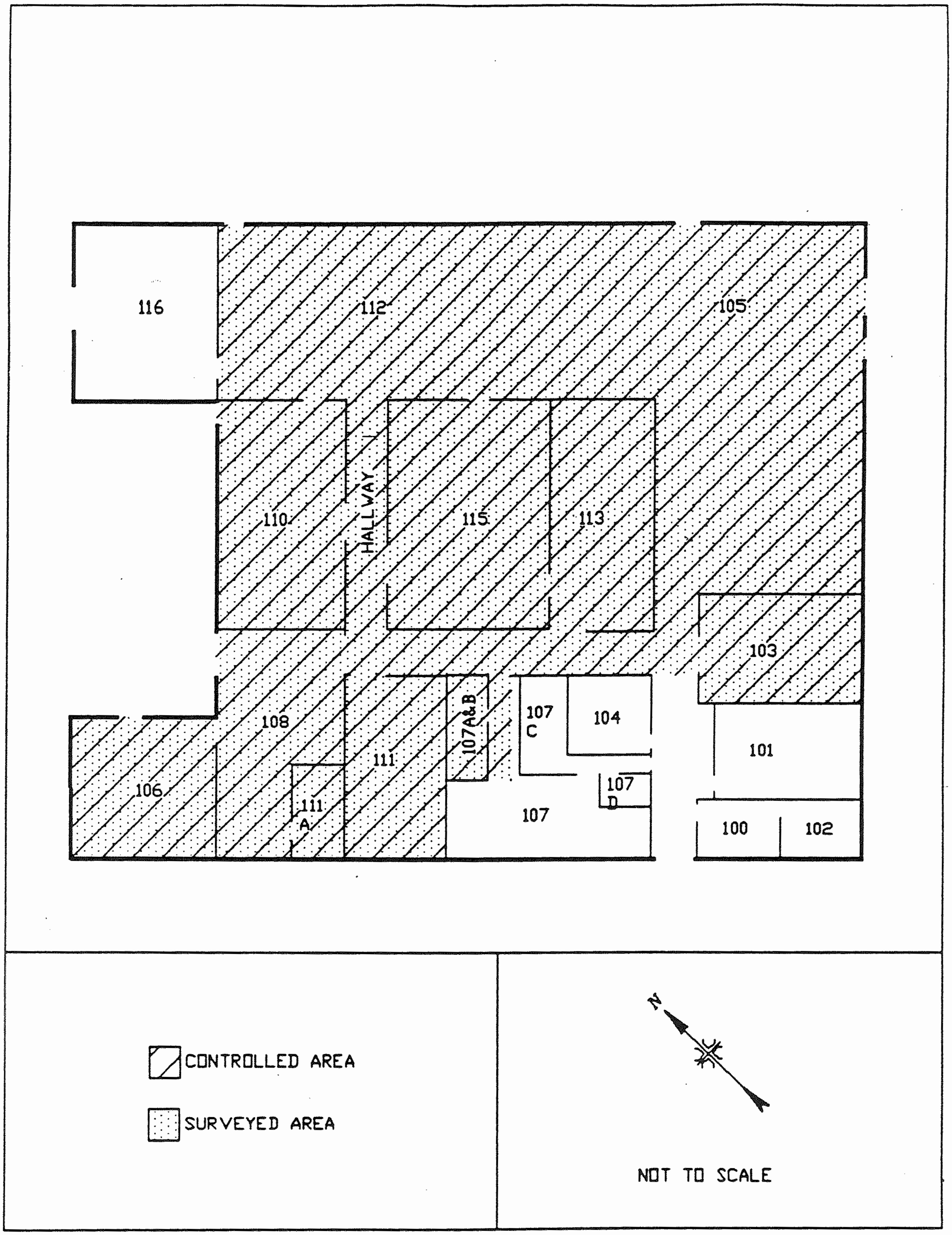

FIGURE 4: Building 005 - Floor Plan, Controlled Area, and Surveyed Areas

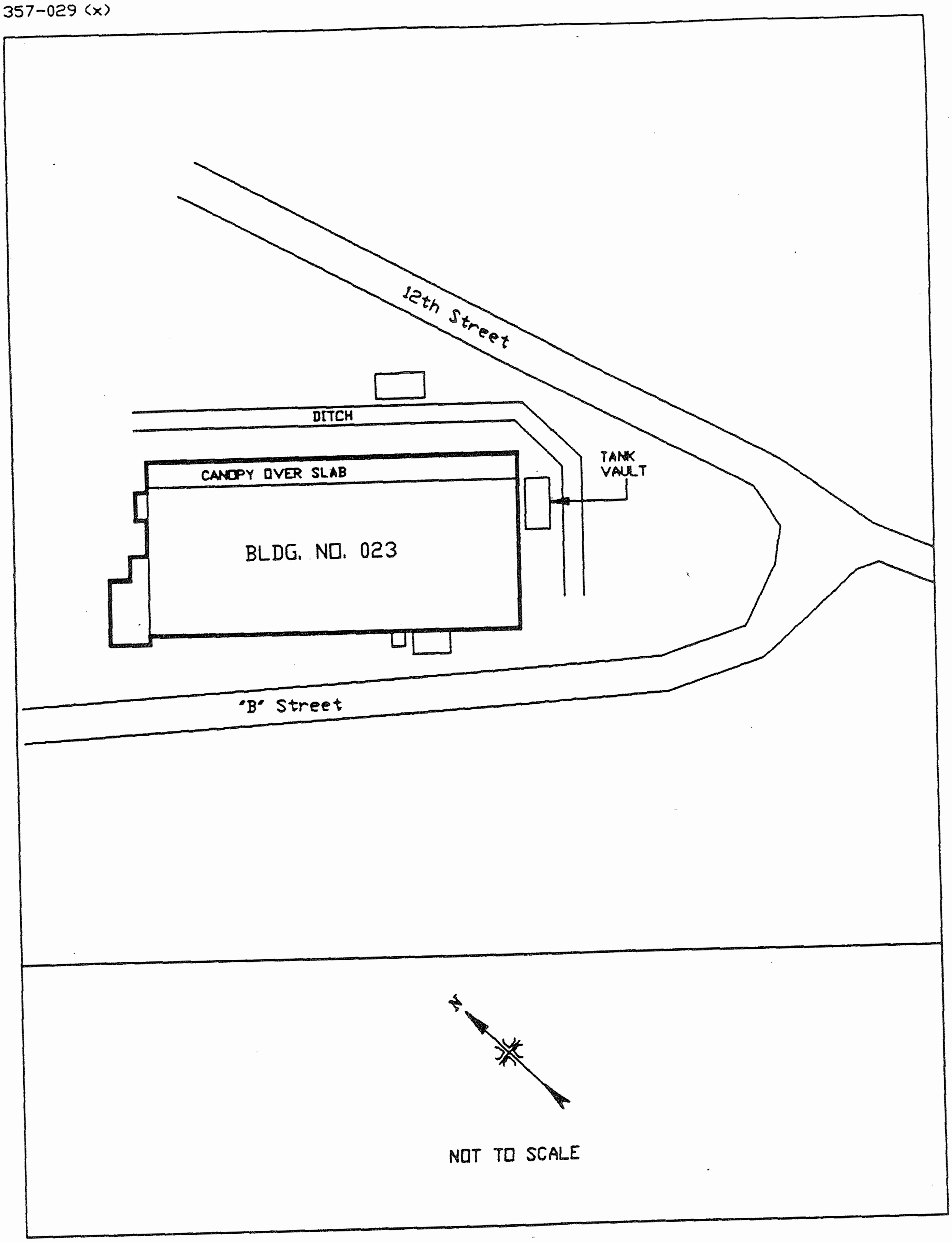

FIGURE 5: Building 023 - Plot Plan

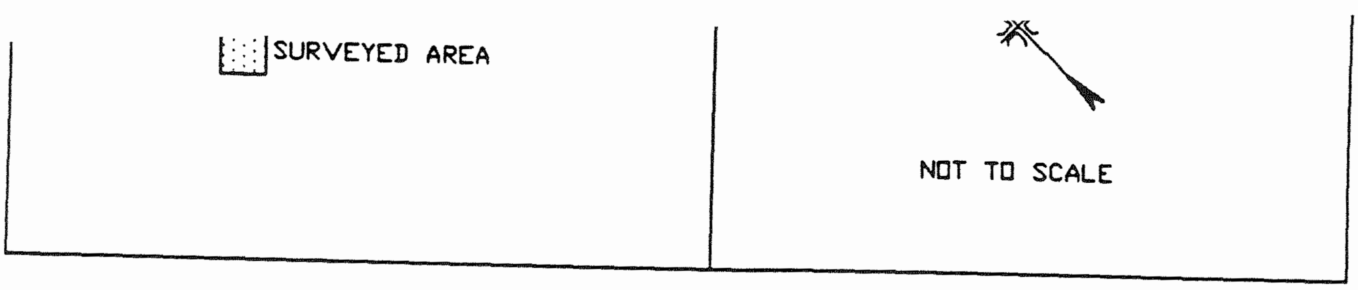

FIGURE 6: Building 023 - Floor Plan and Surveyed Areas

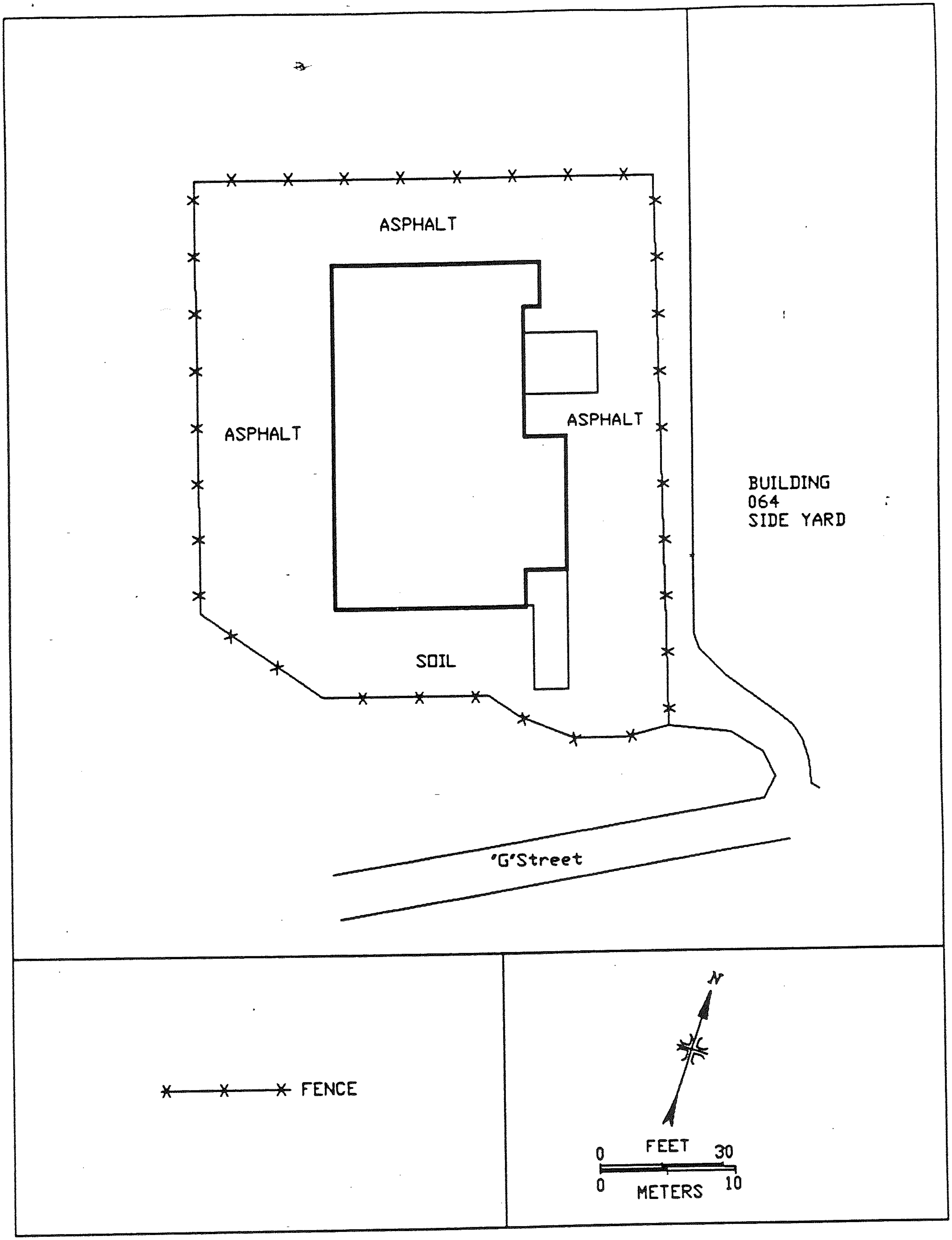

FIGURE 7: Building 064 - Plot Plan

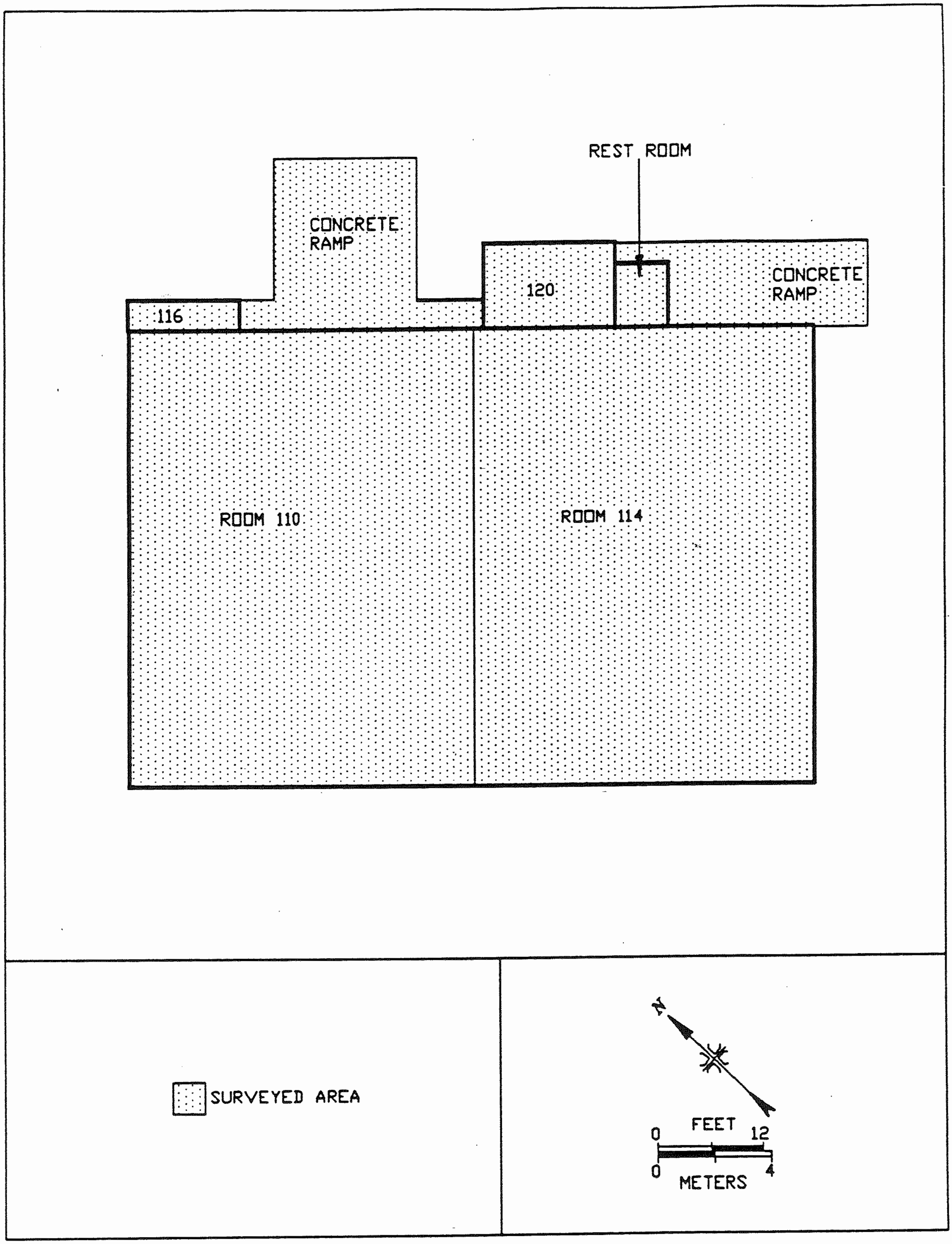

FIGURE 8: Building 064 - Floor Plan and Surveyed Areas

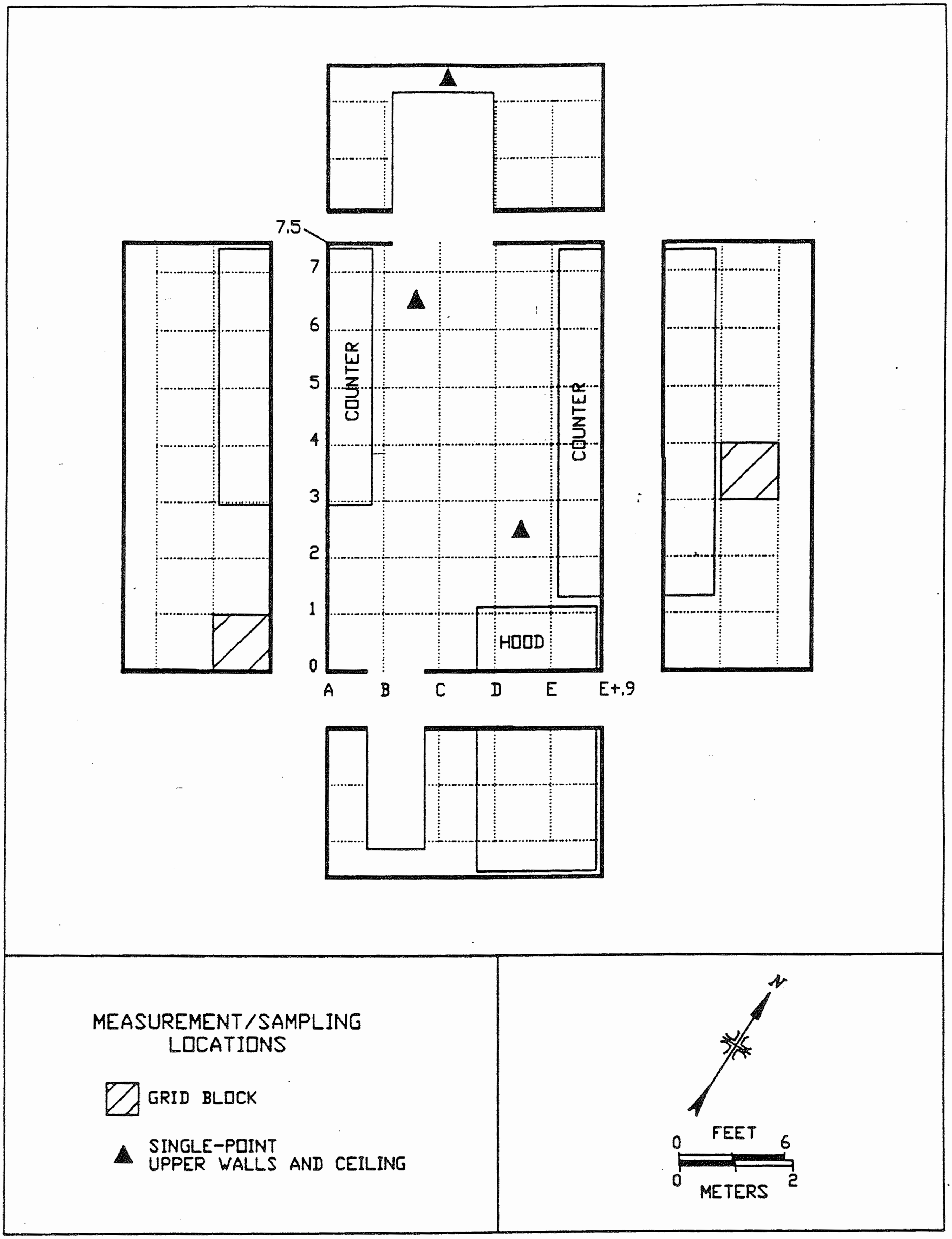

FIGURE 9: Building 005, Room 103 - Measurement and Sampling Locations

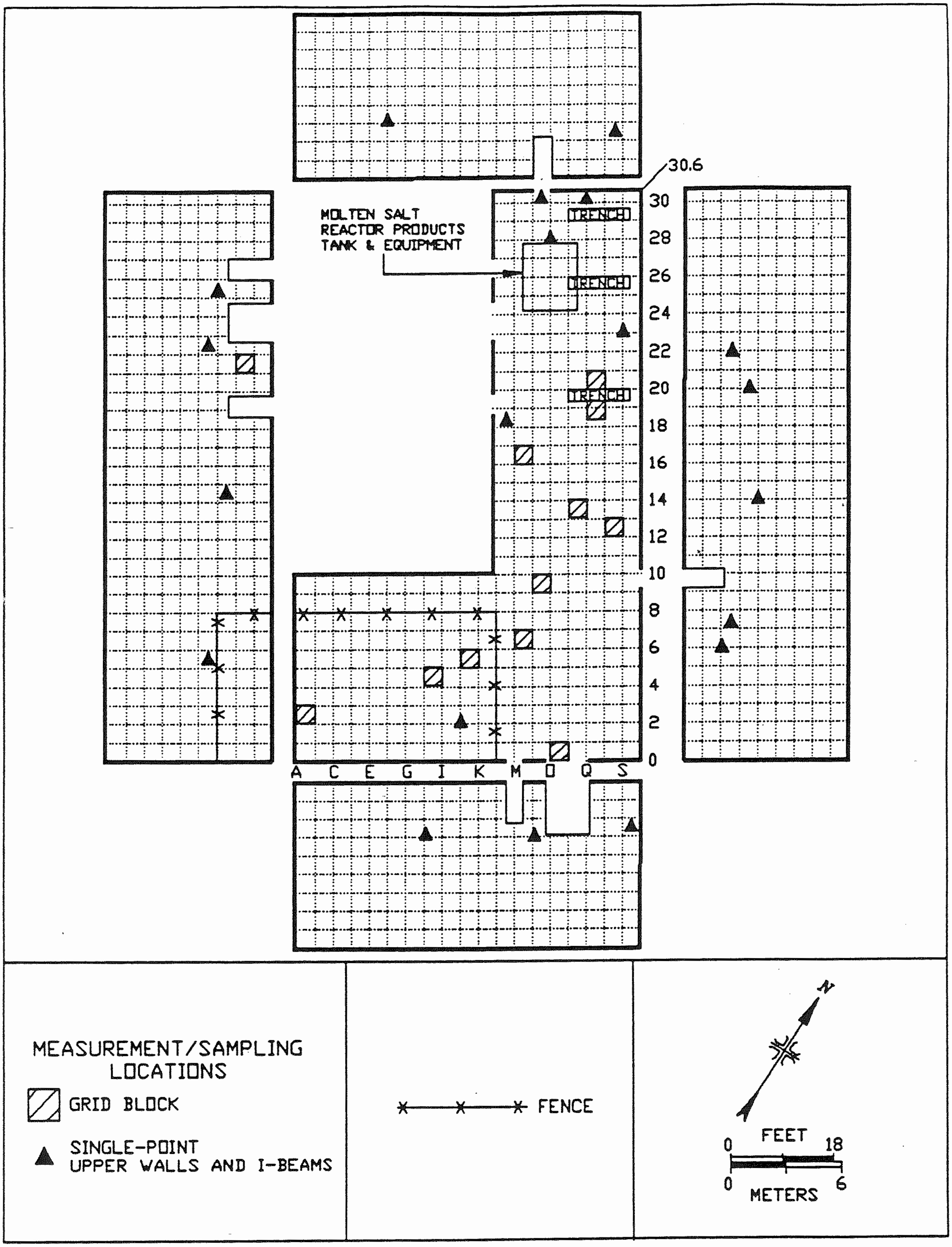

FIGURE 10: Building 005, Room 105/112 - Measurement and Sampling Locations

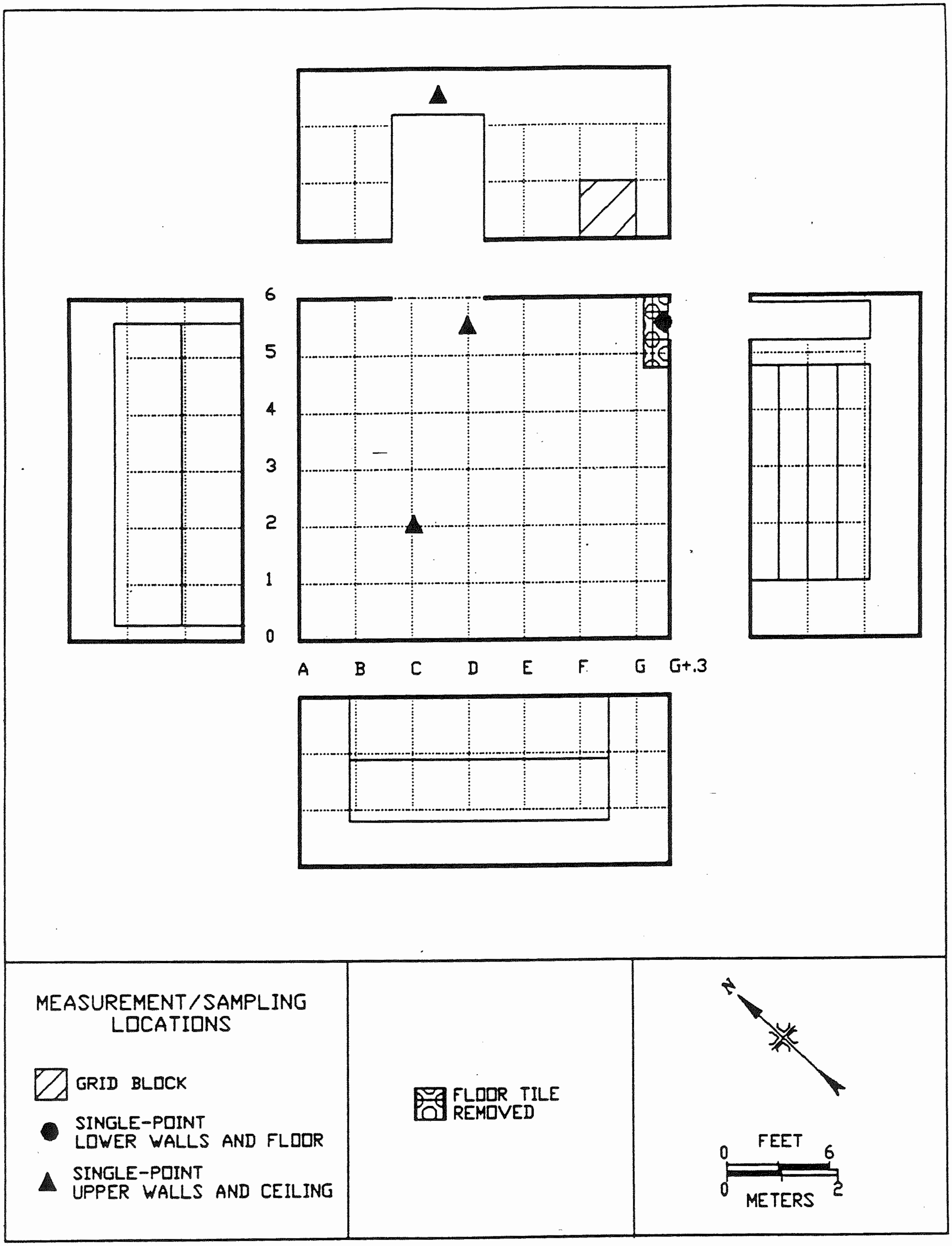

FIGURE 11: Building 005, Room 106 - Measurement and Sampling Locations

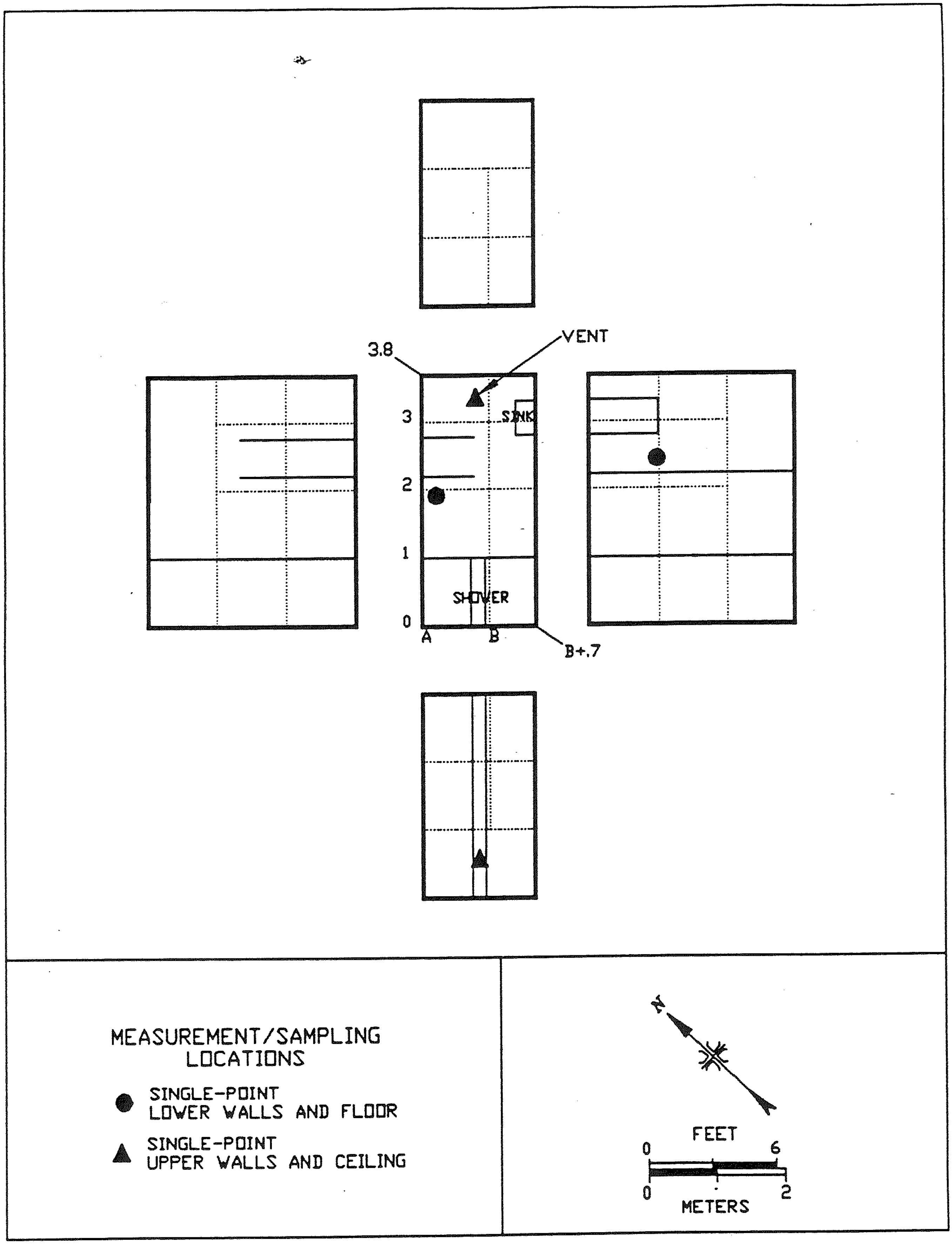

FIGURE 12: Building 005, Room 107A&B - Measurement and Sampling Locations

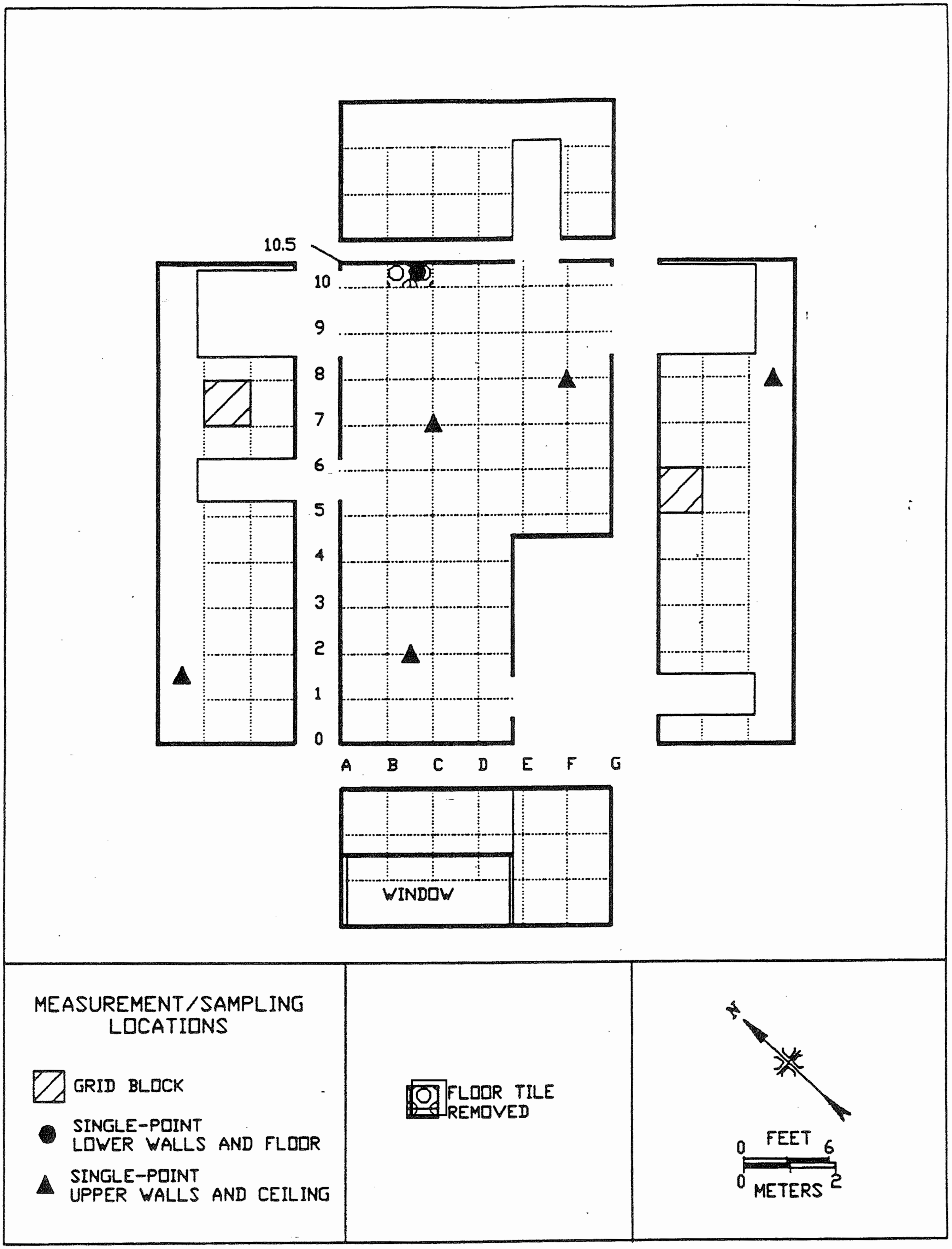

FIGURE 13: Building 005, Room 108 - Measurement and Sampling Locations

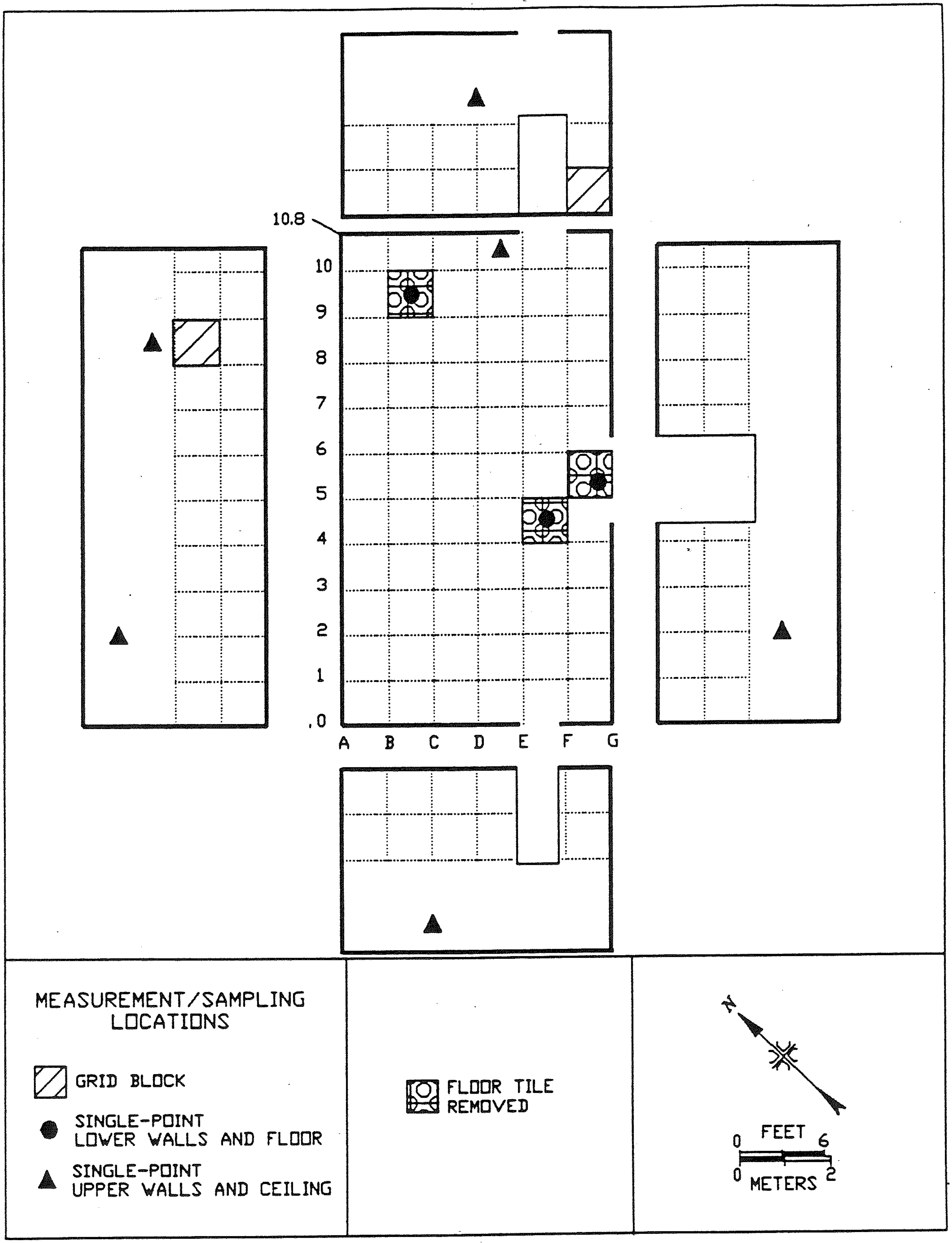

FIGURE 14: Building 005, Room 110 - Measurement and Sampling Locations

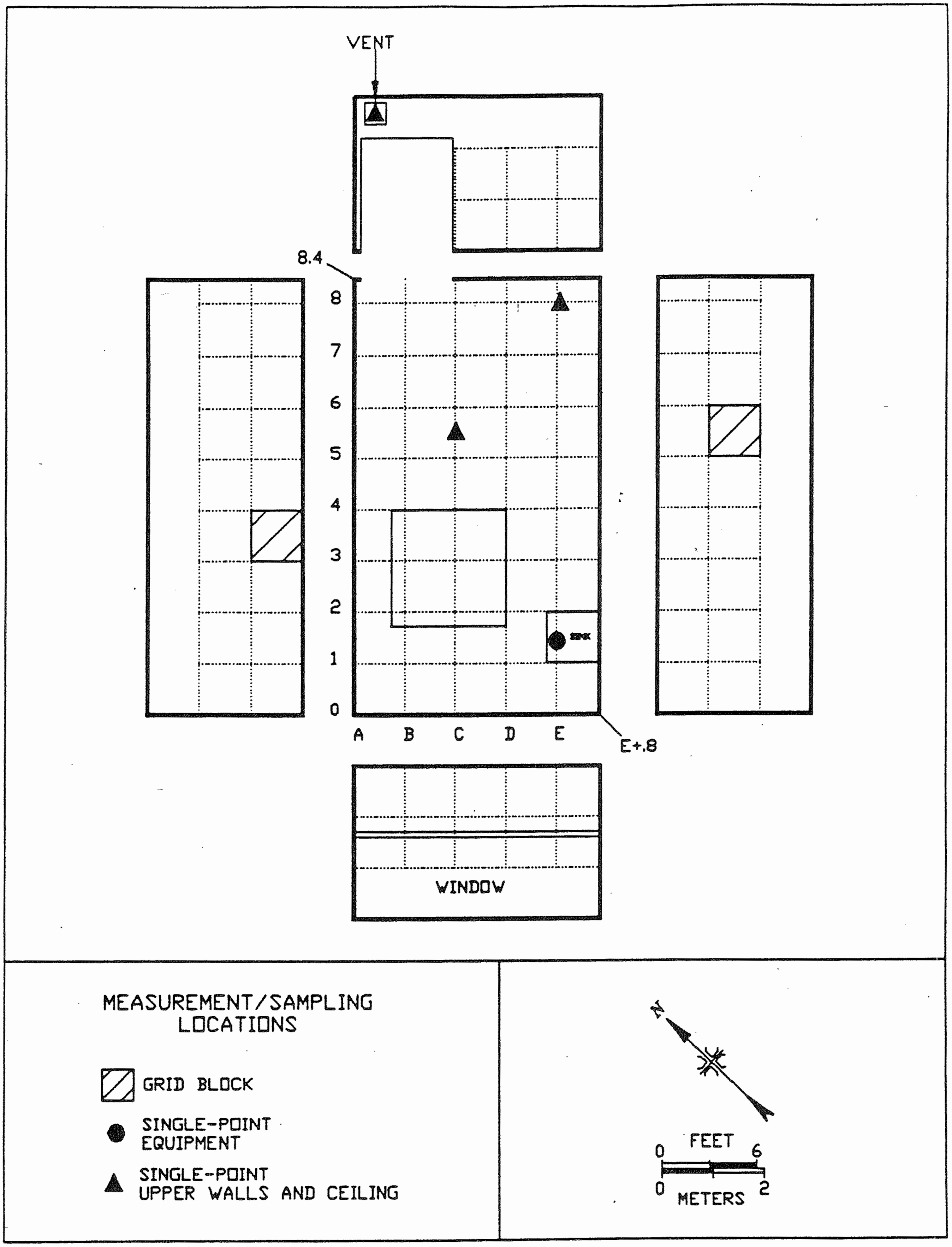

FIGURE 15: Building 005, Room 111 - Measurement and Sampling Locations

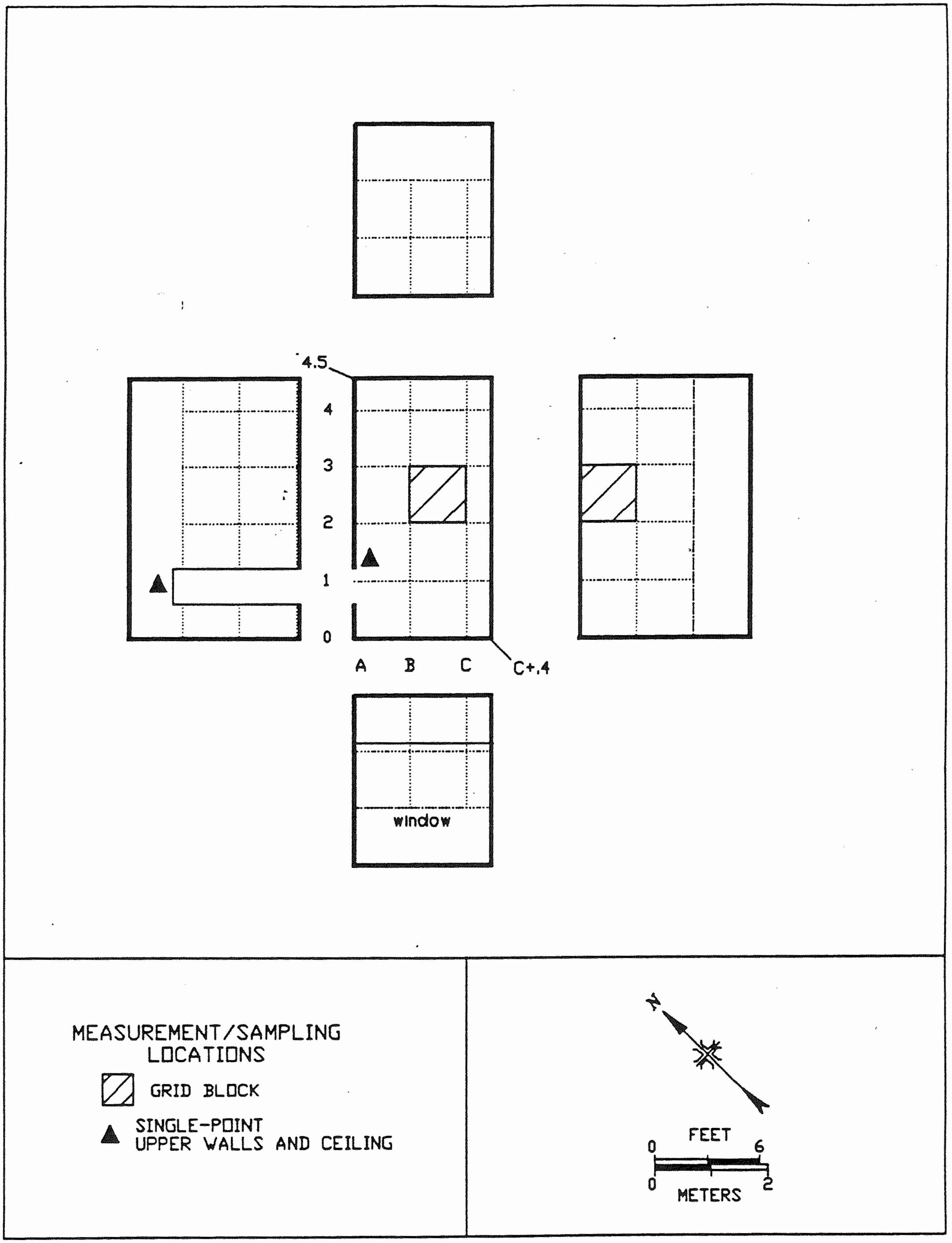

FIGURE 16: Building 005, Room 111A - Measurement and Sampling Locations

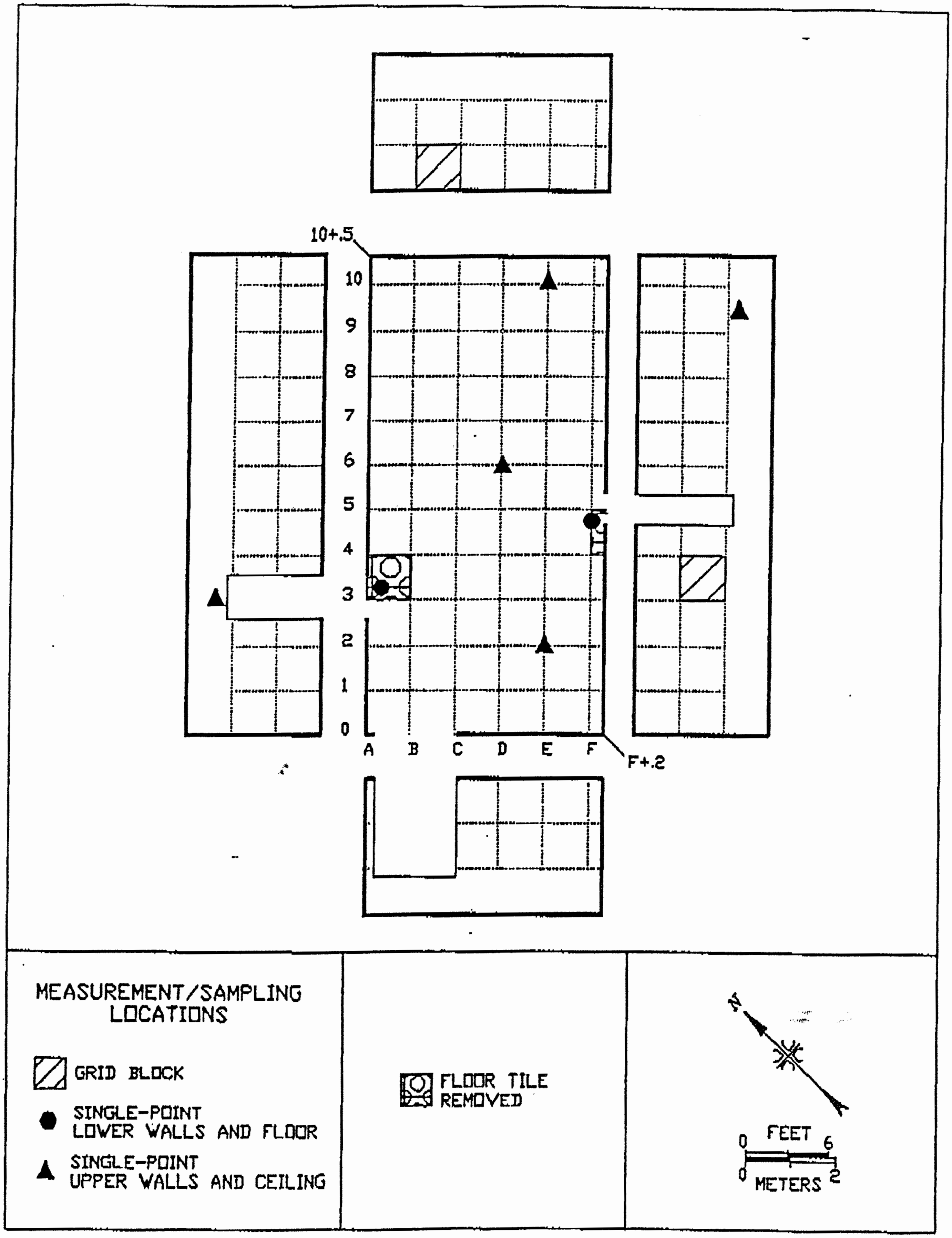

FIGURE 17: Building 005, Room 113 - Measurement and Sampling Locations

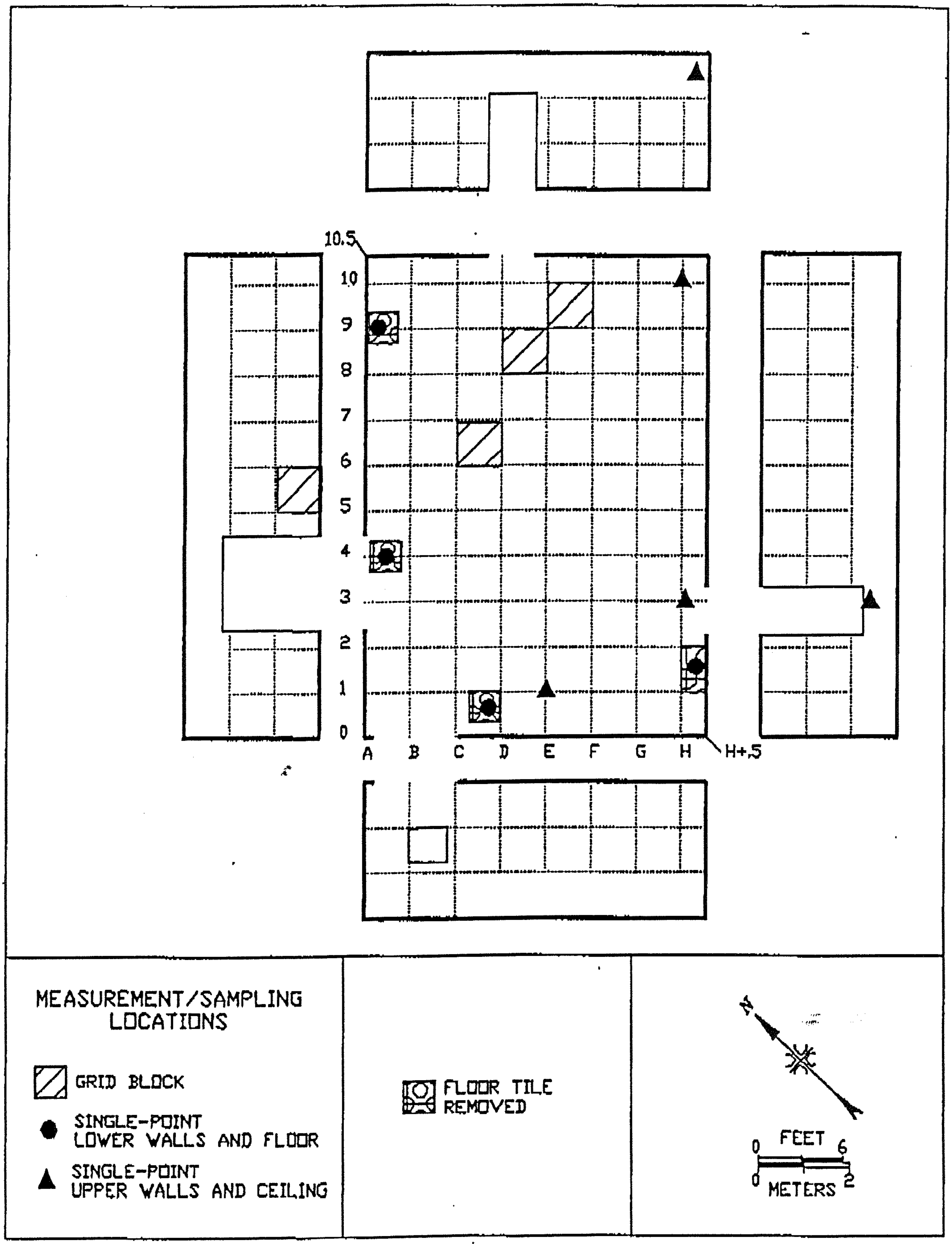

FIGURE 18: Building 005, Room 115 - Measurement and Sampling Locations

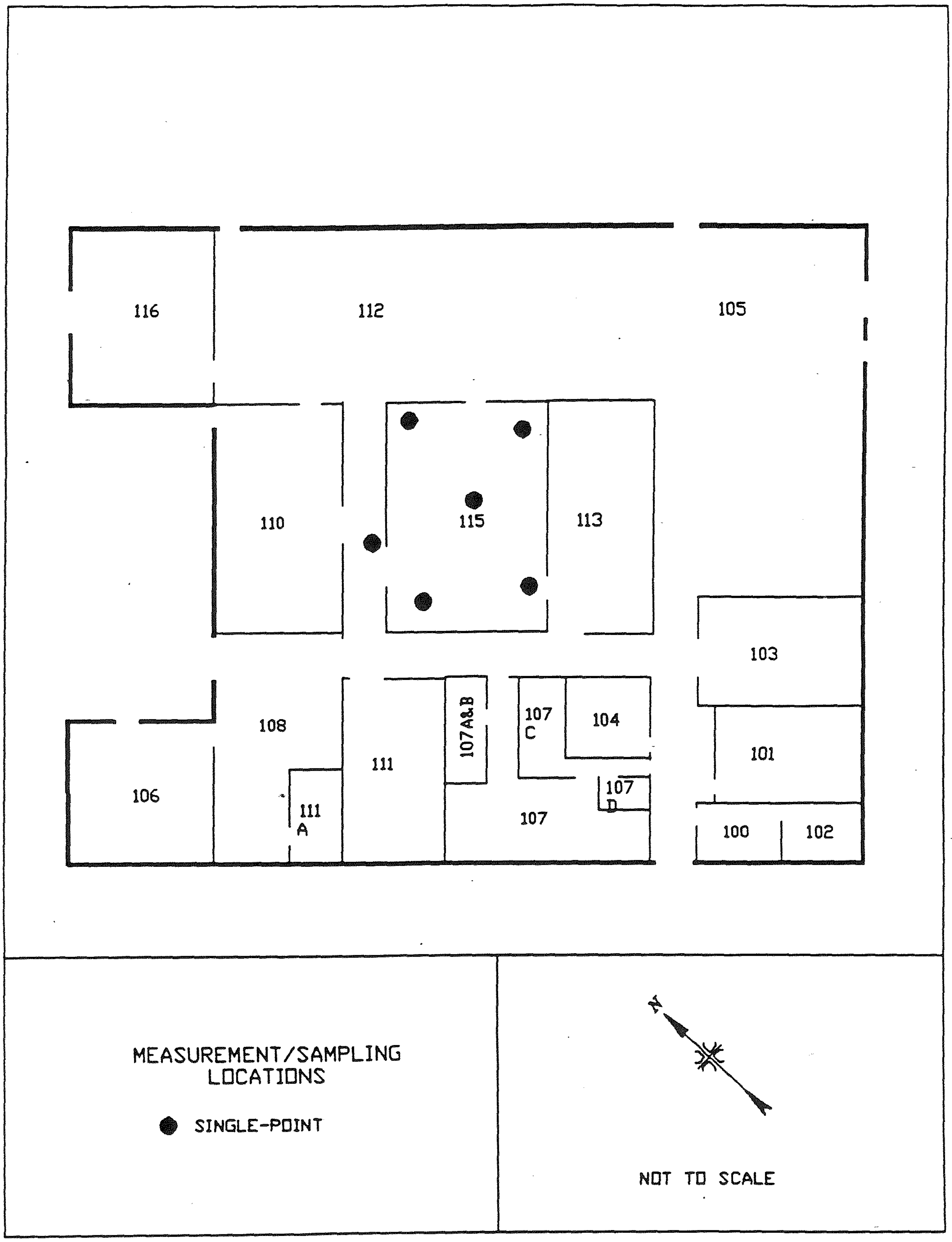

FIGURE 19: Building 005, Attic - Measurement and Sampling Locations

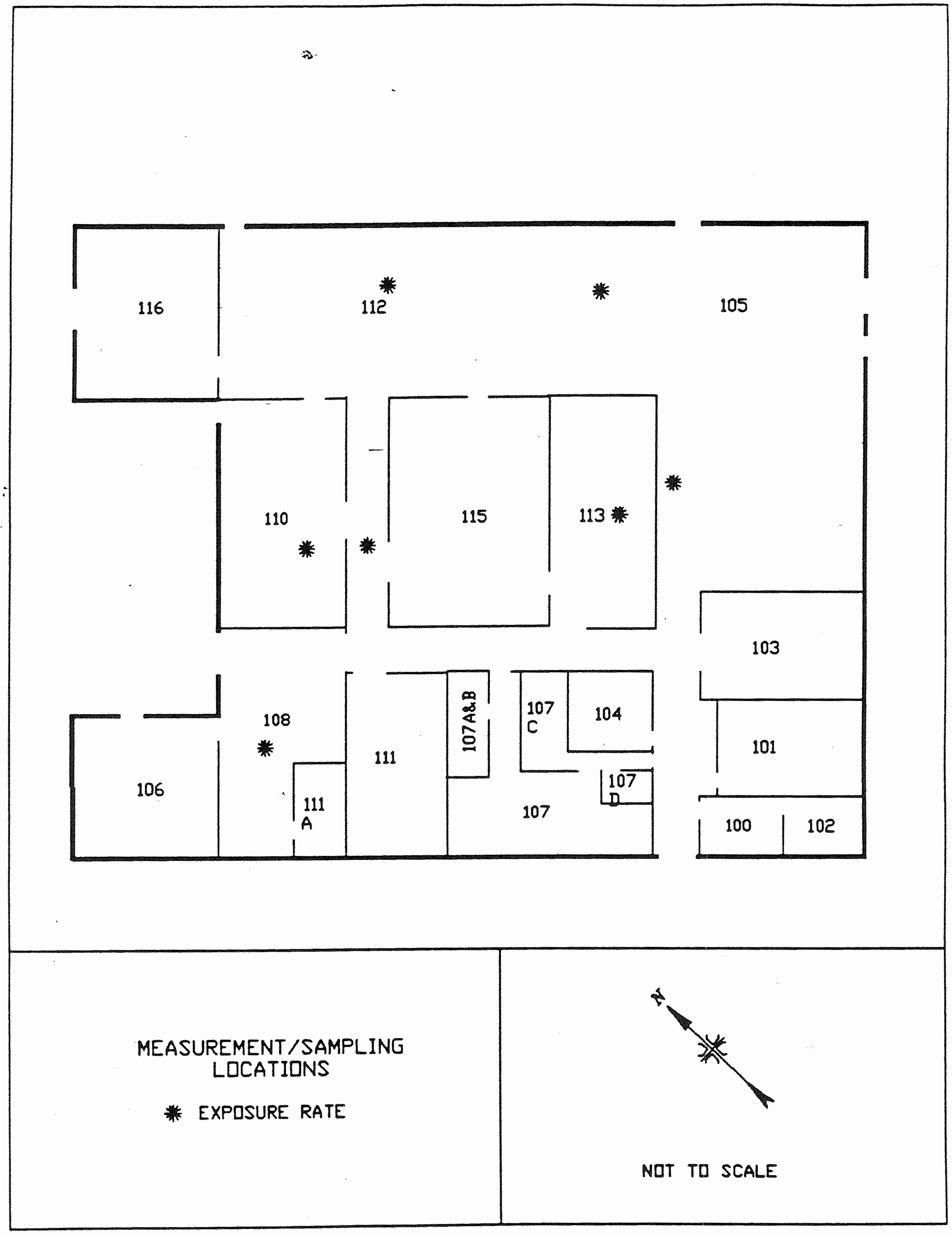

FIGURE 20: Building 005, Interior - Measurement Locations

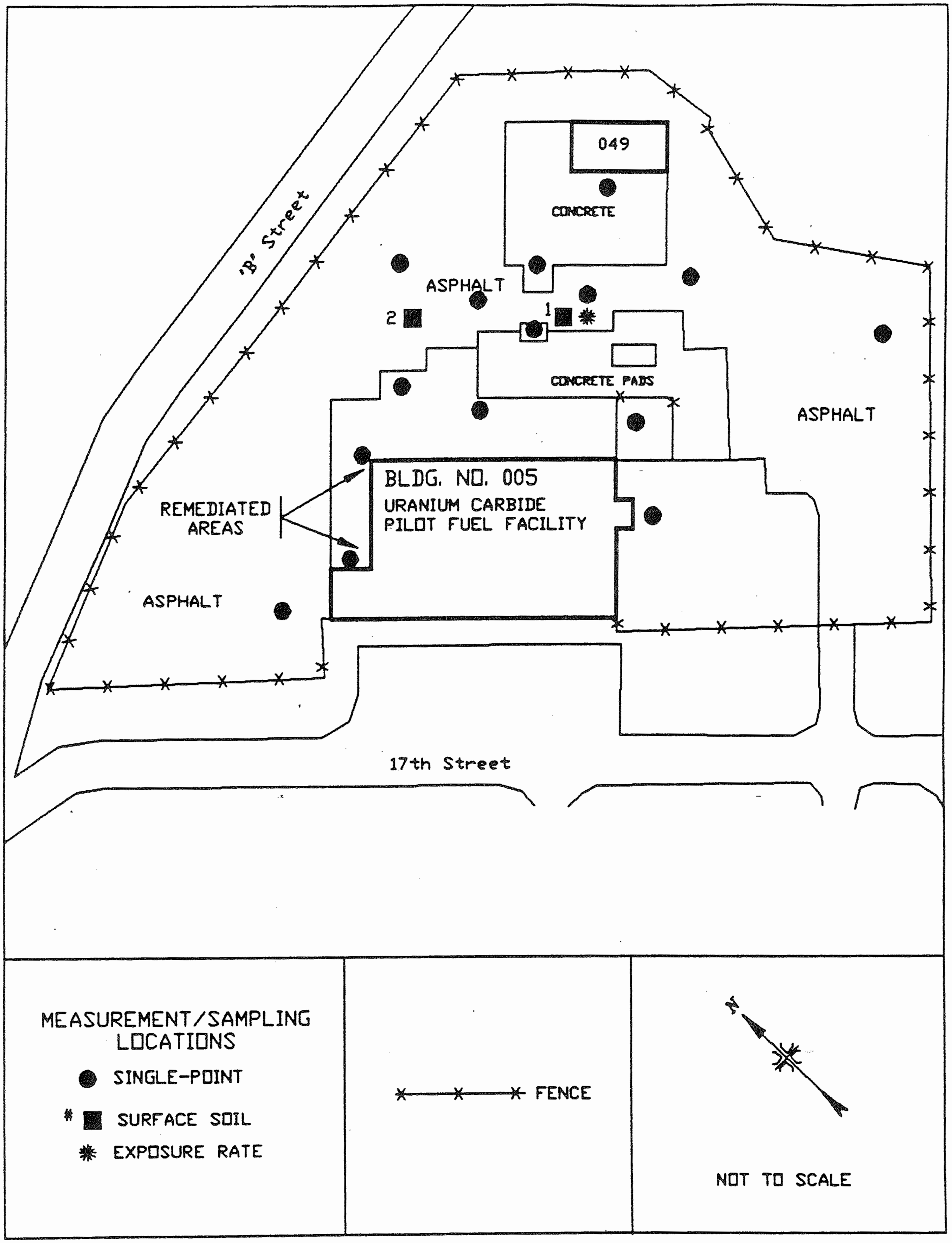

FIGURE 21: Building 005, Exterior Area - Measurement and Sampling Locations

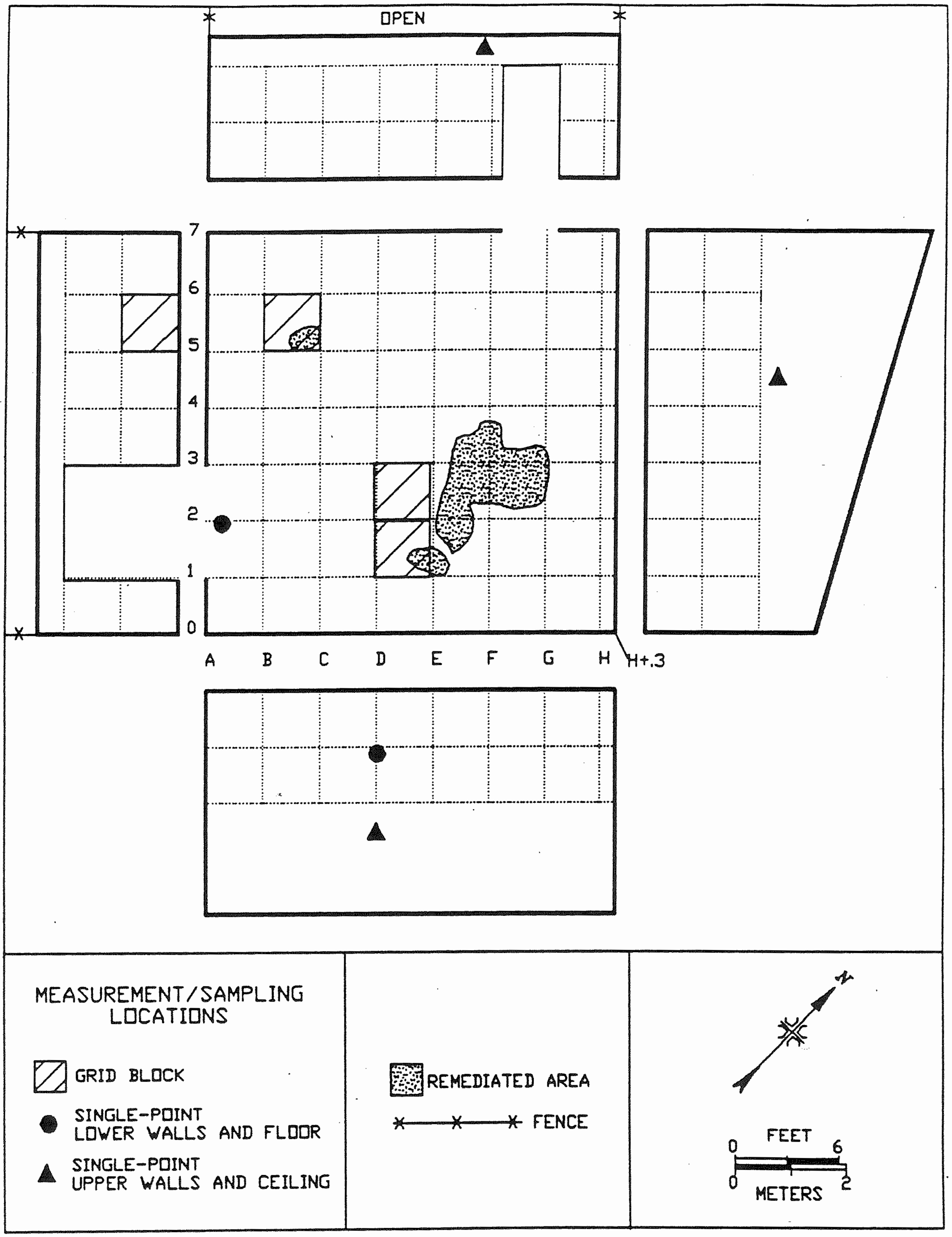

FIGURE 22: Building 023, Control Room - Measurement and Sampling Locations

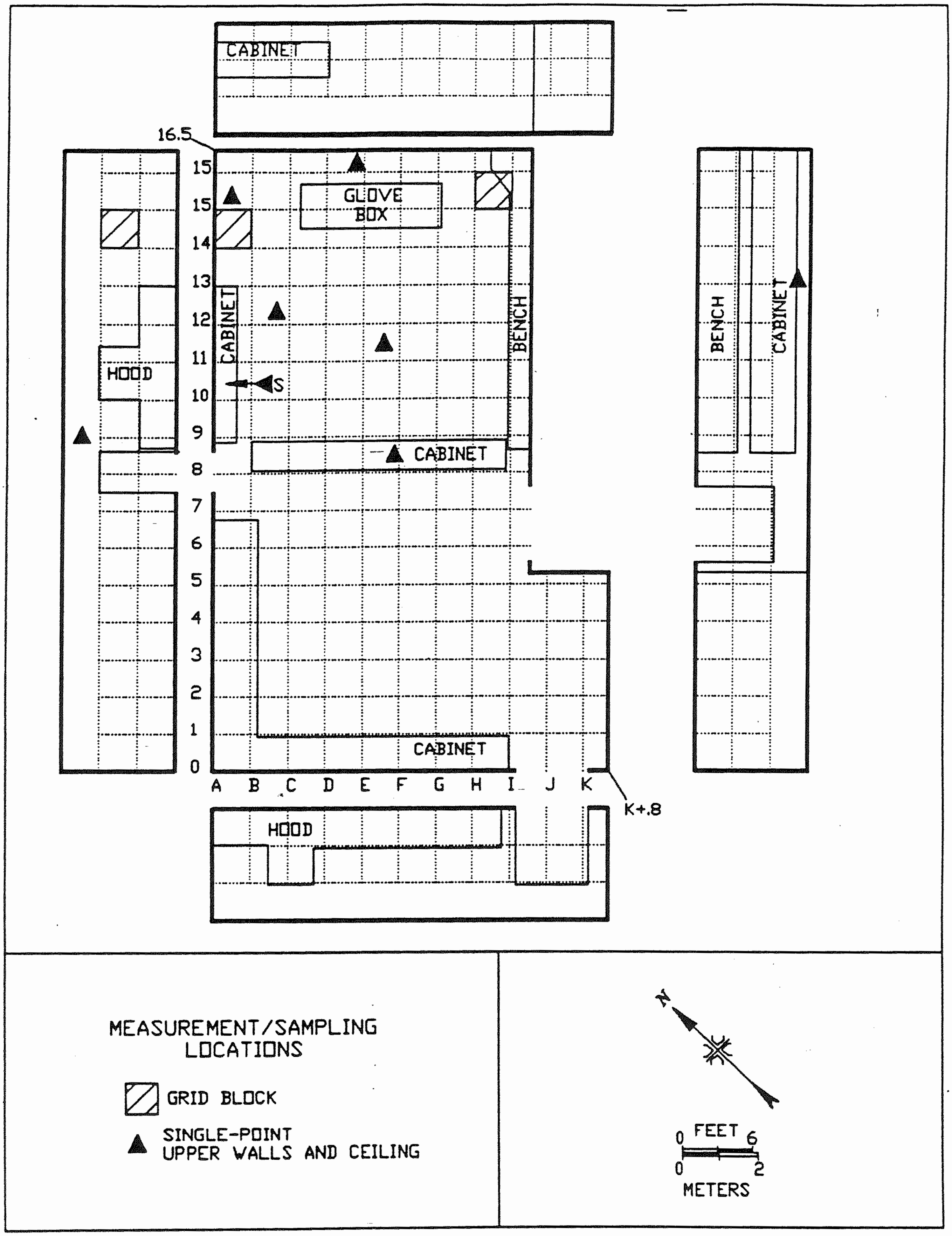

FIGURE 23: Building 023, Room 106 - Measurement and Sampling Locations

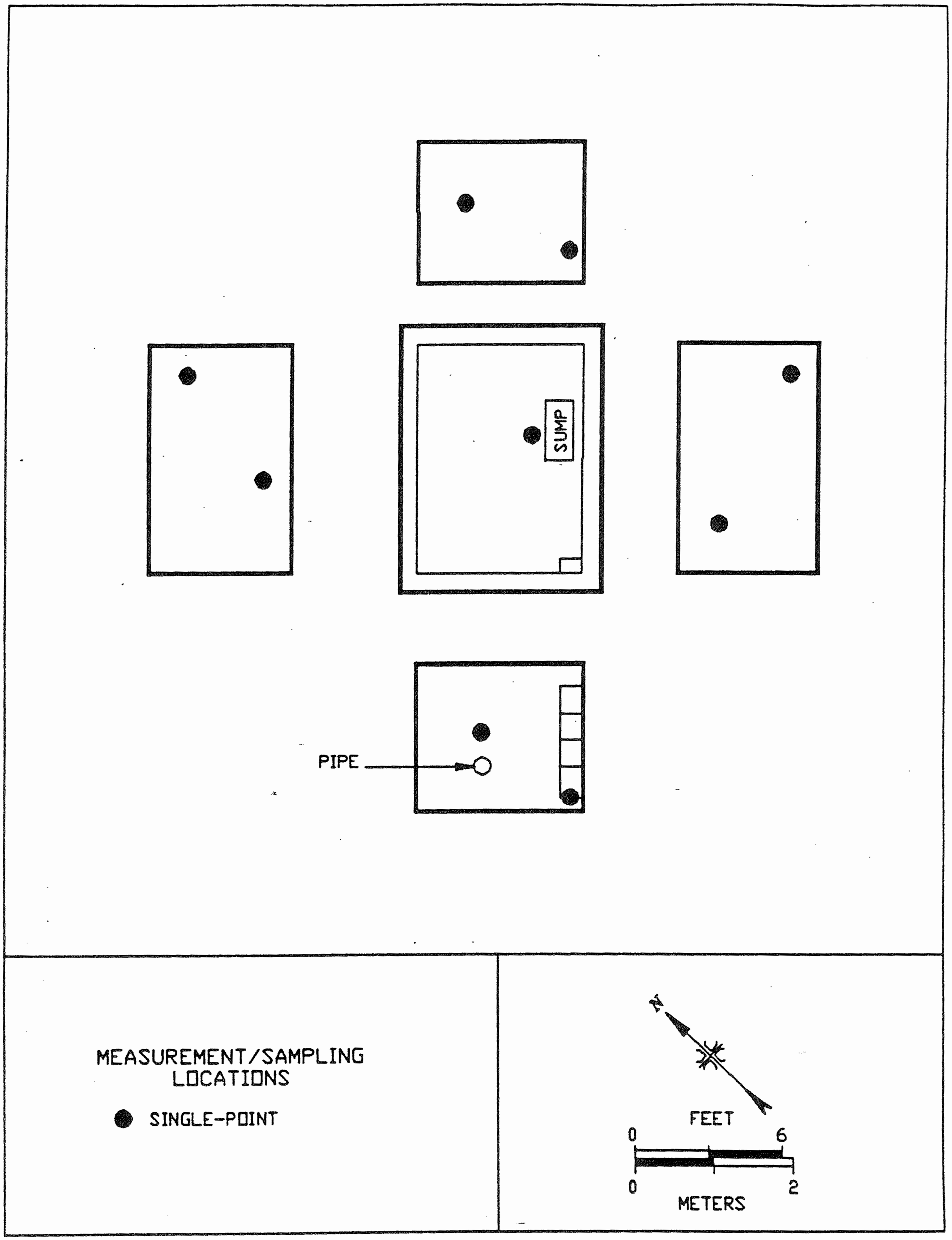

FIGURE 24: Building 023, Rad-Waste Tank Vault - Measurement and Sampling Locations

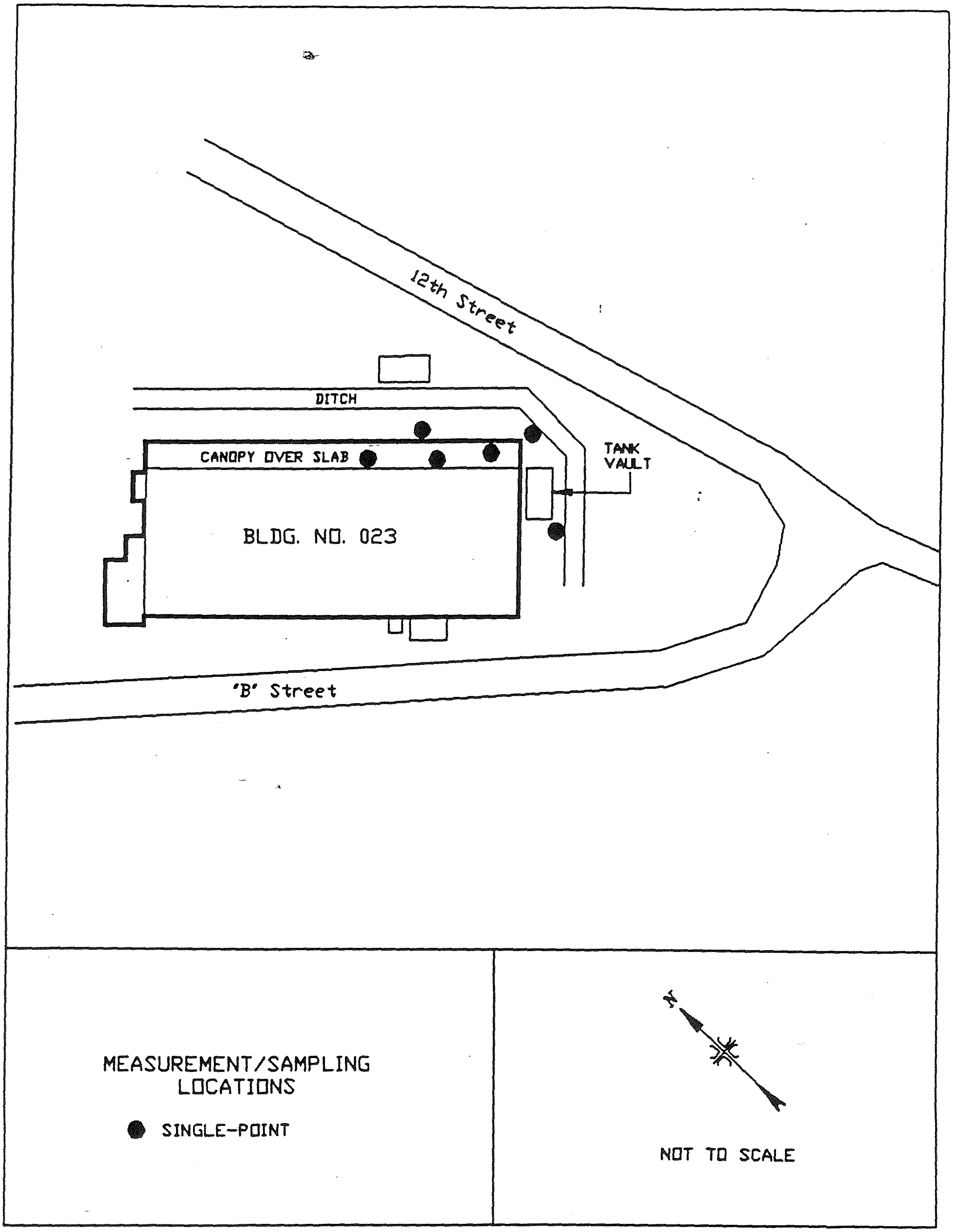

FIGURE 25: Building 023, Exterior Area - Measurement and Sampling Locations

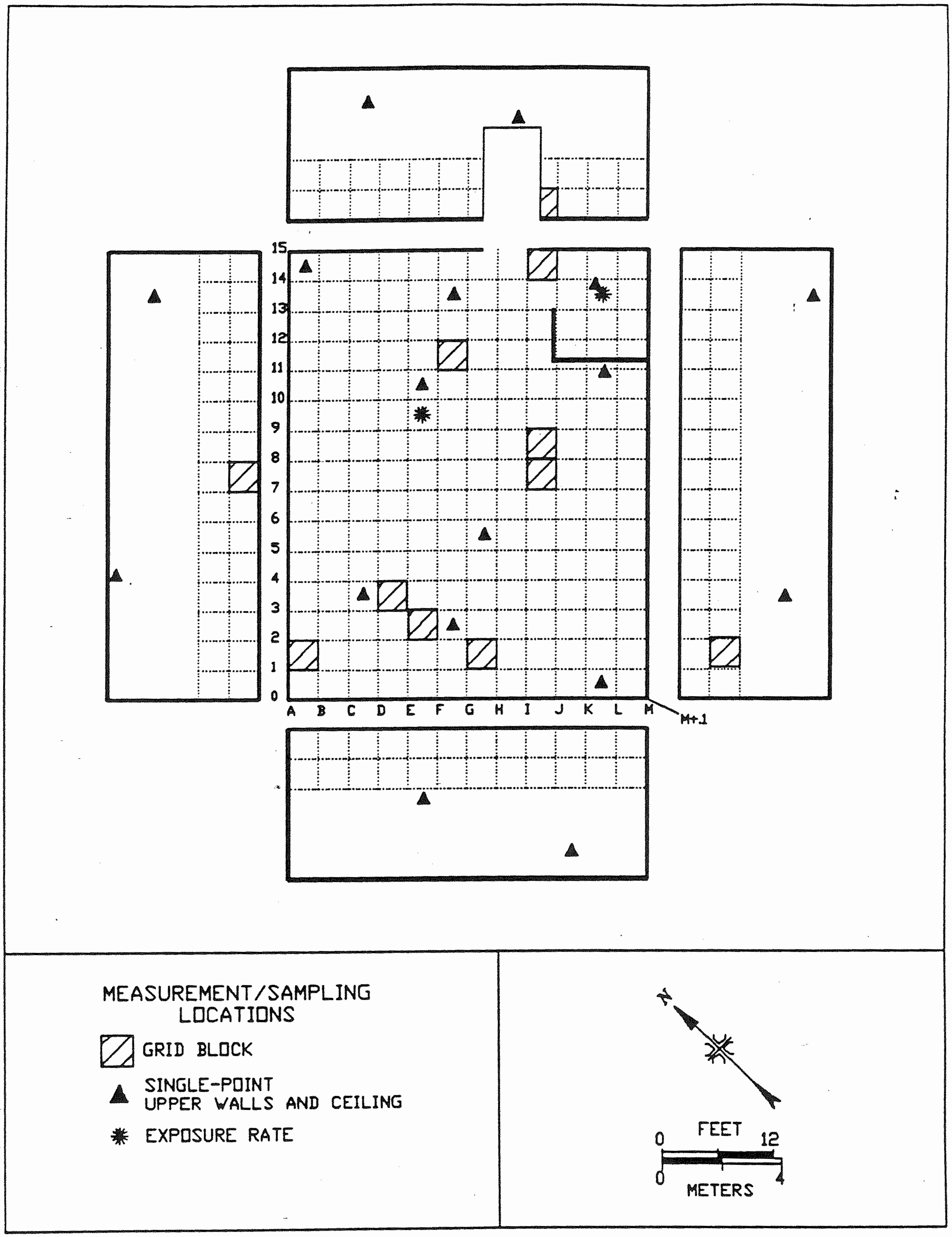

FIGURE 26: Building 064, Room 110 - Measurement and Sampling Locations

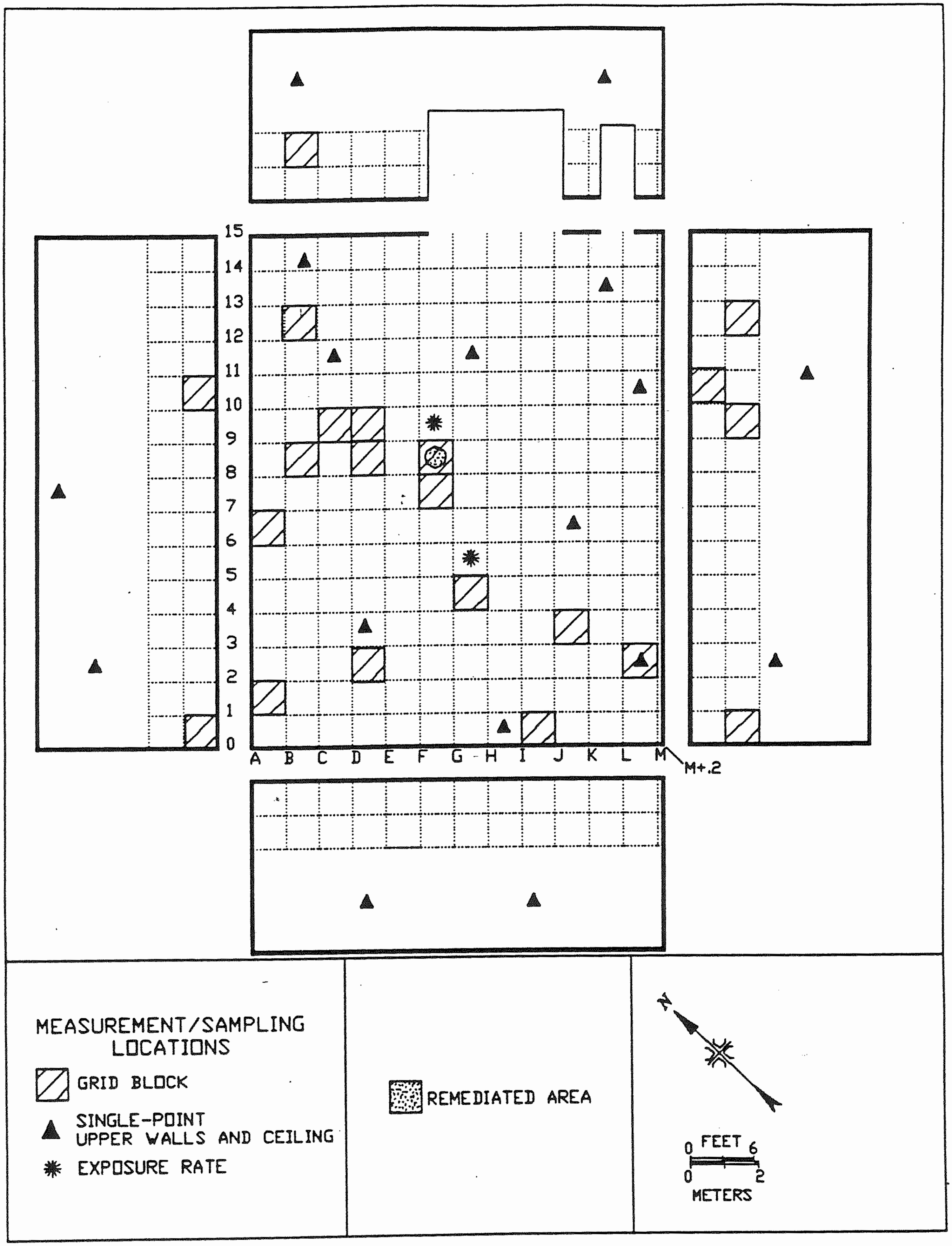

FIGURE 27: Building 064, Room 114 - Measurement and Sampling Locations

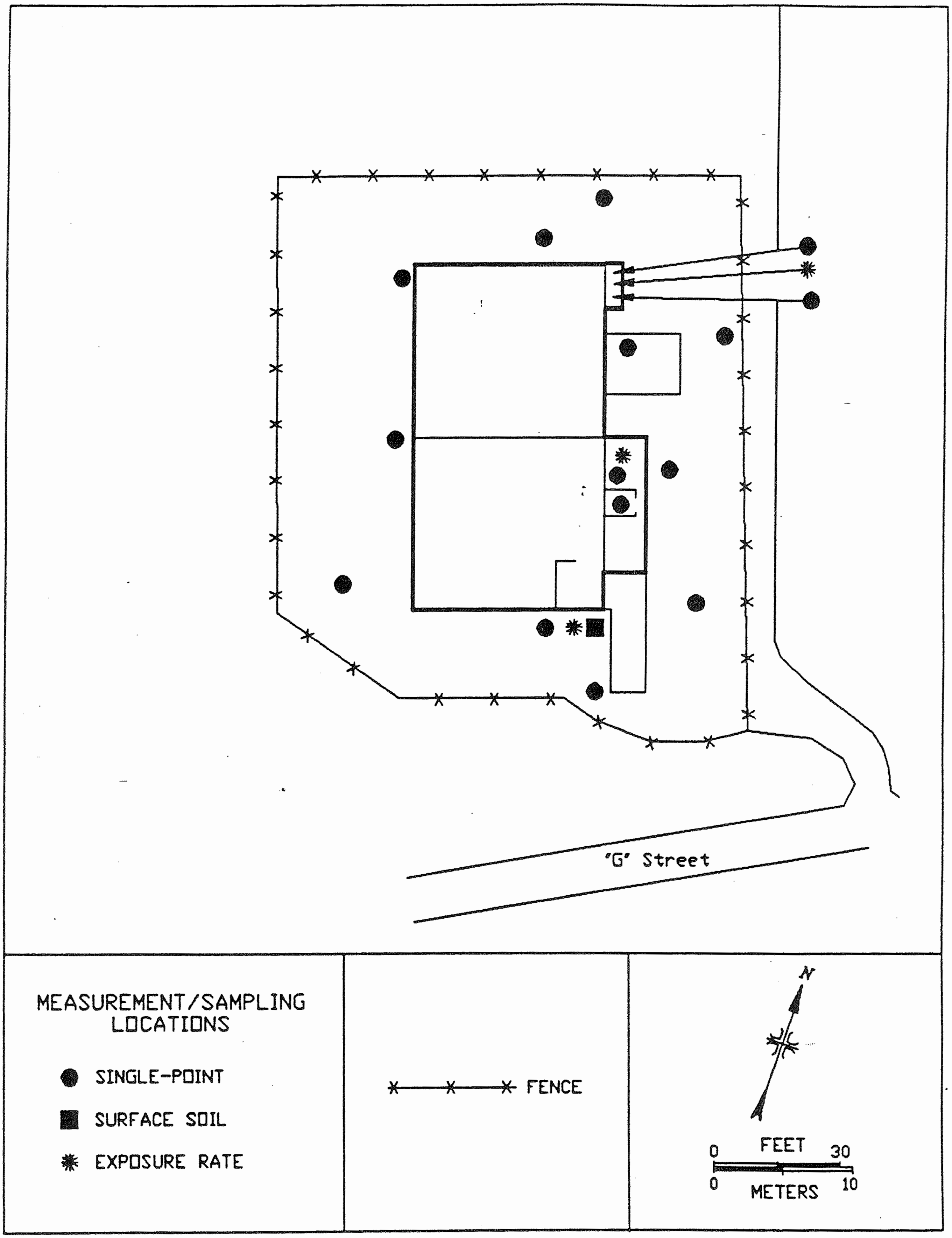

FIGURE 28: Building 064, Outer Rooms and Exterior Area - Measurement and Sampling Locations

ABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations		Range of Total Activity (dpm/100 cm^2)				Range of Removable Activity (dpm/100 cm^2)	
			Single Measurements		Grid Block Average			
	Single Points	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Building 005								
Room 103								
Lower Walls	NA[b]	2	<66	<1,500	<66	<1,500	<12	<16
Upper Walls and Ceilings	3	NA	<66	<1,500	NA	NA	<12	<16
Room 105/112								
Floor	NA	11	<66	<1,400 to 7,100	<66	<1,400 to 2,100	<12	<16
Lower Walls	NA	1	<66	<1,400	<66	<1,400	<12	<16
Upper Walls, I-Beams and Equipment[c]	27	NA	<66 to 110	<1,500	NA	NA	<12	<16
Room 106								
Floor	1	NA	<66	<1,400	NA	NA	<12	<16
Lower Wall	NA	1	<66	<1,400	<66	<1,400	<12	<16
Upper Walls and Ceiling	3	NA	<66	<1,400	NA	NA	<12	<16
Room 107A and 107B								
Floor	1	NA	<66	<1,500	NA	NA	<12	<16
Lower Wall	1	NA	<66	<1,500	NA	NA	<12	<16
Upper Walls and Ceiling	2	NA	89 to 360	<1,500 to 4,400	NA	NA	<12	<16
Room 108								
Floor	1	NA	<66	<1,500	NA	NA	<12	<16
Lower Walls	NA	2	<66	<1,400	<66	<1,400	<12	<16
Upper Walls and Ceiling	5	NA	<66	<1,400	NA	NA	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations		Range of Total Activity (dpm/100 cm^2)				Range of Removable Activity (dpm/100 cm^2)	
			Single Measurements		Grid Block Average			
	Single Points	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Building 005 (Continued)								
Room 110								
Floor	3	NA	<66	<1,500	NA	NA	<12	<16
Lower Walls	NA	2	<66 to 89	<1,500	<66	<1,500	<12	<16
Upper Walls and Rafter	6	NA	<66	<1,500	NA	NA	<12	<16
Room 111 and 111A								
Floor	NA	1	<66	<1,400	<66	<1,400	<12	<16
Lower Walls and Equipment	NA	3	<66 to 80	<1,500	<66	1,500	<12	<16
Upper Walls and Ceiling	6	NA	<66	1,500	NA	NA	<12	<16
Room 113								
Floor	2	NA	<66	<1,500	NA	NA	<12	<16
Lower Wall	NA	2	<66	<1,400	<66	<1,400	<12	<16
Upper Walls and Ceiling	5	NA	<66	<1,400	NA	NA	<12	<16
Room 115								
Floor	4	3	<66	<1,500	<66	<1,500	<12	<16
Lower Wall	NA	1	<66	<1,500	<66	<1,500	<12	<16
Upper Walls and Ceiling	5	NA	<66	<1,400	NA	NA	<12	<16
Attic	6	NA	<66	<1,500	NA	NA	<12	<16
Outdoor Area	15	NA	<66 to 360	<1,500 to 1,900	NA	NA	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations		Range of Total Activity (dpm/100 cm²)				Range of Removable Activity (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single Points	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Building 023								
Control Room								
Floor	1	3	<66	<1,400 to 6,700	<66	<1,400 to 2,400	<12	<16
Lower Walls	1	1	<66	<1,400	<66	<1,400	<12	<16
Upper Walls and Ceiling	3	NA	<66 to 110	<1,400	NA	NA	<12	<16
Room 106								
Floor	NA	2	<66	<1,400	<66	<1,400	<12	<16
Lower Walls	NA	1	<66	<1,400	<66	<1,400	<12	<16
Upper Walls, Ceiling, and Equipment	8	NA	<66 to 400	<1,400 to 3,100	NA	NA	<12	<16
Exterior								
Tank Vault	9	NA	<66 to 71	<1,500	NA	NA	<12	<16
Paved Areas and Walkways	6	NA	<66 to 120	<1,400 to 1,600	NA	NA	<12	<16
Building 064								
Room 110								
Floor	NA	8	<62 to 80	<1,400 to 2,400	<66	<1,500	<12	<16
Lower Walls	NA	3	<66 to 98	<1,500	<66	<1,500	<12	<16
Upper Walls and Ceiling	17	NA	<66 to 290	<1,500	NA	NA	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations		Range of Total Activity (dpm/100 cm^2)				Range of Removable Activity (dpm/100 cm^2)	
			Single Measurements		Grid Block Average			
	Single Points	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Building 064 (Continued)								
Room 114								
Floor	1	14	<66	<1,400 to 1,500	<66	<1,500	<12	<16
Lower Walls	NA	7	<66 to 89	<1,500	<66	<1,500	<12	<16
Upper Walls and Ceiling	17	NA	<66	<1,500	NA	NA	<12	<16
Room 116	2	NA	<66 to 98	<1,400 to 1,500	NA	NA	<12	<16
Room 120	1	NA	<66	<1,400	NA	NA	<12	<16
Rest Room	1	NA	<66	<1,400	NA	NA	<12	<16
Exterior								
Paved Areas and Ramps	11	NA	<66	<1,400 to 2,200	NA	NA	<12	<16

[a]Refer to Figures 9 through 18 and 20 through 28.
[b]NA = Not Applicable.
[c]All Measurements not shown on Figure 10. Seven measurements made on Molten Salt Reaction Products Tank and Equipment are not shown.

TABLE 2

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

Location[a]	Number of Exposure Rate Measurements	Exposure Rate Range (μR/h)[b]
Interior		
Building 005	7	10 to 11
Building 064	6	14 to 17
Exterior		
Building 005	1	12
Building 064	1	14

[a]Refer to Figures 20, 21, and 26 through 28.
[b]Reported exposure rates are inclusive of background.

TABLE 3

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

Location[a]	Radionuclide Concentration (pCi/g)[b]		
	Cs-137	U-235	U-238
Building 005 Loc. 1	<0.1	0.1 ± 0.1[c]	1.7 ± 1.4
Building 005 Loc. 2	<0.1	0.1 ± 0.1	0.7 ± 1.1
Building 064	2.7 ± 0.2	0.5 ± 0.1	3.8 ± 1.7

[a]Refer to Figures 21 and 28.
[b]Only radionuclides of concern reported. Gamma spectrometry results did not identify any photo peaks other than from those radionuclides occurring in nature.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

1. T. J. Vitkus, ORISE, "Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," October 1993.

2. Energy Technology Engineering Center, "Radiological Survey of Building T005," November 16, 1987.

3. Energy Technology Engineering Center, "Building T005 Decontamination and Decommissioning Operations Plan," January 24, 1992.

4. Energy Technology Engineering Center, "Building 005 Final Survey Procedure," December 9, 1992.

5. Energy Technology Engineering Center, "Final Radiological Survey of Building 005," September 21, 1993.

6. Energy Technology Engineering Center, "Final Radiological Survey Report of Building 023," March 1, 1994.

7. Energy Technology Engineering Center, "Radiological Survey of Source and Special Nuclear Material Storage Vault Building T064," August 19, 1988.

8. Energy Technology Engineering Center, "D&D Work Plan for Building 064, Environmental Restoration," February 18, 1992.

9. Energy Technology Engineering Center, "Building T064 Interior Final Survey Procedure," November 18, 1992.

10. Energy Technology Engineering Center, "Building 064 D&D Operations Final Report," August 13, 1993.

11. Energy Technology Engineering Center, "Radiological Assessment of the Building T064 Fenced-In Yard," December 23, 1993.

12. Energy Technology Engineering Center, "Final Radiological Survey Report of Building 064 Interior," January 14, 1994.

13. Letter from T. J. Vitkus, ORISE, to A. F. Kluk, U.S. Department of Energy, "Revised Verification Survey Plan for Buildings 005, 023, and 064, Santa Susana Field Laboratory, Ventura County, California," July 11, 1994.

REFERENCES (Continued)

14. Letter from T. J. Vitkus, ORISE, to A. F. Kluk, U.S. Department of Energy, "Comments on the Radiological Survey, Decontamination and Decommissioning and Final Status Survey Documentation for Building T005 and T064, Santa Susana Field Laboratory, Ventura County, California," March 22, 1994.

15. Letter from T. J. Vitkus, ORISE, to A. F. Kluk, U.S. Department of Energy, "Comments on the Decontamination and Decommissioning and Final Status Survey Documentation for Building 023, Santa Susana Field Laboratory, Ventura County, California," April 4, 1994.

16. Letter from G. Gaylord, Rockwell International, to J. Cullen, U.S. Department of Energy, "Response to Comments by ORISE and OAK on Rocketdyne Final Survey Reports for Building T005, T023, and T064," June 2, 1994.

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

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

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

Reuter-Stokes Pressurized Ion Chamber
Model RSS-111
(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)

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 in accordance with ESSAP Surface Scanning procedures 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 (15.5 cm^2 and 59 cm^2) hand-held detectors. Identification of elevated surface activity 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
	—	pancake GM detector with ratemeter-scaler
Gamma	—	NaI scintillation detector with ratemeter

Surface Activity Measurements

Alpha and beta activity measurements were performed in accordance with Alpha Radiation Measurement and Beta Radiation Measurement procedures on floors, walls, upper room surfaces, some equipment, and at locations of elevated direct radiation, 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. The alpha activity background countrates for the ZnS scintillation detectors averaged approximately 1 cpm for each detector. Alpha efficiency factors, based on calibration with Pu-239, ranged from 0.19 - 0.20 for the ZnS scintillation detectors. The beta activity background count rates for the GM detectors averaged approximately 55 cpm. Beta efficiency factors for Tc-99 ranged from 0.16 - 0.17 for the GM detector. The effective window for the ZnS scintillation and GM detectors were 59 cm^2 and 15.5 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined in accordance with ESSAP Determination of Removable Activity procedures, using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear with two or three fingers, 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

Quantitative measurements of gamma exposure rates, at 1 m above surfaces, were performed in accordance with ESSAP Gamma Radiation (Exposure Rate) Measurement procedures using a pressurized ionization chamber (PIC). Qualitative exposure rates were determined by comparing gamma count rates, from NaI detector ratemeter combinations, and cross calibrating to site exposure rates obtained using the PIC.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled. Sampling and labeling was in accordance with ESSAP Surface Soil Sampling and Sample Identification and Labeling procedures.

ANALYTICAL PROCEDURES

Removable Activity

Smears were counted on a low background gas proportional system for gross alpha and gross beta 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 and ranged from 757 to 888 g of material. 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. Energy peaks used for determination of radionuclides of concern were:

Cs-137	0.662 MeV
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

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 4.66 times the standard deviation of the background count:

$$2.71 + (4.66\sqrt{BKG})$$

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, 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 standards/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:

- Survey Procedures Manual, Revision 8 (December 1993)
- Laboratory Procedures Manual, Revision 8 (August 1993)
- Quality Assurance Manual, Revision 6 (July 1993)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C for Quality Assurance and NQA-1 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 reasonable 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

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]
Cesium-137 and Uranium	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 $(100/A)^{1/2}$, 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.

REFERENCES

1. "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.

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

ORISE 93/J-107

VERIFICATION SURVEY OF THE OLD CONSERVATION YARD, BUILDING T064 SIDE YARD, AND BUILDING T028 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by

T. J. Vitkus

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division
Oak Ridge Institute for Science and Education
Oak Ridge, TN 37831-0117

Prepared for the

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

OCTOBER 1993

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

VERIFICATION SURVEY
OF THE
OLD CONSERVATION YARD, BUILDING T064 SIDE YARD,
AND BUILDING T028
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Prepared by: ______________________ Date: 10/13/93
T. J. Vitkus, Environmental Project Leader
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 10/14/93
W. L. Beck, Acting Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 10/14/93
M. R. Landis, Project Manager
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 10/15/93
A. T. Payne, Quality Assurance Officer
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 10/14/93
J. D. Berger, Program Director
Environmental Survey and Site Assessment Program

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FIELD STAFF

T. C. Bright
R. B. Slaten

LABORATORY STAFF

J. S. Cox
R. D. Condra
R. L. Epperson
M. S. Laudeman
S. T. Shipley
F. E. Weaver

CLERICAL STAFF

T. T. Claiborne
D. A. Cox
M. S. Perry
K. E. Waters

ILLUSTRATORS

E. A. Powell
T. D. Herrera

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ABBREVIATIONS AND ACRONYMS

ac	acres
AEC	Atomic Energy Commission
cm	centimeter
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurement Laboratories
ER	Office of Environmental Restoration
ERDA	Energy Research and Development Administration
ESG	Energy Systems Group
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
ft	feet
ft^2	square feet
ha	hectares
in	inch
km	kilometer
m	meter
m^2	square meter
mi	mile
mrem	millirem
NIST	National Institute of Standards and Technologies
OCY	Old Conservation Yard
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocurie per gram
STR	Shield Test Reactor
SSFL	Santa Susana Field Laboratory
STIR	Shield Test and Irradation Reactor
μR/h	microroentegens per hour

VERIFICATION SURVEY
OF THE
OLD CONSERVATION YARD, BUILDING T064 SIDE YARD,
AND BUILDING T028
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) for the Department of Energy (DOE). The facility, known as the Energy Technology Engineering Center (ETEC), began nuclear energy research and development programs in 1946. 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 of nuclear reactor systems and components. Other site activities have also been conducted for the Nuclear Regulatory Commission, the Department of Defense, and other government related or affiliated organizations and agencies.

Numerous buildings and land areas became radiologically contaminated as a result of facility operations and site activities 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, depleted, and enriched isotopic abundances), plutonium, americium-241, fission products (primarily cesium-137 and strontium-90), activation products (cobalt-60, europium-152, nickel-63, promethium-147, and tantalum-182) and tritium. Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater.

Decontamination and decommissioning of facilities began in the late 1960's and continues as specific DOE-sponsored projects are phased out. In addition to radiological surveys to support current facility decontaminations, Rockwell/Rocketdyne determined that the documentation describing the radiological status for a number of early projects was inadequate; therefore, surveys or resurveys of selected sites were initiated in 1985. Sites surveyed in these recent investigations included the Old Conservation Yard (OCY), Building T064 Side Yard, and Building T028.

From 1952 until 1977, the OCY and surrounding land areas were used for the storage of excessed equipment some of which was contaminated with either uranium or mixed fission products. The 1988 radiological survey of the OCY identified elevated concentrations of Cs-137 in soil, with assumed equivalent concentrations of Sr-90. Although there is no available confirming documentation, the source of the contamination is believed to be the result of a contaminated liquid spill. The area was further investigated to delineate the areal extent of contamination. This investigation identified a 37 m^2 (400 ft^2) area with contamination to a depth of 15 cm (6 in). A Cs-137 clean-up guideline was established through the use of the DOE computer code RESRAD.[1] Contaminated soil was excavated, and post-remedial action measurements and sampling were performed and documented.

Building T064, which was formerly known as the Source and Special Nuclear Material Storage Facility, was used for the storage of packaged items of source and special nuclear materials prior to 1980; it is currently used to store non-nuclear components and equipment and metal boxes containing low-level contaminated soil. Site history indicates that the area around the building and the side yard was occasionally used for storage of recoverable uranium scrap, irradiated fuel elements, and miscellaneous radioactive wastes, which included in the early 1960's a lead-pig cask containing irradiated "Seawolf" fuel and contaminated water. The drain plug in the cask failed, allowing the water to leak onto the Side Yard. A 65 m^2 area was excavated immediately following the incident; however, a 1988 comprehensive radiological survey of the area around Building T064 identified elevated soil concentrations of Cs-137 (assumed equivalent amount of Sr-90). Further investigations determined that a 47 m^2 area of contamination was located within the northeast fence line and extended in a northeast direction past the fence line over an additional area of 370 m^2. A Cs-137 guideline was developed and the top 41 cm of soil was subsequently excavated from the area and a post-remedial action survey performed and documented.

Building T028 housed the Shield Test Reactor (STR) from 1961 until 1964, at which time STR was modified and renamed the Shield Test and Irradiation Reactor (STIR) which operated until 1972. The reactor was dismantled and the building decontaminated. From 1977 to 1981, experiments were conducted in the building to investigate the behavior of molten uranium oxide, which resulted in recontamination of building and equipment surfaces. Decontamination of the building was performed in 1988 and the above-grade portion demolished in 1989, leaving only the concrete slab floor, below-grade concrete test vault, and stairwell intact.

DOE's Office of Environmental Restoration (DOE/ER), Northwestern Area Programs, San Francisco Operations Division 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 Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has been designated as the organization responsible for this task at SSFL. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located near Chatsworth in the Simi Hills of southeastern Ventura County, California, approximately 47 km (29 mi) northwest of downtown Los Angeles (Figure 1). The site is comprised of a total of approximately 1090 hectares (2700 acres) and is divided into four administrative areas (Areas I - IV) and a Buffer Zone. DOE operations are conducted in Rockwell International-owned and DOE-owned facilities located within the 117 ha Area IV. The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha. The Area IV plot plan is provided in Figure 2 and indicates the locations of those areas addressed by this report.

The OCY is located in the northeast quadrant of Area IV and is a portion of adjacent land groupings totaling 2 ha, termed the Old Energy Systems Group (ESG) Salvage Yard, Rocketdyne Barrel Storage Yard and the New Salvage yard (also known as T583). The OCY occupies an area at the corner of G Street and the Old Salvage Yard Road (Figure 3). The surface is paved with asphalt and is currently used for trailer storage.

Building T064 is in the northeast quadrant of Area IV, north of and above G Street (Figure 4). The Side Yard is located to the east of T064 and includes an area of approximately 0.8 ha.

Building T028 is located in the north-central portion of Area IV. The above-grade concrete slab is approximately 300 m^2 in area. The below-grade vault measures approximately 60 m^2 with 6 m (20 ft) ceilings. Construction consists of a concrete slab floor with concrete walls and ceiling.

OBJECTIVE

Through document reviews and independent surveys, an independent evaluation is performed. The purpose of the evaluation is to validate that cleanup procedures and survey methods utilized by Rockwell/Rocketdyne were adequate. In addition, independent verification 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

The final decontamination and survey reports for the OCY, Building T064 Side Yard, and Building T028 were reviewed for general thoroughness, accuracy, and completeness.[2,3,4] The procedures used and data developed for area characterization and post-remedial action monitoring were evaluated to determine if surveys had been adequately performed, areas of contamination were identified and remediated, and that the DOE guidelines had been met.

PROCEDURES

ESSAP personnel conducted independent measurement and sampling activities at SSFL on June 9 and 10, 1992. Survey activities were performed in accordance with a site specific survey plan, using procedures and instruments described in the ESSAP Survey Procedures Manual and summarized in Appendices A and B.

SURVEY PROCEDURES: OCY AND T064 SIDE YARD

Reference Grid

A reference grid, consisting of 10 m x 10 m grid blocks, was established on outdoor areas associated with the OCY and T064 Side Yard (Figures 5 and 6). The remaining 2 ha and 0.8 ha land areas were not gridded. Measurements and samples from ungridded surfaces were referenced to prominent site features.

Surface Scans

Gamma surface scans were performed over the remediated portions of the OCY and T064 Side Yard. In addition, portions of the respective 2 ha and 0.8 ha adjacent areas were also surface scanned. Scans were performed with NaI detectors, coupled to ratemeters with audible indicators. Locations of elevated direct radiation identified by surface scans were marked for further investigation.

Soil Sampling

Composite surface (0-15 cm) soil samples were collected from three 100 m^2 areas within the OCY and T064 Side Yard. Two additional soil samples were collected from the T064 Side Yard at locations of elevated direct radiation detected during surface scans. Figures 5 and 7 show soil sampling locations.

SURVEY PROCEDURES: BUILDING T028

Reference Grid

A reference grid, consisting of 1 m^2 grid blocks, was established on the above-grade concrete slab and on the floor and lower walls (up to 2 m) of the below-grade vault (Figures 8 and 9). Upper walls, ceilings and the stairwell were not gridded. Measurements and samples from ungridded surfaces were referenced to the floor or lower wall grid or to prominent building features.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed on the concrete slab and below-grade floors, walls and overhead surfaces using ZnS scintillation, GM, and NaI detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

The primary contaminant within Building T028 was uranium in natural and depleted isotopic abundances. Uranium emits both alpha and beta radiations at approximate ratios of 1:1 and 1:1.6 for natural and depleted uranium, respectively. The surface contamination guidelines for uranium are in units of alpha dpm/100 cm^2; however, because rough, dirty, or damp surfaces selectively attenuate alpha radiation, beta activity was also measured.

Direct measurements for total alpha and total beta activity were performed on a total of ten randomly selected grid blocks located in the vault or on the above-ground concrete slab. One set of five direct measurements was obtained from each grid block. Measurements were performed at the center and four points equidistant from the center and grid block corners. Single-point alpha and beta measurements were performed at six locations on upper walls and ceiling of the vault and at three locations in the stairwell. Direct measurements were made using ZnS and GM detectors coupled to ratemeter-scalers. A smear sample, for determining gross alpha and gross beta activity, was collected from the location within each grid block corresponding to the highest total direct measurement and from each single-point measurement location. Figures 8 through 10 indicate measurement and sampling locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, TN for analysis and interpretation. Soil samples were analyzed by gamma spectrometry for Cs-137 and uranium. Spectra were also reviewed for other identifiable photopeaks. Soil samples were also analyzed by wet chemistry methods for Sr-90. Soil sample results are reported in units of pCi/g. Smear samples were analyzed for gross alpha and gross beta activity using a low background proportional counter. Smear sample results and direct measurement data were converted to units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2).

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of the SSFL decontamination and survey reports identified several procedural, analytical, and data findings where clarification would provide additional support that the sites have been adequately characterized and meet the requirements for release without radiological restrictions. These findings were provided in a June 5, 1992 correspondence.[5]

OCY AND T064 SIDE YARD

Surface Scans

Gamma surface scans of the OCY and T064 Side Yard identified three locations of elevated direct radiation, each measuring less than 1 m^2 in area, within the T064 Side Yard (Figure 6). All other gamma surface scans were within the range of ambient site background.

Radionuclide Concentration In Soil

Radionuclide concentrations in soil samples are summarized in Table 1. Concentrations in samples from two of the locations of elevated direct radiation that were individually sampled were: Cs-137, 35.1 and 210 pCi/g; Sr-90 <0.4 and 2.0 pCi/g; U-235, 0.3 pCi/g; U-238, 0.9 and 1.4 pCi/g. Concentrations in the composite samples, which represent the averages in 100 m^2 areas, were as follows: 0.6 to 27.7 pCi/g Cs-137; <0.5 to 1.9 pCi/g Sr-90; 0.1 to 0.4 pCi/g U-235; and 0.9 to 1.6 pCi/g U-238.

BUILDING T028

Surface Scans

Surface scans of the above-ground concrete slab, below-grade vault, and the stairwell for alpha, beta, and gamma activity did not identify any locations of elevated direct radiation.

Surface Activity Levels

Surface activity levels for Building T028 are summarized in Table 2. The average surface activity levels within surveyed 1 m^2 grid blocks were <83 dpm/100 cm^2 for alpha and ranged from <860 to 1200 dpm/100 cm^2 for beta. Individual direct measurements ranged from <83 to 89 for alpha and <860 to 1400 dpm/100 cm^2 for beta. Removable activity levels were <12 dpm/100 cm^2 for gross alpha and <15 to 25 dpm/100 cm^2 for gross beta.

ESSAP's independent investigation supports Rockwell/Rocketdyne's field and analytical data for the Old Conservation Yard and following the additional remediation, the Building T064 Side Yard. ESSAP's independent measurement and sampling data for Building T028 were within the generic surface contamination DOE guidelines. It is, therefore, ESSAP's opinion that these areas meet the requirements for release to unrestricted use.

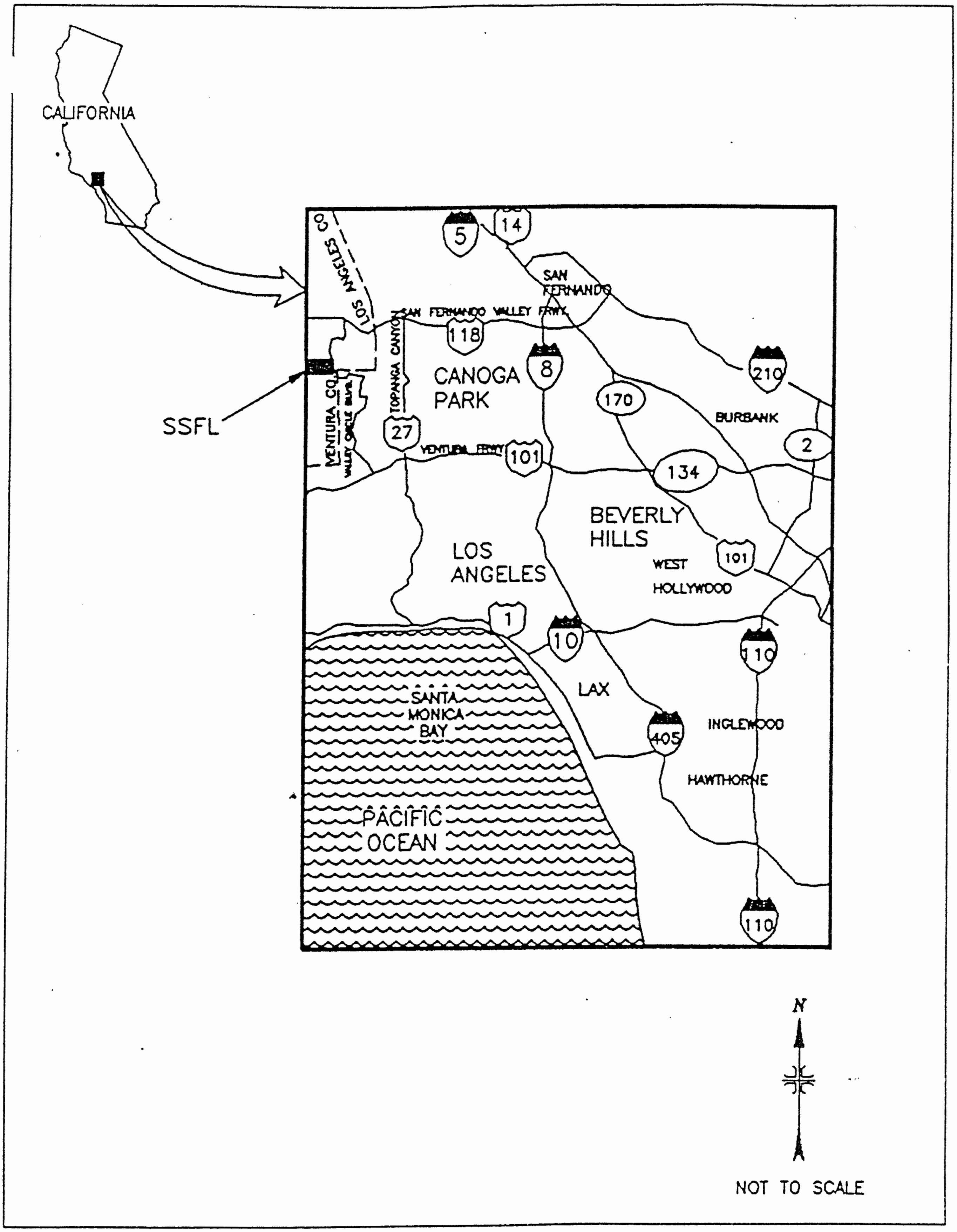

FIGURE 1: Los Angeles California Area, Location of Santa Susana Field Laboratory Site

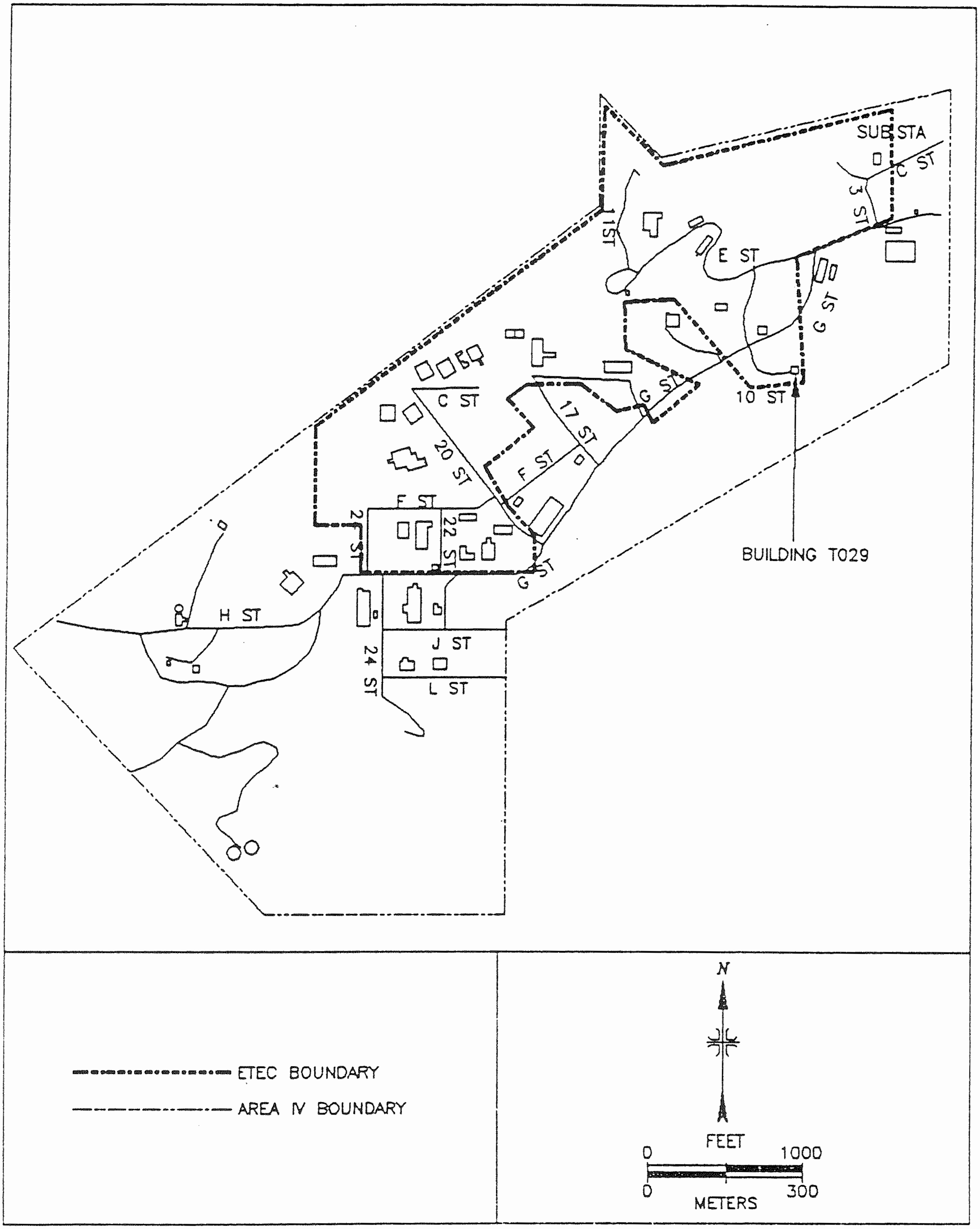

FIGURE 2: Plot Plan of Santa Susana Field Lab Area IV

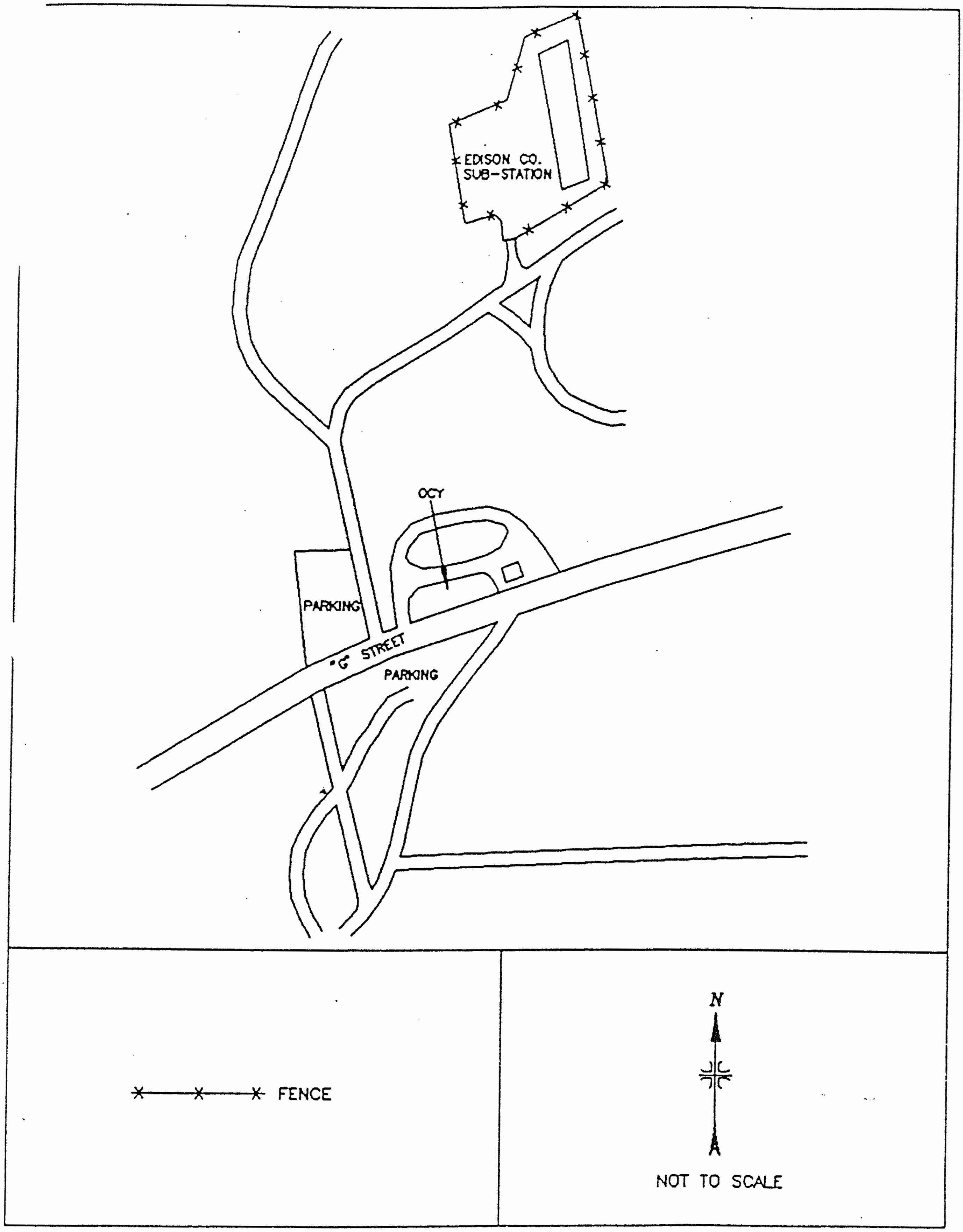

FIGURE 3: Location of the Old Conservation Yard

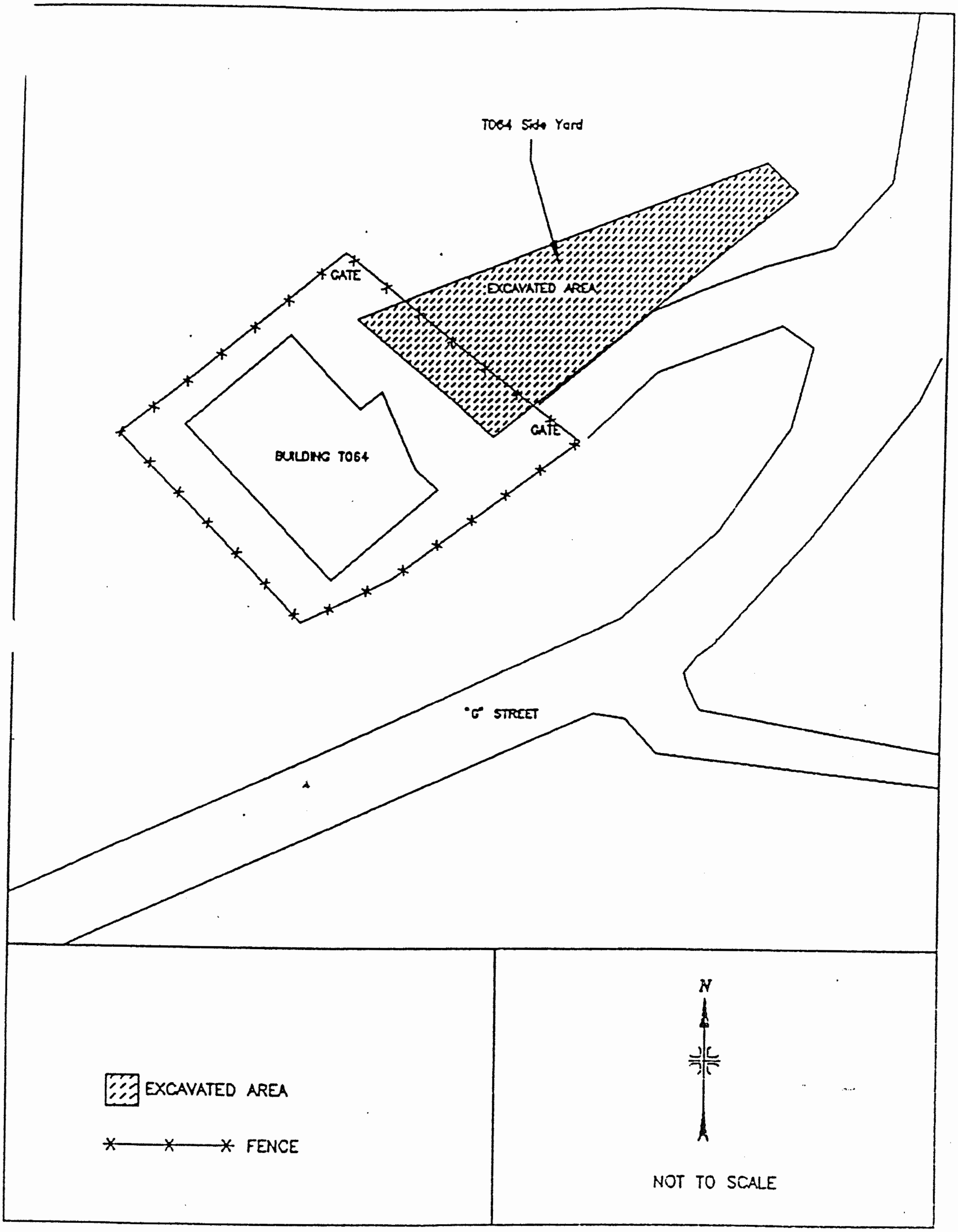

FIGURE 4: Location of Building T064 Side Yard

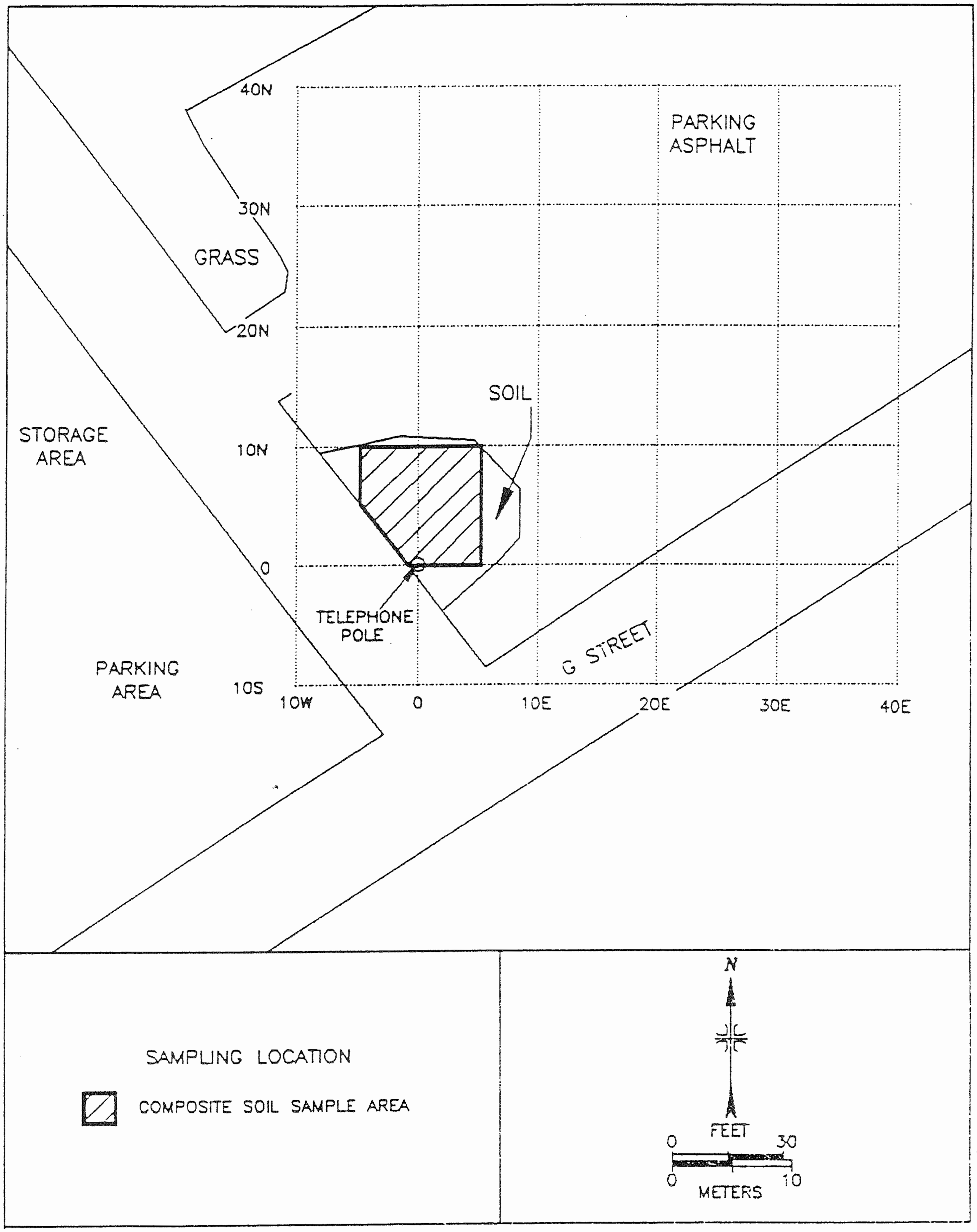

FIGURE 5: Old Conservation Yard — Reference Grid and Sampling Locations

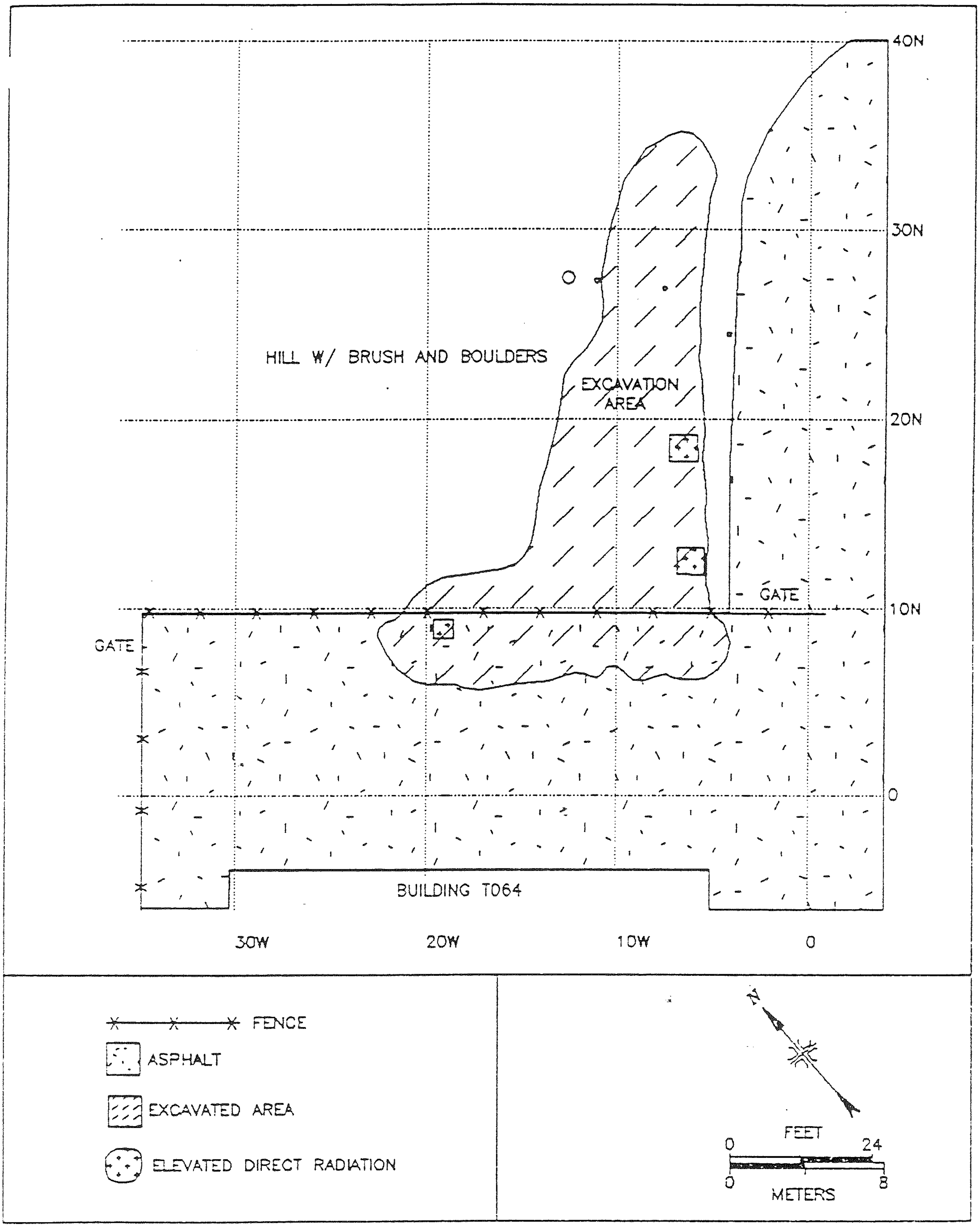

FIGURE 6: Building T064 Side Yard – Locations of Elevated Direct Radiation

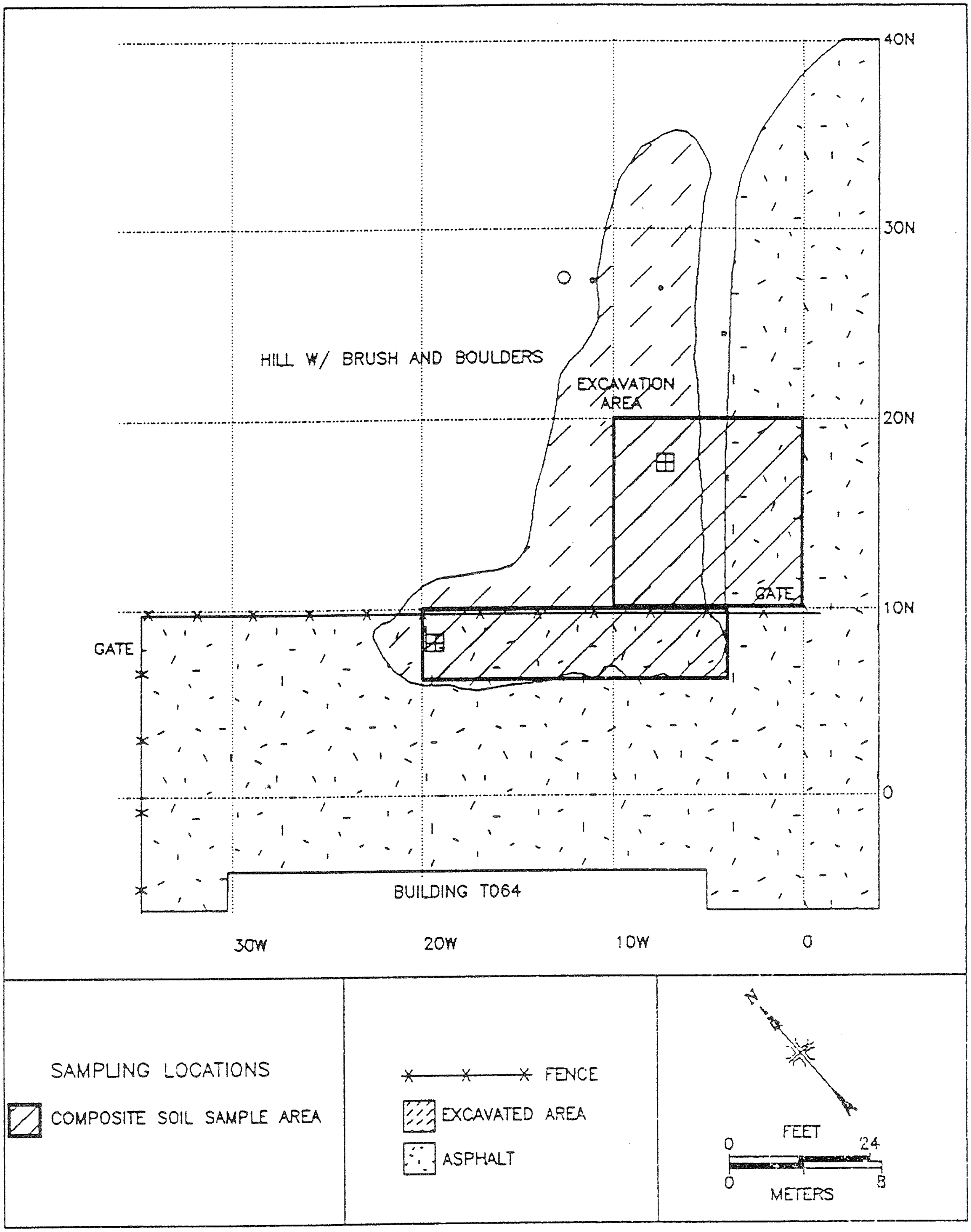

FIGURE 7: Building T064 Side Yard – Reference Grid and Measurement and Sampling Locations

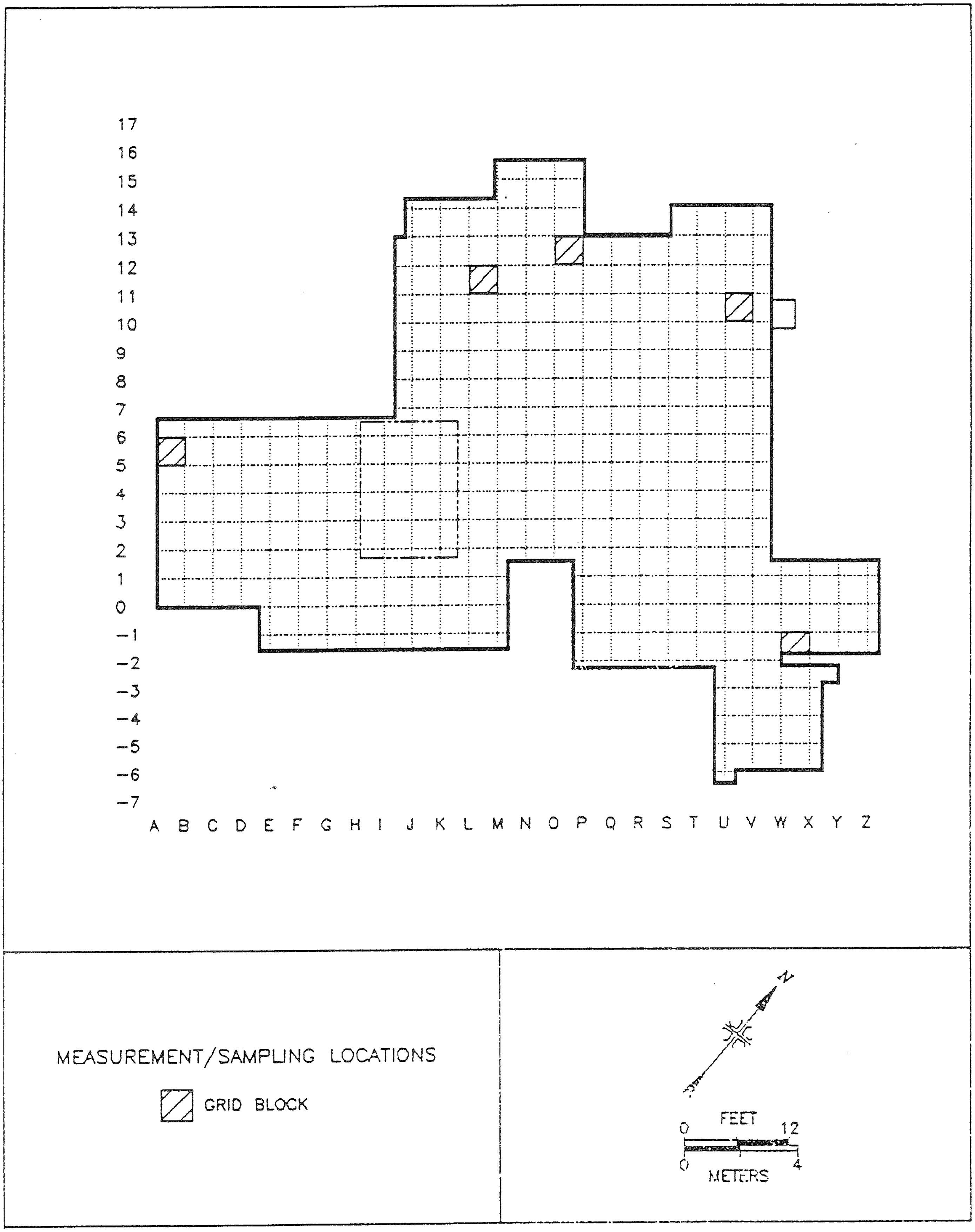

FIGURE 8: Building T028 Above Grade Pad – Reference Grid and Measurement and Sampling Locations

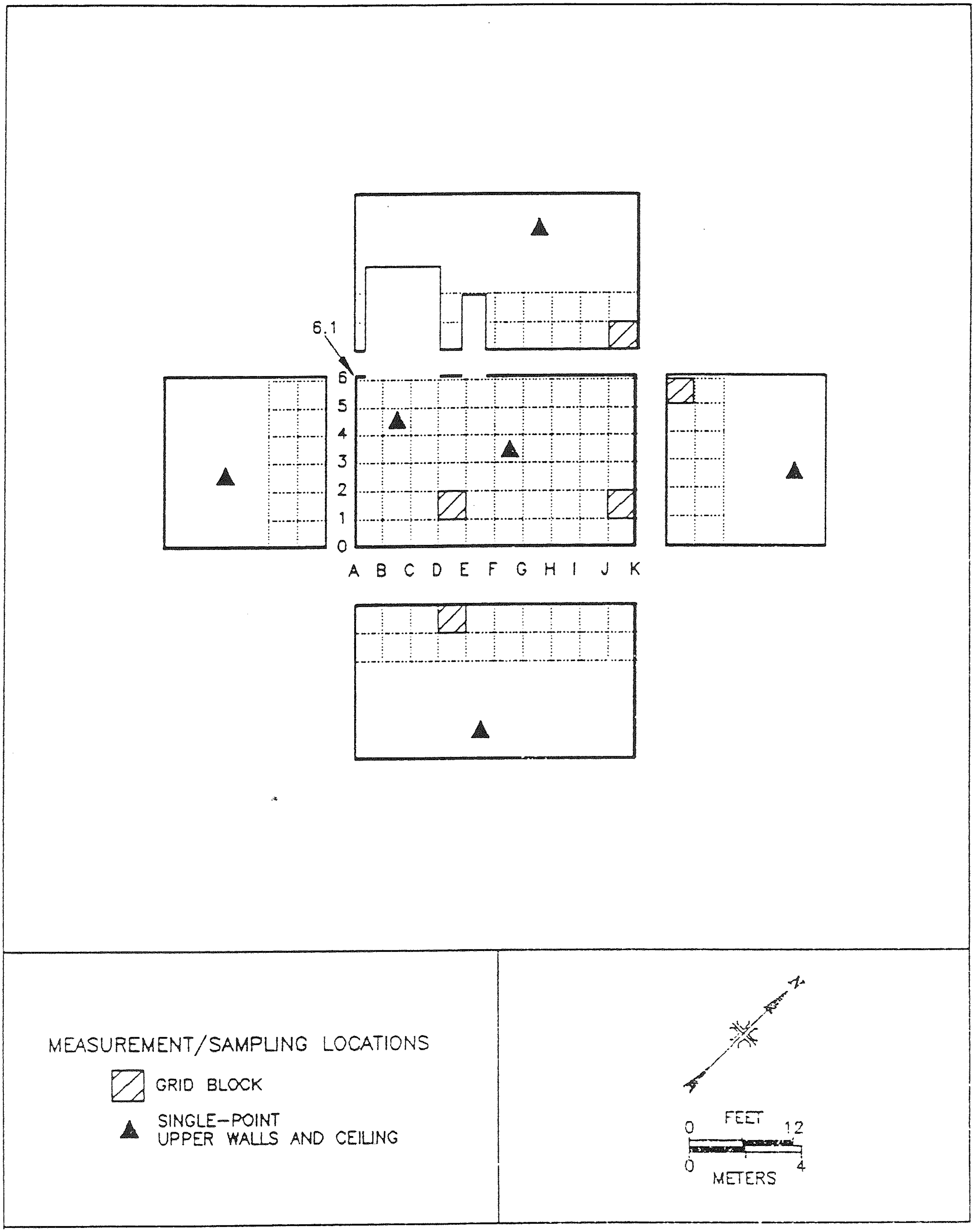

FIGURE 9: Building T028 Vault – Reference Grid and Measurement and Sampling Locations

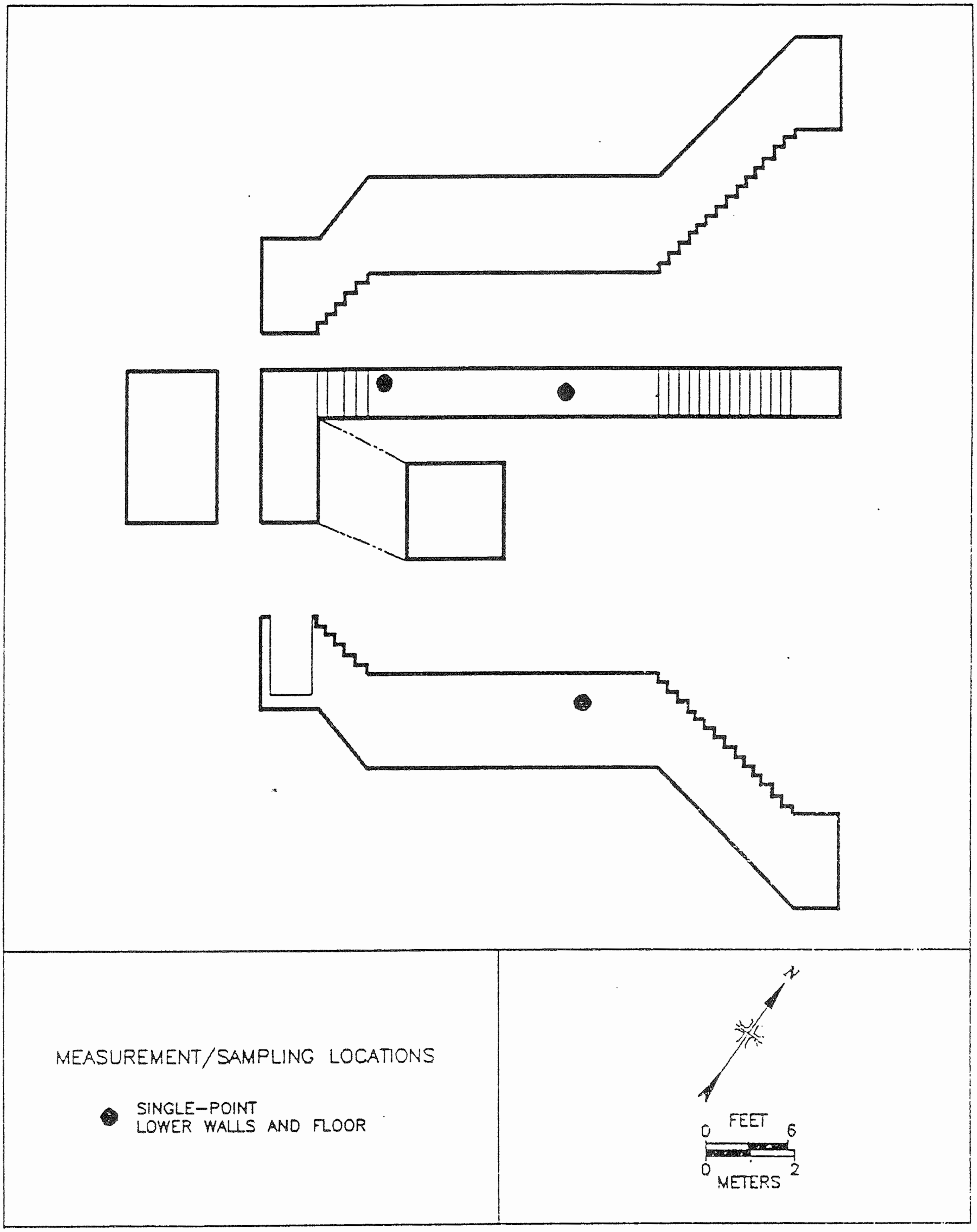

FIGURE 10: Building T028 Stairwell — Measurement and Sampling Locations

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN SOIL
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
CANOGA PARK, CALIFORNIA

Location[a]	Radionuclide Concentration (pCi/g)			
	Cs-137	Sr-90	U-235	U-238
<u>QCY</u>				
0N, 5W[b]	0.6 ± 0.1[c]	<0.6	0.1 ± 0.1	1.4 ± 1.2
<u>T064 Side Yard</u>				
0N, 20W[b]	7.5 ± 0.9	<0.5	<0.2	1.6 ± 1.2
10N, 10W[b]	27.7 ± 3.1	1.9 ± 1.0	0.4 ± 0.2	1.2 ± 1.2
9N, 19.5W[d]	35.1 ± 3.9	<0.4	0.3 ± 0.2	0.9 ± 1.2
19.5N, 8.5W[d]	210 ± 23	2.0 ± 0.3	0.3 ± 0.3	1.4 ± 2.8

[a]Refer to Figures 5 and 6.
[b]Radionuclide concentration levels presented are the averages for a composite sample representing a 100 m^2 area and include "hot-spots".
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]Radionuclide concentration levels presented are those for a single "hot-spot" location.

TABLE 2

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDING T028
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
CANOGA PARK, CALIFORNIA

Location[a]	Number of Measurement Locations		Range of Total Activity (dpm/100 cm²)				Range of Removable Activity (dpm/100 cm²)	
			Single Measurement		Grid Block Average			
	Single Pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Foundation	N/A	5	<83-89	<860-1400	<83	<860-1200	<12	<15
Vault, Floor and Lower Wall	N/A	5	<83	<990-1000	<83	<990	<12	<15-25
Vault, Upper Wall and Ceiling	6	N/A	<83	<990	N/A	N/A	<12	<15
Vault, Stairwell	3	N/A	<83	<990-1000	N/A	N/A	<12	<15

[a]Refer to Figures 7, 8, and 9.

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 author or their employers.

DIRECT RADIATION MEASUREMENT INSTRUMENTATION

Instruments

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

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

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

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

LABORATORY ANALYTICAL INSTRUMENTATION

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-5110
(Tennelec, 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. Surfaces were scanned using portable gamma scintillation and small area (15.5 cm^2 or 59 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	-	ZnS scintillation detector with ratemeter-scaler
Beta	-	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 instrumentations 4 π efficiency, determined at calibration, and correcting for the active area of the detector. The alpha activity background countrates for the ZnS scintillation detectors averaged approximately 1 cpm for each detector. The alpha efficiency factor was 0.19 for the ZnS scintillation detectors. The beta activity background count rate for the GM detectors averaged 52 cpm. Beta efficiency factors ranged from 0.24 to 0.27 for the GM detectors. The effective windows for the ZnS scintillation and GM detectors were 59 cm^2 and 15.5 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.

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.

ANALYTICAL PROCEDURES

Removable Activity

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

Gamma Spectrometry

Soil Samples

Samples of soil 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 and ranged from 800 to 900 g of material. 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. Energy peaks used for determination of radionuclides of concern were:

Cs-137	0.662 MeV
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 and 0.093 MeV from Th-234*
	(or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Strontium-90

Soil Samples

Soil samples were dried, mixed, crushed and then aliquots of the soil were dissolved using a potassium fluoride pyrosulfate fusion in which strontium was precipitated as a sulfate. Successive treatments with EDTA preferentially removed lead and excess calcium and returned the strontium to solution. Ferric and other insoluble hydroxides were precipitated at a pH of 12 to 14. Strontium was reprecipitated as a sulfate and barium was removed as a chromate using DTPA. The final precipitate of strontium carbonate was counted using a low-background gas proportional counter and the activity calculated using an in-house algorithm specifically designed for strontium analyses.

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. When the net sample count was less than 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedures. 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. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents:

-Survey Procedures Manual Revision 7 (June 1992)
-Laboratory Procedures Manual Revision 6 (April 1991)
-Quality Assurance Manual Revision 5 (June 1992)

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

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

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable 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 reasonable achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Surface Contamination Guidelines

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1] Average[3,4]	Maximum[4,5]	Removable[4,6]
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	Reserved	Reserved	Reserved
Th-Natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay product, alpha emitters	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.[7]	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[8,9]
Cs-137 and Sr-90	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

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

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

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

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

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

[6] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[7] 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.

[8] 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.

[9] 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.

EXHIBIT IV

FACILITY 4064 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	35120		32	N/C	EID-04600

Program Title CLOSURE OF ETEC (R21-RF)

Document Title FINAL REPORT, DECONTAMINATION & DECOMMISSIONING OF FUEL STORAGE FACILITY, 4064

Document Type D&D Report	Related Documents
Original Issue Date 9-11-99 / Release Date RELEASE 9-11-99	Approvals / Date
Prepared By/Date: Satish N. Shah / August 23, 1999; Dept. 117; Mail/Addr T038	R. D. Meyer 8-25-99 P. H. Horton 8/26/99 S. E. Reeder 8-27-99 P. D. Rutherford 8/25/99
IR&D Program? Yes ☐ No ☒ If Yes, Enter Authorization No.	M. E. Lee 8/27/99

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Abstract

This document summarizes the D&D process for the former Fuel Storage Facility, including building 4064, the fenced-in area, the Side Yard and the Surroundings.

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

Reserved for Proprietary/Legal Notice

Rocketdyne Form 651-F REV. 2-97

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FIGURES

TABLES

APPENDICES

1.0 INTRODUCTION and SUMMARY

This report summarizes the Decontamination and Decommissioning (D&D) process for the former Fuel Storage Facility. The facility consisted of the building, B4064, and a fenced-in area (See Figure 1-4). This building is referred to in this document as Building 4064. In other documentation and references this building can be called T064, 064 or B/064 depending on the designation at the time. The D&D process of this facility included the building, the fenced-in area, and "Surrounding Areas", that were found to be slightly contaminated (Fig. 1-4). The surrounding areas included a "Side Yard", which was an approximately 4,500 ft^2 area east of the building, of which approximately 4,000 ft^2 was outside the security fence.

1.1 Building 4064

Constructed in 1958, the Fuel Storage Facility was a vault, built to provide secure storage for non-irradiated fissionable nuclear materials (enriched uranium and plutonium) used to make reactor fuel. The building was constructed aboveground of concrete and concrete blocks, to meet the Atomic Energy Commission (AEC) criteria for vaults for storage of fissionable material. It was equipped with intrusion alarms. Closed containers of radioactive waste were also stored outside on a concrete pad within the locked, fenced facility perimeter.

All nuclear materials were removed from the building by 1993. The building was decontamiminated and a final survey of the building was performed in 1993 (Ref. 3). In 1996, the building was released for demolition by the Department of Energy (DOE) and the California Department of Health Services (DHS) Radiation Branch. The building was demolished in 1997 and the waste was shipped off-site as clean waste.

Key Milestones, B4064:

Period of operation	1958 - 1993
Decontamination and decommissioning	1993
Rocketdyne Final Survey of B/4064 interior	January 1994
Rocketdyne Final Survey of B/4064 fenced-in yard	January 1994
ORISE verification survey	October 1994
DHS verification survey	1994
DOE approval to demolish building	June 1996
DHS approval to demolish building	August 1996
Demolition complete	August 1997

1.2 Side Yard and Surrounding Areas of B/4064

During the operating history of Building 4064, the concrete pad northeast of the building had been built to store sealed containers of radioactive material. During this period of handling containers of radioactive material, the side yard became contaminated with Cs-137 (Ref. 8).

In 1988, a Characterization Survey (Ref. 1) was performed which identified the location of contaminated soil. Remedial excavation was performed and a subsequent Rocketdyne survey was conducted. A follow-up verification survey was performed by ORISE (Oak Ridge Institute of Science & Education) in 1992 and additional excavation was performed in 1993.

The Area IV Survey, performed in 1994 and 1995, identified two more locations above release limits. These areas, including a septic tank and the leach field, were excavated in 1997. Subsequent scoping surveys indicated the area was below release limits.

In May 1998, sub-surface core sampling down to bedrock was performed under the original building, in the side yard, under the main access road, "G" street, and east of "G" street (Ref. 10). All sample results proved to be within the range of background levels.

The Rocketdyne Final Status Survey of the entire 2 acre-area (Ref. 10), and the ORISE verification survey were conducted in September 1998. In October 1998, the California Department of Health Services (DHS) also performed a verification survey.

Key Milestones, 4064 Side Yard & Surroundings

Characterization survey	July 1988
Remediation	1989
Interim final survey	October 1990
ORISE verification survey	December 1992
Remediation	1993
Revision to Interim final survey report	1993
Area IV survey	1995
Remediation of septic tank and leach field	1997
Sub-surface core sampling	May 1998
Rocketdyne final status survey	September 1998
ORISE verification survey	September 1998
DHS verification survey	October 1998

2.0 LOCATION

Facility 4064 was located within the former Rockwell International Santa Susana Field Laboratories (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. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 2-1. An enlarged map of neighboring SSFL communities is shown in Figure 2-2. Figure 2-3 is a plot plan of the western portion of SSFL, known as Area IV, where Building 4064 was located. Figure 2-4 shows the relative locations of the building, the Side Yard and the surrounding areas including the locations of a septic tank and its leach field. A drawing (plan view) of Building 4064 and its adjoining areas is shown in Figure 2-5. Figure 2-6 shows the former building in the Area IV of SSFL and the surrounding area. Building 4064 was totally fenced in with a chain-link fence (Ref. 1). An aerial photograph of the 4064 site prior to demolition is shown in Figure 2-7.

Using USGS terminology, the USGS description for the Building 4064 is: Township T2N; Range RI 7W; and Section 30, Calabasas Quadrangle.

Figure 2-1. Map of Los Angeles Area

Figure 2-2. Map of Neighboring SSFL Communities

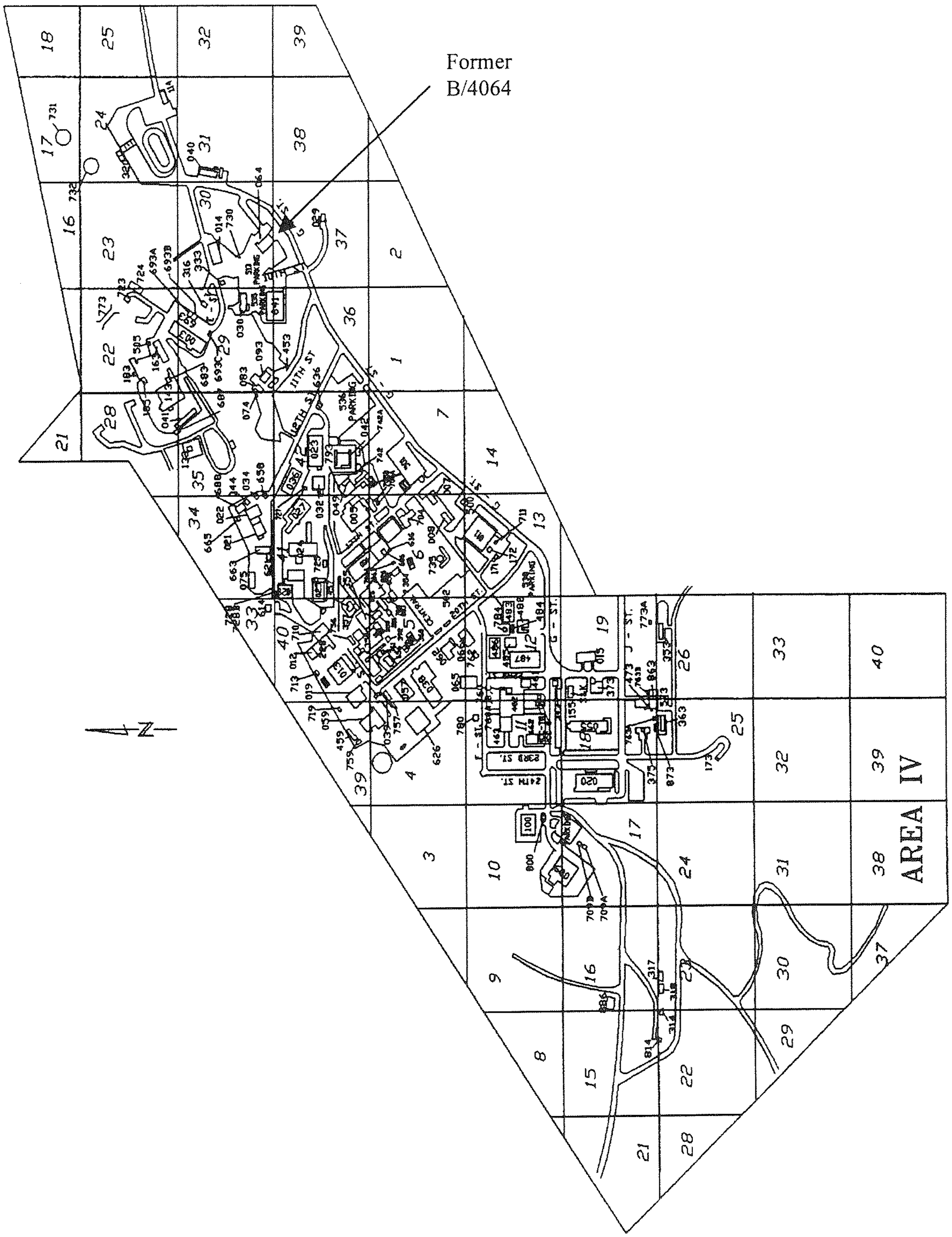

Figure 2-3. SSFL Layout Showing Location of the Former Building 4064

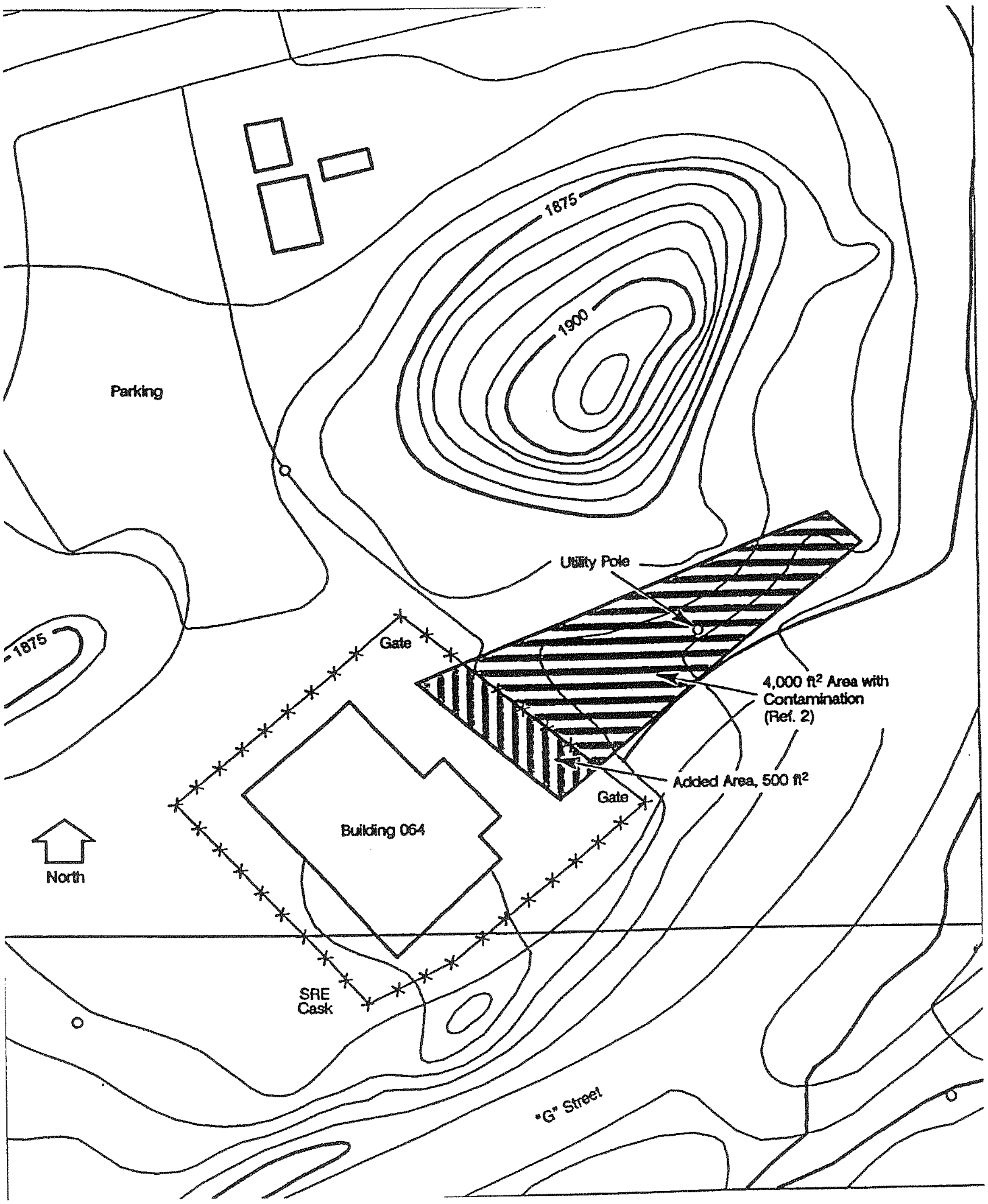

Figure 2-4. Former Facility 4064, Side Yard and Surrounding Area

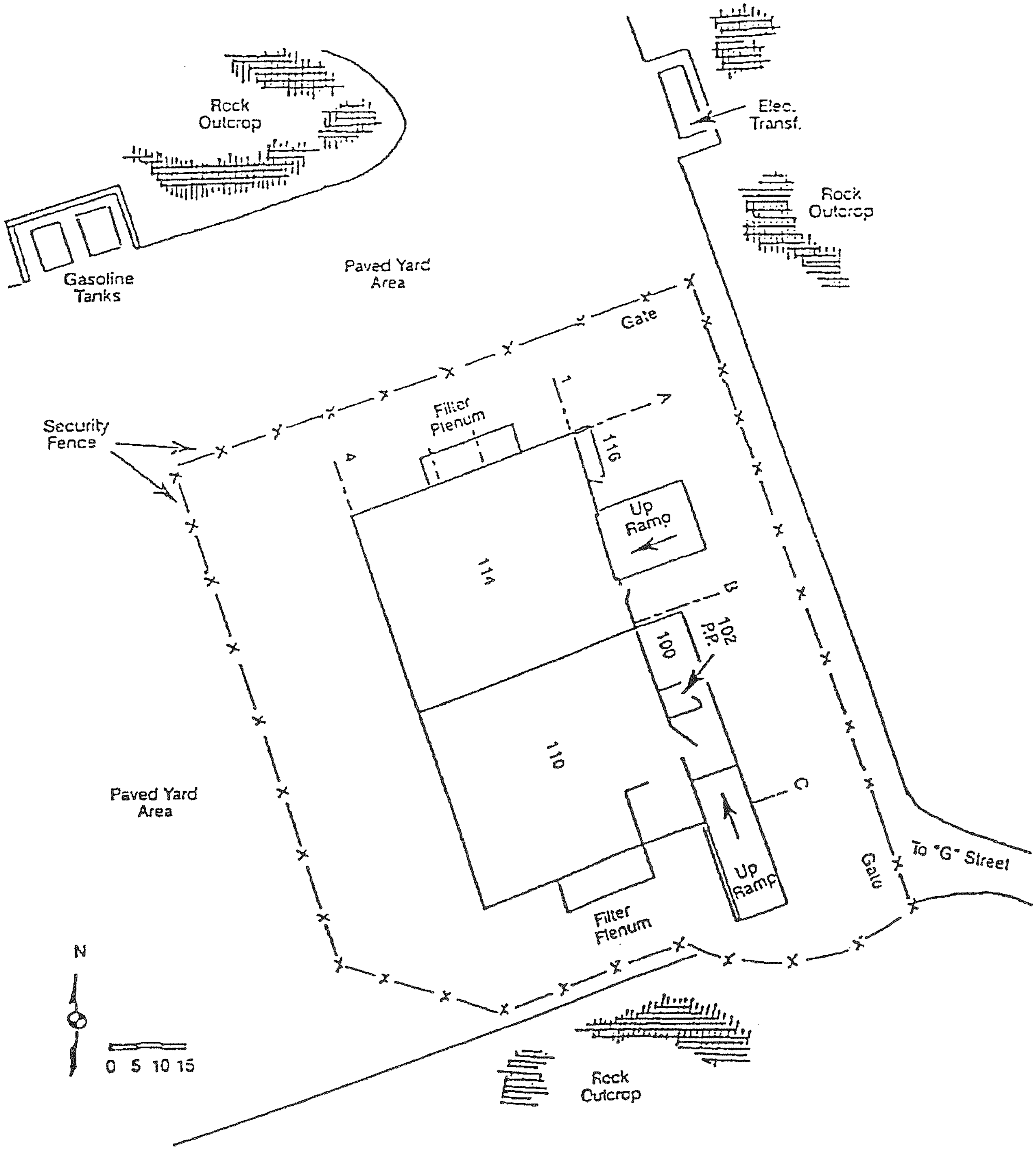

Figure 2-5. Plot plan - Former Building 4064

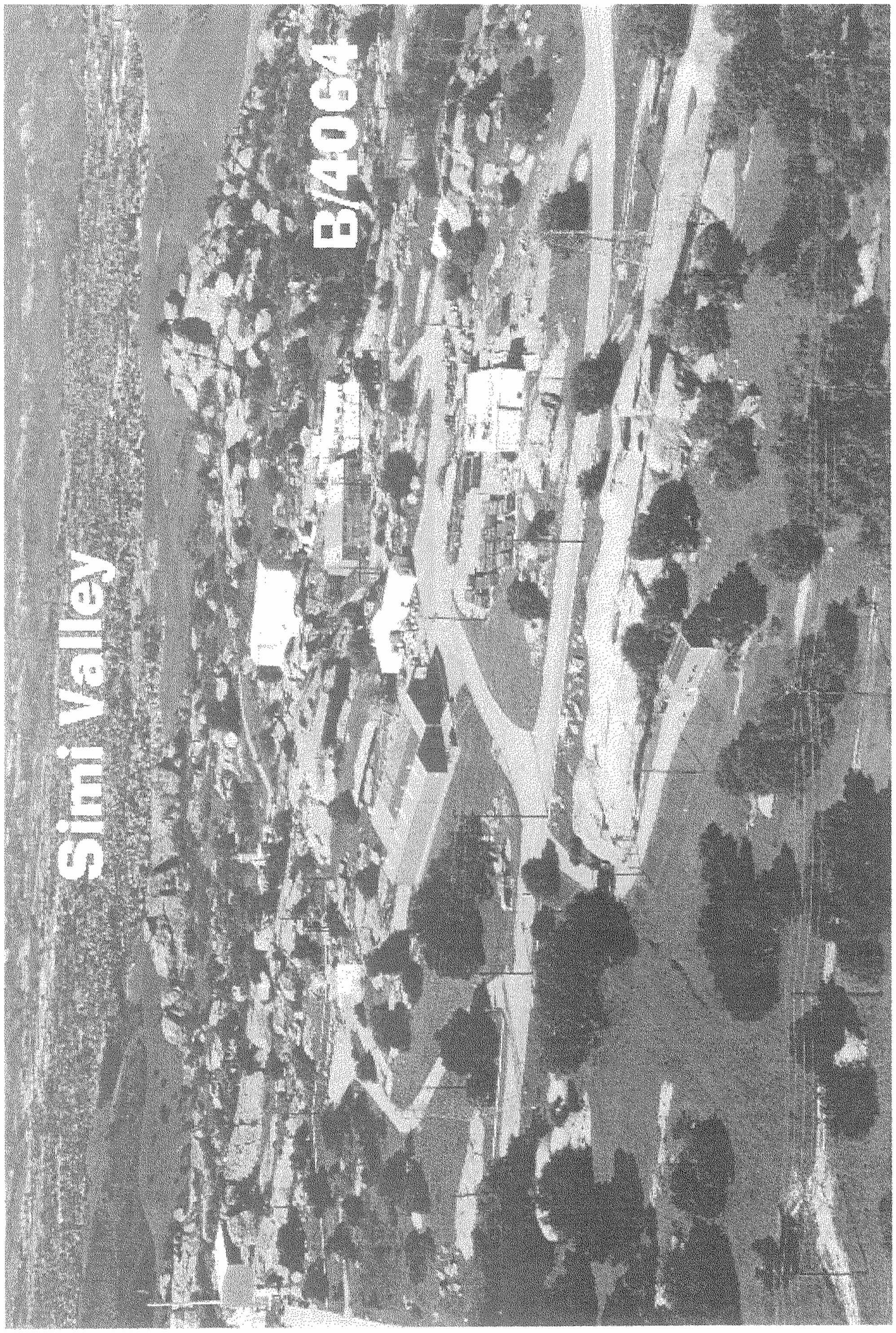

Figure 2-6. Location of B/4064 in Area IV and Surroundings

Figure 2-7. Aerial View of Former Building 4064 Site

3.0 FACILITY DESCRIPTION AND SITE TOPOGRAPHY

3.1 Building and Site

Building 4064 was designed and built as a special nuclear material and source radioactive material storage building. It was constructed in two phases. The first phase was constructed in 1958. This 2137 ft^2 portion (Room 110) was a reinforced concrete structure with 11-in. thick walls on a concrete slab. The building eaves height was 16 ft and the structure was open bay except for a 12 ft x 13 ft material handling area in the southeast corner of the building. A fume hood was installed in this small southeast corner (Room 104).

In 1963, the building was enlarged by adding a bay to the north (Room 114) bringing the total square footage of the building to 4418 ft^2. This addition used 12-in. concrete block construction with cores filled with concrete. Total square footage included a small 150 ft^2 office (Room 100) and a 50 ft^2 restroom (Room 102), both located on the dock on the east side of the building. On the northwest corner was a small supply and storage room, about 50 ft^2 (Room 116). Room 114 was accessible from the east through a 20 ft x 15 ft electrically driven rollup door and a conventional hinged door. Room 110 was accessible from the east through a heavy secured door. Ramps leading to each room allowed easy transport of materials via forklift.

The concrete slab floors were covered with 12-in. square vinyl-asbestos tiles. The concrete-block walls were painted. In 1980, the entire facility was reroofed; interior wall surfaces were patched and painted; floor tile was removed and replaced; the restroom and office were restored; plumbing was repaired; heating and ventilation was repaired; a window air-conditioner was installed in the office; and yard asphalt was patched. New fluorescent lights were installed. Storage racks were constructed to accommodate fuel.

Since nuclear material was only stored here, there was no processing equipment within the building. No sinks were installed in the storage areas. The only water supply was to the restroom (Room 102). Initially sanitary waste water was discharged to a septic tank and leach field. In about 1960 the facility was connected to the local sewage system. The facility was not air-conditioned. Each room was ventilated by dedicated blowers through a plenum containing pre-filters and HEPA filters. Room 104 had a fume hood that exhausted through the south filter plenum.

A disconnected sanitary leach field existed just north of the access road to "G" Street on the southeast section of the property. The building was surrounded by a chain link fence, located from 20 to 30 ft from the exterior walls of the building. The area enclosed, including the building, was about 11,000 ft^2.

There were three points of access to the site location of Building 4064. One access was directly from the north through the 513 parking area, which was on the east side of 10th Street. A second point of access was directly off 10th Street at the northwest corner of the facility, and the third was a paved roadway connecting the southeast corner of the facility with "G" Street to the east. There were two gates for accessing the fenced-in storage yard; one from the northeast corner off the 513 parking lot, and the other from the southeast corner off "G" Street.

The facility sat atop a plateau about 25 ft above "G" Street and slightly above the 513 parking lot. Figure 3-1 shows the building and surrounding area during demolition (half of the building was demolished at the time of this picture). Rock outcroppings exist up slope to the north-northeast and down slope in every other direction. Water runoff was primarily due east at the southern end of the facility.

3.2 Fenced-in Yard, Side Yard and the Surrounding Areas

The "fenced-in yard" was a 6,580 square foot area within the security fence as shown in Figure 2-5.

The "Building 4064 Side yard" was a designation given to approximately 4500 square foot trapezoidal area near building 4064 for D&D (Fig. 2-4).

The "Surrounding Areas" included a 2-acre area of the former 4064 facility, including drainage pathways, former parking lot areas, surrounding areas, and the Side yard area (Ref. 10). The septic tank, and the leach field that had serviced the Building 4064, were located within the Surrounding Areas (Fig. 2-4). Figure 3-2 shows the septic tank in the ground after the surrounding soil was removed.

Figure 3-1. North Half of Building 4064 during Demolition

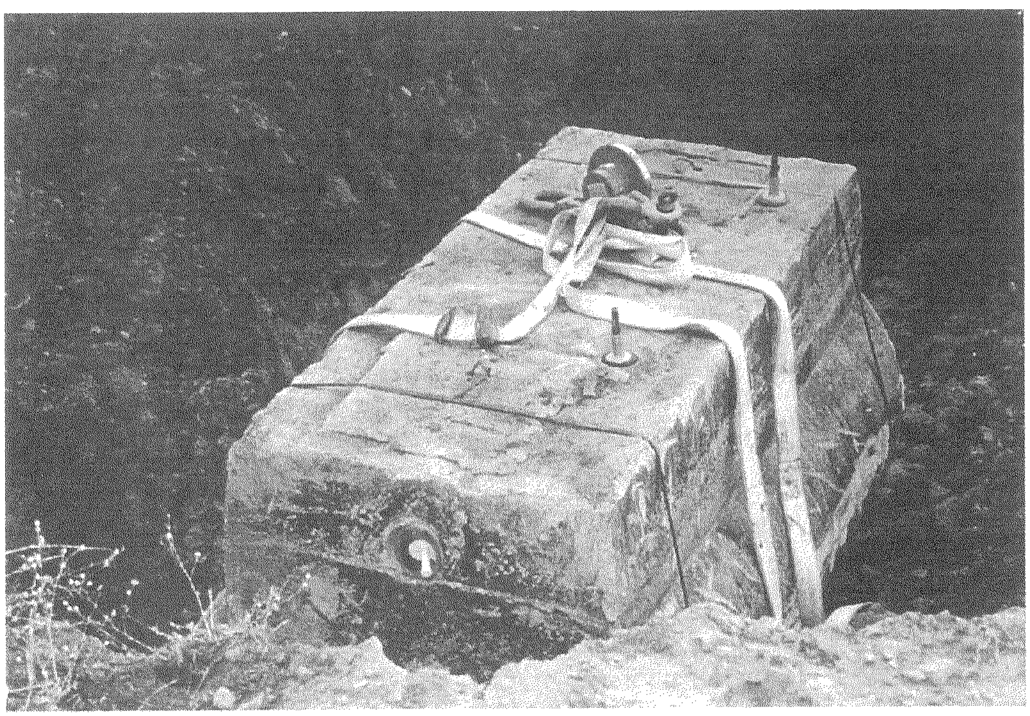

Figure 3-2. Uncovered Septic Tank for Former Building

4.0 OPERATING HISTORY

4.1 Building 4064

Building 4064 was used primarily for storage of packaged items of source material (normal uranium, depleted uranium, and thorium), and packaged special nuclear material (enriched uranium, plutonium, U-233) of various forms and configurations. Originally Room 114 and Room 110 contained steel racks for storing material. Room 110 was primarily used for storage of highly enriched uranium and plutonium; Room 114 was primarily used for source material and low enriched uranium storage.

Enriched uranium powders and source material powder packages were split into smaller units or combined into larger units in a glove box located in the small work area alcove (Room 104) in the southeast corner of Room 110. Plutonium was handled only in packaged form; never in a loose form. No plutonium handling was done other than transferring sealed packages between containers. Transfers of solid metallic forms of material generally were handled in the glove box; however, on occasion, larger solid metallic pieces were transferred and repackaged within the room.

During the early 1960's, a changed storage configuration was required. The metal racks from the south half of Room 110 were removed in order to store material in storage containers and drums. This storage included large quantities of special nuclear material recoverable scrap.

During this time, recoverable scrap storage space was needed. As a result, the yard area in front of the building (east), the side (north), and the back (west) was used to store 55-gallon drums of low enriched recoverable scrap. This material was shipped off-site from Rocketdyne to various government sites in the mid-to-late 1960's and early 1970's.

No plutonium or U-233 packages were ever opened in this facility. Any residual radioactive contamination was enriched uranium, normal uranium, depleted uranium, or thorium and came from handling bare metallic pieces (Ref. 1).

During the mid-1970's to early-1980's, most of the major DOE nuclear development and reactor contracts had ended. Later, following removal of all fissionable material, miscellaneous equipment and containers of radioactive waste (principally soil) were stored in the building. The building was emptied of all contents (both radioactive and non- radioactive) by 1993 (Ref. 5).

The building was decontamiminated and a Rocketdyne final survey of the building interior and also the fenced-in yard was performed in 1993 and was documented in 1994. The Oak Ridge Institute of Science and Education (ORISE) and the California Department of Health Services (DHS) performed verification surveys in 1994. In 1996, the building was released for demolition by the Department of Energy (DOE) (Appendix 1) and the California DHS (Appendix 2).

In May, 1997, the alarm system was removed from the building to prepare for demolition. The asbestos and paint were removed from the building by a contractor specializing in asbestos abatement. The building demolition process was completed in August, 1997, and the waste was shipped off-site as conventional waste.

4.2 Side yard and Surrounding Areas of B/4064

In 1988, a Characterization Survey was performed which confirmed the location of contaminated soil. Remedial excavation was performed to remove the contaminated soil. A subsequent Rocketdyne survey comprising of one-meter gridded exposure measurements and soil sampling was documented in 1990. A follow-up verification survey was performed by ORISE in 1992. Further excavation was performed in two locations in 1993, following imposition of more stringent clean-up standards by the Department of Energy, and documented in a revision to Rocketdyne's 1990 survey report (Ref. 6).

During the Area IV Survey in 1994 through 1995, two locations, one in the original side yard and one located across the other side of "G" Street were identified as remaining above release limits. These areas were excavated in 1997 including the removal of an abandoned septic tank and leach field that had serviced Building 4064. Scoping surveys and soil samples conducted during and after excavation proved the 4064 area beneath the previous building foundations, and surrounding yard areas were non-contaminated.

In May, 1998, sub-surface core sampling down to bedrock was performed under the original building, in the side yard, under the main access road, "G" street, and east of "G" street (Ref. 10). All sample results proved to be within the range of background.

In September, 1998, the Final Status Survey was conducted in the entire 2 acre site, including drainage pathways, former parking lot areas, surrounding areas, and the side yard area. One hundred and thirty one (131) soil samples were taken, 553 one-meter gridded exposure measurements were taken and a surface exposure survey of all two acres was performed. All measurements demonstrated that the facility met cleanup standards for release for unrestricted use. The Final Status Survey Report was issued in April, 1999 (Ref. 10).

In September, 1998, the Oak Ridge Institute of Science and Education (ORISE) performed a verification survey (Reference 9). In October, 1998, the California Department of Health Services (DHS) performed a verification survey.

5.0 PROJECT ACTIVITIES

5.1 Building 4064

A radiological survey of the facility structure and yard was performed in 1987/88 (Ref. 1). That survey revealed low level contamination on most of the fixtures inside Room 110 and in the two exhaust systems that were serving Rooms 110 and 114. The office, restroom and a janitor's closet showed no signs of contamination. The floor tiles were surveyed for radiological contamination, none was found, and the tiles were removed from these rooms during the asbestos containing material (ACM) abatement of the facility.

5.1.1 Room 114

After work had ceased at Building 4064, miscellaneous packaged components and approximately 125 cubic yards of containerized soil were stored in Room 114. The remediation work performed in Room 114 consisted of the removal of these stored items. During the removal of the equipment and boxes of soil, frequent area contamination surveys were performed by radiation protection personnel to assure that container integrity and contamination control were maintained. All contaminated equipment, components and soil that had been stored in Room 114 were transported to the Radioactive Materials Handling Facility (RMHF) for temporary storage and eventual disposal at an approved DOE burial site.

5.1.2 Room 110

Most items in Room 110 had been used for operations at Building 4064 and were contaminated to varying degrees. When practical, size reduction and packaging were performed on site. However, some of the equipment required more aggressive techniques for size reduction and contamination control. These items included: a fume hood that had been used to package enriched uranium powders and source materials, two large balances (Fig. 5-1), and several 6 in. diameter x 5 ft. long steel shipping drum inserts. All of these items were transferred to the RMHF for size reduction and packaging for disposal. The fluorescent light fixtures in this room were also contaminated. The fixtures were taken down, disassembled and the PCB containing ballasts removed. The fixtures less ballasts and bulbs were packaged and disposed of as radioactive waste, the ballasts were surveyed and found to be radiologically clean and were disposed of as hazardous PCB waste, the fluorescent bulbs were decontaminated and disposed of as conventional waste. The storage racks (Fig. 5-2) contained fixed radioactive contamination and were disassembled, size reduced and packaged on site and transferred to the RMHF for eventual shipment to an approved disposal facility.

5.1.3 HEPA Filtered Exhaust Systems

To maintain contamination control during the size reduction of the HEPA filter plenums, size reduction was done at the RMHF. The plenums were detached from the buildings and blowers as intact units and transported to the RMHF. Because of the large size of the exhaust plenums this effort required the fabrication of custom boxes to assure contamination containment during transport. Inlet (Fig. 5-3) and outlet openings were sealed, the units were disconnected from the building, placed in the boxes and transferred to the RMHF. The plenums were cut into manageable size pieces using a plasma torch and packaged for disposal as radioactive waste.

Because the facility had been used for storage for several years, special attention was given to identifying hazardous or potentially hazardous materials requiring disposition. Two scales were found to contain oil and one also contained lead. A 4-oz quantity of oil from one of the scales was determined to contain radioactive contamination and was effectively treated during the Molten Salt Oxidation (MSO) Bench Scale Unit tests being performed at the RMHF. The other oil and the lead were certified as "Containing no DOE-Added Radioactivity," in accordance with ER-SP-0001 (Ref. 2) and were disposed of in accordance with the Rocketdyne Environmental Control procedures. The ballasts removed from the light fixtures in Room 110 were hermetically sealed units and after a thorough radiological survey were also certified as "Containing No DOE-Added Radioactivity" and were disposed of in accordance with the Rocketdyne Environmental Control procedures.

Because the floor tiles throughout the facility had been determined to contain asbestos, and were in a deteriorated state, their removal was required. A sampling plan was developed and implemented in accordance with ER-SP-0001. Randomly selected tiles were removed and the tiles and subfloor were surveyed for total contamination. The results of this survey sampling concluded that the tiles and subfloor had no detectable activity (NDA) above background; therefore, all tiles were certified as "Containing No DOE-Added Radioactivity." An asbestos abatement contractor was employed to remove a total of 4,352 ft^2 of tile. The tile and abatement-related ACM wastes were packaged and placed in an approved hazardous waste container and were disposed at an approved disposal facility. Copies of certifications were forwarded to the DOE.

5.2 Side yard and Surrounding Areas

The characterization survey of 1988 indicated areas of contaminated soil, which were subsequently removed. In 1993, the Department of Energy imposed stricter clean-up standards, and soil was excavated from two additional locations (Ref. 6). The demolition of building 4064 was placed on hold until removal of all contaminated soil was completed.

The Area IV survey of 1994-95 identified two more locations with elevated readings, one in the original Side yard, and the other located across the other side of "G" street. The remediation of these locations was performed in 1995. Soil samples from these locations were taken to determine the amount of soil needed to be removed. Roll-off containers were used for interim storage of contaminated soil. The removal of soil areas with elevated readings was completed by the end of 1995.

The location of the abandoned septic tank was confirmed during the above-described excavations.
A methodology was developed to determine the extent of side yard contamination. It was decided to auger holes 18" deep and measure activity using a NaI detector. Additional side yard samples were taken using this methodology. The removal of elevated radiological spots was completed by the end of 1995. In April, the leach field distribution box was surveyed in detail and contamination was found in both the inlet and outlet lines. The distribution box was removed in June and sent to the Radioactive Materials Handling Facility (RMHF) for further processing. The box was packaged at the RMHF for shipment to the DOE-Hanford disposal site. It was shipped in March, 1999.

The radiological boundary determination showed that an area inside of the drip line of an oak tree needed to be excavated. In January, 1996, a radiological survey of the buried septic tank showed no radioactivity. In February, the water and sludge samples from the tank were analyzed and found to be non-hazardous. The tank then was decanted and the non-contaminated water was allowed to evaporate. Permits to remove the septic tank and to excavate around oak trees were obtained in June 1996. The Critical Lift procedure was modified for the septic tank, and the tank and piping were removed in July 1996 (see Fig. 5-4) and sent to RMHF for processing. Low Level contamination was detected in the sludge in the tank. The sludge was absorbed in diatomaceous earth. The tank was size reduced (rubblized) and packaged for shipment to the DOE-Hanford disposal site. Figure 5-5 shows the locations of the tank and its leach field after excavation.

The soil sampling based on the boundary determination methodology was completed in 1996. The soil defined by this methodology was excavated and was shipped to the Envirocare facility in Utah.

Figure 5-1. Room 110, Fume Hood (left) and Voland Balance

Figure 5-2. Room 110, Storage Racks

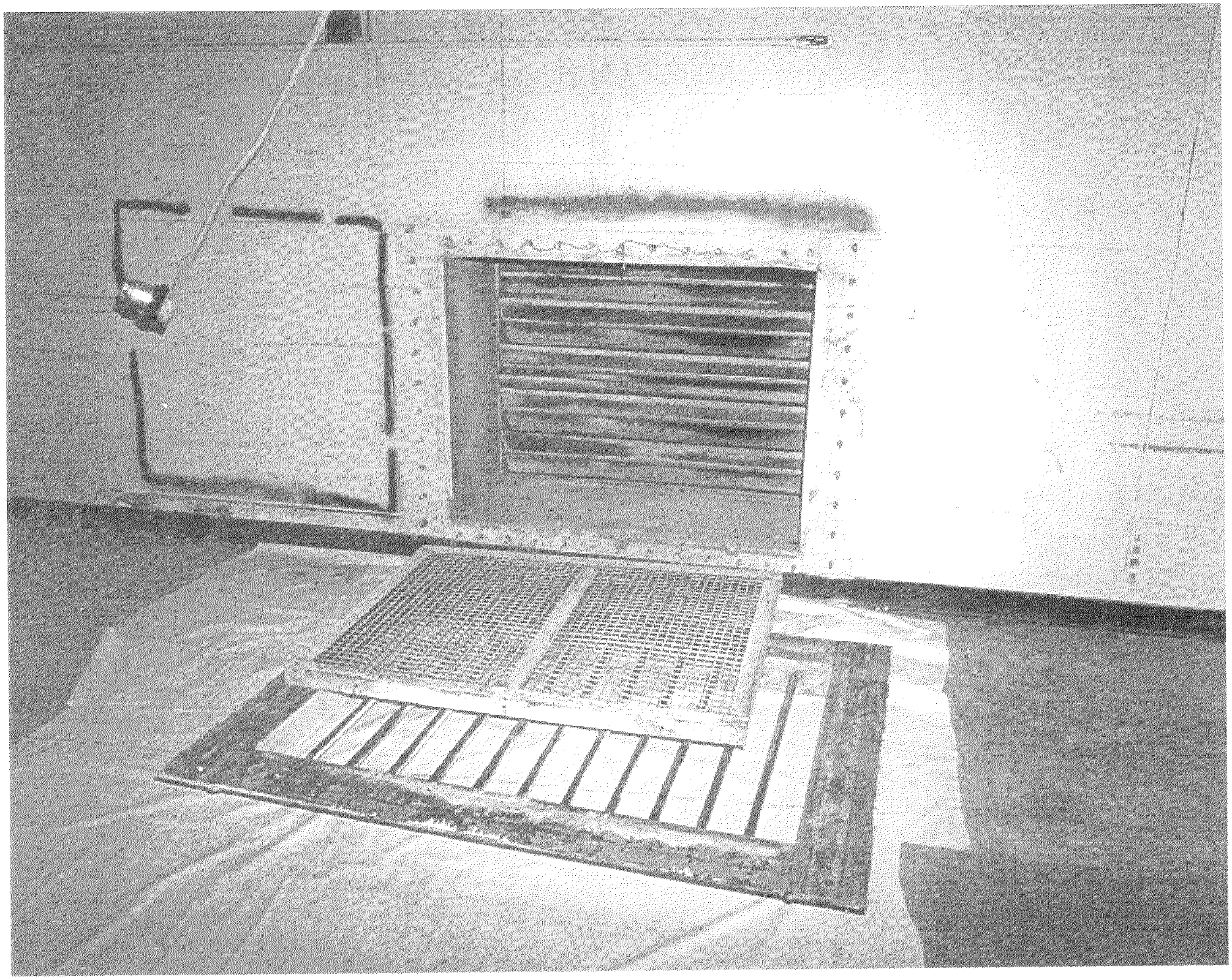

Figure 5-3. HEPA Filtered Exhaust Inlet (Typical Rooms 110 and 114)

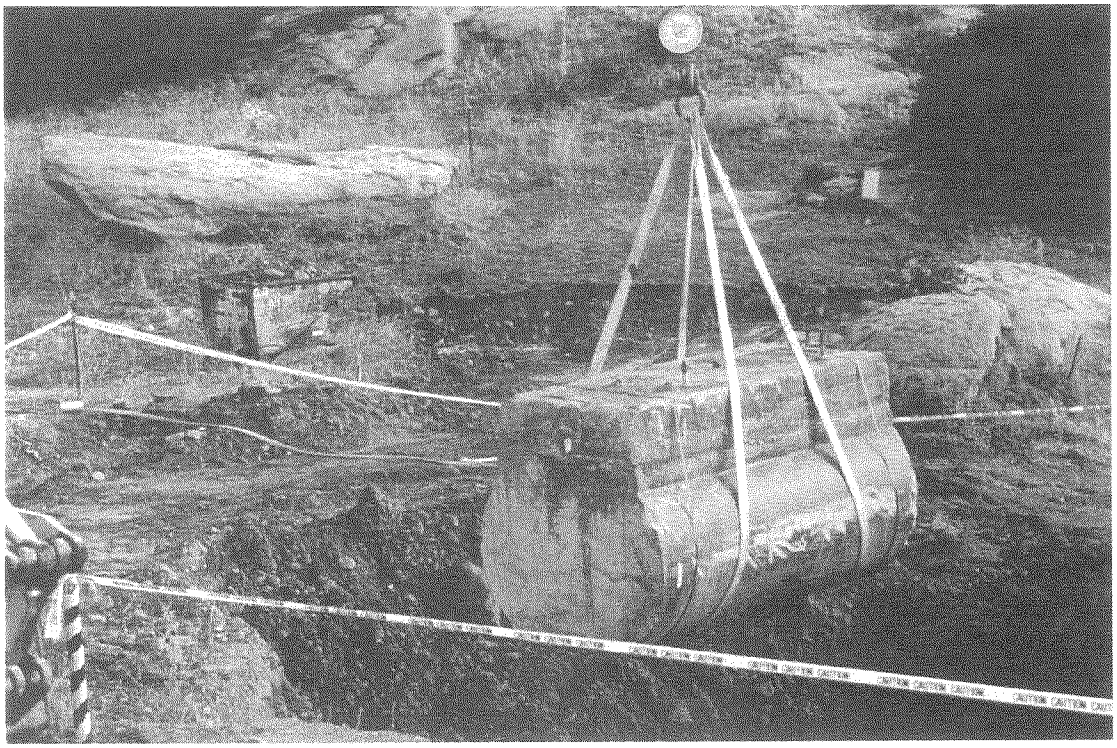

Figure 5-4. Removal of the 4064 Septic Tank

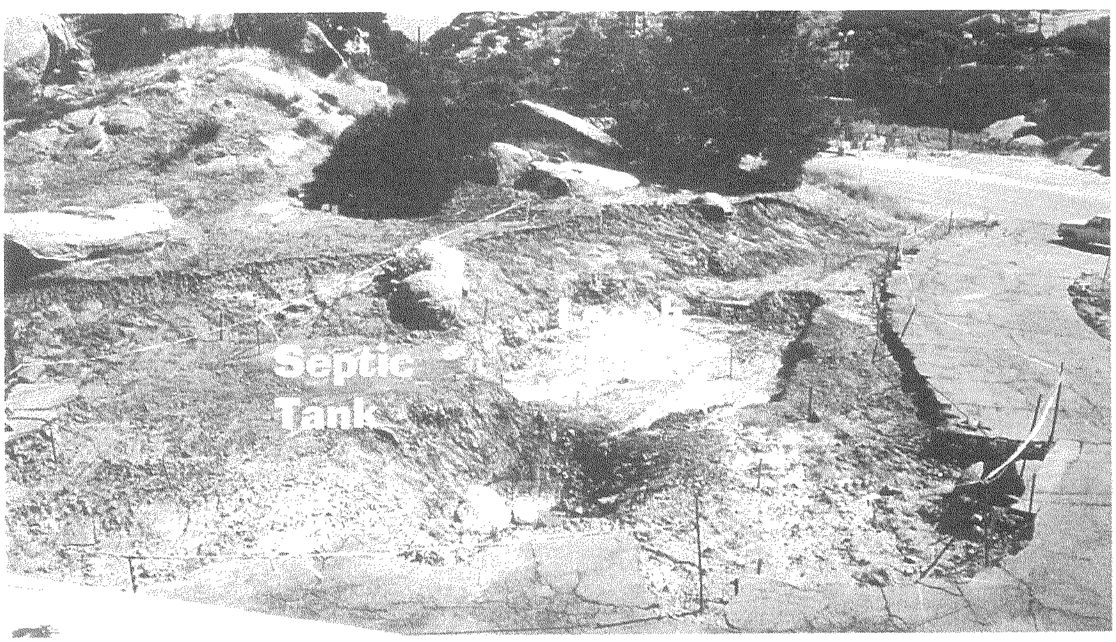

Figure 5-5. Locations of the Septic Tank and the Leach Field after Excavation

6.0 SURVEY RESULTS

6.1 Overview

Upon D&D of radioactive constituents, releasing a facility or area for unrestricted use requires a formal radiation survey to demonstrate that the applicable regulatory limits for such a release are met. The survey is performed under an established plan, and a statistical interpretation of the resulting data is made to verify that the regulatory release criteria have been met. References 3, 8 and 10 provide information that demonstrates that Building 4064 and the Area 4064, which includes the Side yard and the "Surrounding Areas", meet DOE, NRC, and State of California criteria for release of the facility for unrestricted use.

6.2 Scope of the Survey

6.2.1 Building 4064

For the final radiological survey of Building 4064, the interior rooms and office were separated into sample lots. These sample lots are graphically shown in Figure 6 of Reference 3. Sample lots were treated separately for the purposes of statistical data analyses. Distinguishable properties for selecting the sample lots were areas or rooms, which contained contaminated components that were recently decontaminated. The chosen sample lots or areas are shown in Table 1 of Reference 3 with the corresponding type of survey performed.

6.2.2 Area 4064 (Side yard and the Surrounding Areas)

The entire 2-acre lot was surveyed and sampled including a direct qualitative surface gamma scan (100%) for contamination, ambient gamma exposure measurements at 1 meter above the ground at 10 ft by 10-ft grids, and both surface and subsurface soil sampling (Ref. 10).

6.3 Survey Summary and Conclusions

6.3.1 Building 4064

Survey measurements were made for surface contamination (alpha and beta) on the interior walls, floors, and ceilings in Building 4064, and for ambient gamma exposure rate at 1 meter above the interior floors. These measurements were tested statistically for compliance with acceptable contamination limits for enriched uranium, activation products, and mixed fission products, and for ambient exposure rate.

All tests for surface contamination showed that the facility was suitable for release without radiological restrictions. Interpretation of the gamma exposure rate measurements for the Building 4064 interior is based on the average gamma exposure rate background value (15.76 μR/hr) for a building of similar construction (Building S445) that has never been used for any radiological purposes. The probability distributions for the comparisons between these measurements shows no local contamination, except for two measurements that were affected by the near proximity of smoke alarm units containing approximately 80 μCi Am-241. The results indicate a natural/normal background distribution for the building, with an average value of 14.7 μR/hr. Therefore, the Building 4064 interior average gamma exposure rate was consistent with the average gamma exposure rate for Building S445.

A confirmatory survey of the building was performed by ORISE (Ref. 4). The results of the final survey and the confirmatory survey showed that the building was suitable for release for use without radiological restrictions.

An inspector from the State of California, Department of Health & Services-Radiologic Health Branch (DHS-RHB) accompanied the confirmatory survey team and also made independent measurements. The results of these measurements were consistent with the confirmatory survey. (see attached letters in the Appendix).

6.3.2 Area 4064 (Side yard and the Surrounding Areas)

The test statistic for the distribution of the background –subtracted gamma exposure rate is 4.1 μR/hr, which is below the acceptance limit of 5 μR/hr.

The [post-remediation] soil samples indicate that the Cs-137 contamination, historically observed at Area 4064, has been remediated and is now below the clean-up standard of 9.2 pCi/gm. Most samples indicated no Cs-137, while a small number of samples showed trace levels of Cs-137 above background levels with a maximum level of 3.1 pCi/gm.

All soil sample and radiation exposure measurements are below the Department of Energy's and California Department of Health Services' approved release limits. The 4064 area, including surrounding areas, is suitable for release for unrestricted use (Ref. 10).

6.4 Verification Surveys

A verifcation survey of Area 4064 was performed by ORISE (Ref. 9). This report concludes that the 4064 Side Yard satisfies the criteria for release for unrestricted use. A verification survey of Area 4064 was performed by DHS-RHB and confirmed the Rocketdyne and ORISE conclusions.

7.0 WASTE VOLUME GENERATED AND DISPOSAL

The types of waste materials generated during the D&D of Building 4064 included steel (exhaust hoods, parts, and storage racks) and miscellaneous items (HEPA, filters, fiberboards, and glass, etc.). Table 7-1 lists actual amounts of generated waste.

TABLE 7-1

Source	lb.	Ft^3
Piping/Miscellaneous Steel	5,600	150
Misc. Items	31,600	930
Total	37,200	1,080

Additionally, the demolition contractor disposed of several tons of non-hazardous building material, such as walls and roof, in 1997. The contractor also disposed of some asbestos containing materials.

The excavation from the Side yard and the Surrounding Areas include soil, asphalt and concrete from the distribution box. Table 7-2 lists the amounts of waste.

TABLE 7-2

Source	lb.	Ft^3
Soil	1,270,600	15,820
Asphalt	313,000	3,700
Soil & asphalt	684,400	8,560
Concrete (From Distribution Box)	6,000	140
TOTAL	**2,274,000**	**28,220**

Additionally, the size-reduced septic tank, weighing approximately 25,000 lb., is in a roll-off (~405 Ft^3) awaiting shipment to the DOE-Hanford Disposal Facility.

8.0 PERSONNEL RADIATION EXPOSURE

No personnel radiation exposure was anticipated or encountered from the D&D activities for Building 4064, the Side yard or the Surrounding Areas.

9.0 PROJECT COST SUMMARY

The total cost associated with the decontamination and decommissioning of Building 4064 in Table 9-1.

TABLE 9-1

D&D plans and performance	$154,000
Burial and transportation	$ 54,000
Survey & Reporting	$ 45,000
Building structure demolition & disposal	$ 35,000
Asbestos abatement/paint removal	$ 13,000
TOTAL	**$301,000**

The cost associated with sampling, excavating, packaging and disposing the debris from the Side yard and the Surrounding Areas is given in Table 9-2.

TABLE 9-2

Labor including overhead (Radiation Protection Department - approx. 40% of total)	$114,000
Roll-off rental for soil storage	$ 92,000
Soil sampling	$ 9,000
Disposal including transportation & fees	$310,000
Misc. Materials, leases	$ 21,000
TOTAL	**$546,000**

10.0 REFERENCES

1. GEN-ZR-0005, "Radiological Survey of the Source and Special Nuclear Materials Storage Vault - Building 064" (8/19/88)
2. ER-SP-0001, "Management and Disposition of Known or Potentially Hazardous Wastes Originating in a RMMA" (10/22/91)
3. SSWA-ZR-0001, "Final Radiological Survey Report of Building 064 Interior" (1/14/94)
4. "Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California", T. J. Vitkus, ORISE (October 1994)
5. SSWA-SR-0002, "Building 064 D&D Operations Final Report" (8/13/93)
6. N704SRR990031, "Final Decontamination and Radiological Survey of the Building T064 Side Yard", Revision A (9/10/93)
7. "Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California", T. J. Vitkus, ORISE (October 1993)
8. N704SRR990035, "Radiological Assessment of the Building T064 Fenced-in Yard" (1/12/94)
9. "Second Addendum to the Verification Survey of the Building T064 Side Yard, Santa Susana Field Laboratory, Ventura County, California (ORISE 1993 and 1994)", from Tim Vitkus, ORISE, to Anand Gupta, US DOE (EM-43), January 25, 1999
10. RS-00003, "Area 4064, Final Status Survey Report" (4/13/99)

APPENDIX 1. DOE LETTER, DEMOLITION BIULDING T064

Department of Energy
Oakland Operations Office
1301 Clay Street, N700
Oakland, CA 94612-5208

June 25, 1996

Majelle Lee
Program Manager
Environmental Programs
Energy Technology Engineering Center
Rocketdyne Division
Rockwell International Corporation
P.O. Box 7930
Canoga Park, CA 91309-7930

Subject: Demolition of Building 064

Dear Ms. Lee:

The cleanup of radioactive decontamination at Building 064 is complete. ORISE has verified the condition of the building. Consequently, approval is given for the demolition of B064. The empty site (the land) will be combined with the B064 Sideyard into one release site. This release site is expected to be ready for a release for unrestricted use in FY97, after the remediation of the Sideyard is completed.

Sincerely,

Michael Lopez

Michael Lopez
ETEC PM
Environmental
Restoration Division

W022-003.

APPENDIX 2. STATE OF CALIF. H&S LETTER TO ETEC.

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

August 19, 1996

1234567 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEP 1996
RECEIVED

Mr. Phil Rutherford, Manager
Environmental Remediation
Rocketdyne Division
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309-7930

Subject: Demolition and Disposal of Structural Material from Building T064 at SSFL

Dear Mr. Rutherford:

This letter is to acknowledge the receipt of your letter dated July 30, 1996, with attachments, requesting concurrence of the above subject. Based on the review of your submittal and the results of the surveys performed by the inspection staff of our Los Angeles office, the Radiologic Health Branch (RHB) concurs that you may proceed with the demolition of the Building T064 and that you also may dispose of the structural material resulting from such demolition as conventional waste.

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

W022-003.DOC

ENERGY TECHNOLOGY ENGINEERING CENTER

OPERATED FOR THE U.S. DEPARTMENT OF ENERGY
ROCKETDYNE DIVISION, ROCKWELL INTERNATIONAL

No. SSWA-AR-0002 Rev. NEW
Page 1 of 13
Orig. Date August 13, 1993
Rev. Date NEW

DRR 25061 DS

TITLE: Building 064 D&D Operations Final Report

- APPROVALS -

Originator: P. Waite
G. Gaylord
Facility Mgr: R. Meyer
RP&HPS: P. Rutherford

QA

REV. LTR.	REVISION	APPROVAL/DATE

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MAY 3 1994
NOTICE: WILL NOT BE UPDATED

Form 735-A-6 Rev 6-91

1.0 INTRODUCTION

This report summarizes the recent (post 1990) activities performed during the decontamination and decommissioning (D&D) of Building 064. This facility, known as the Source and Special Nuclear Materials Storage Vault, is located in Area IV of the Santa Susana Field Laboratory. Cleanup performed in the early 1960's (ref. 1) and in the late 1980's (ref. 1) has been previously documented and is not addressed in this report.

2.0 BACKGROUND

Building 064 was a high security facility originally consisting of a ~ 2100 ft^2 "vault" (Room 110) and a small office area. In 1963, a second ~ 2100 ft^2 "warehouse" (Room 114) was added (Figure I). The facility was utilized for support of Atomic Energy Commission (AEC), Energy Research and Development Administration (ERDA) and Department of Energy (DoE) related nuclear programs for the storage and repackaging of source and special nuclear materials, and for sectioning and repackaging fresh fuel elements. Plutonium was also handled at the facility in packaged form but never as "loose" powder. The yard area was also used for storage of drums of low enriched uranium recoverable scrap.

As public acceptance and funding for nuclear research programs and related activities waned in the late 1970's and early 1980's the facility was relegated to the storage of radioactively contaminated equipment and as an "overflow" waste container storage facility for the RMDF.

Room 110 contained several pieces of contaminated equipment including weighing scales, tools, a fume hood, empty storage containers and empty shipping drums. There were also four floor to ceiling, earthquake reinforced, "safe" storage racks in the northern portion of the room. Items stored in room 114 were containerized and consisted of contaminated pumps, equipment control consoles and packaged soil that had been excavated during the 1980's cleanup of the eastern yard and adjacent area. Both rooms' 110 and 114 were equipped with high efficiency particulate air (HEPA) filtered exhaust systems which were operational during fuel handling operations at the facility.

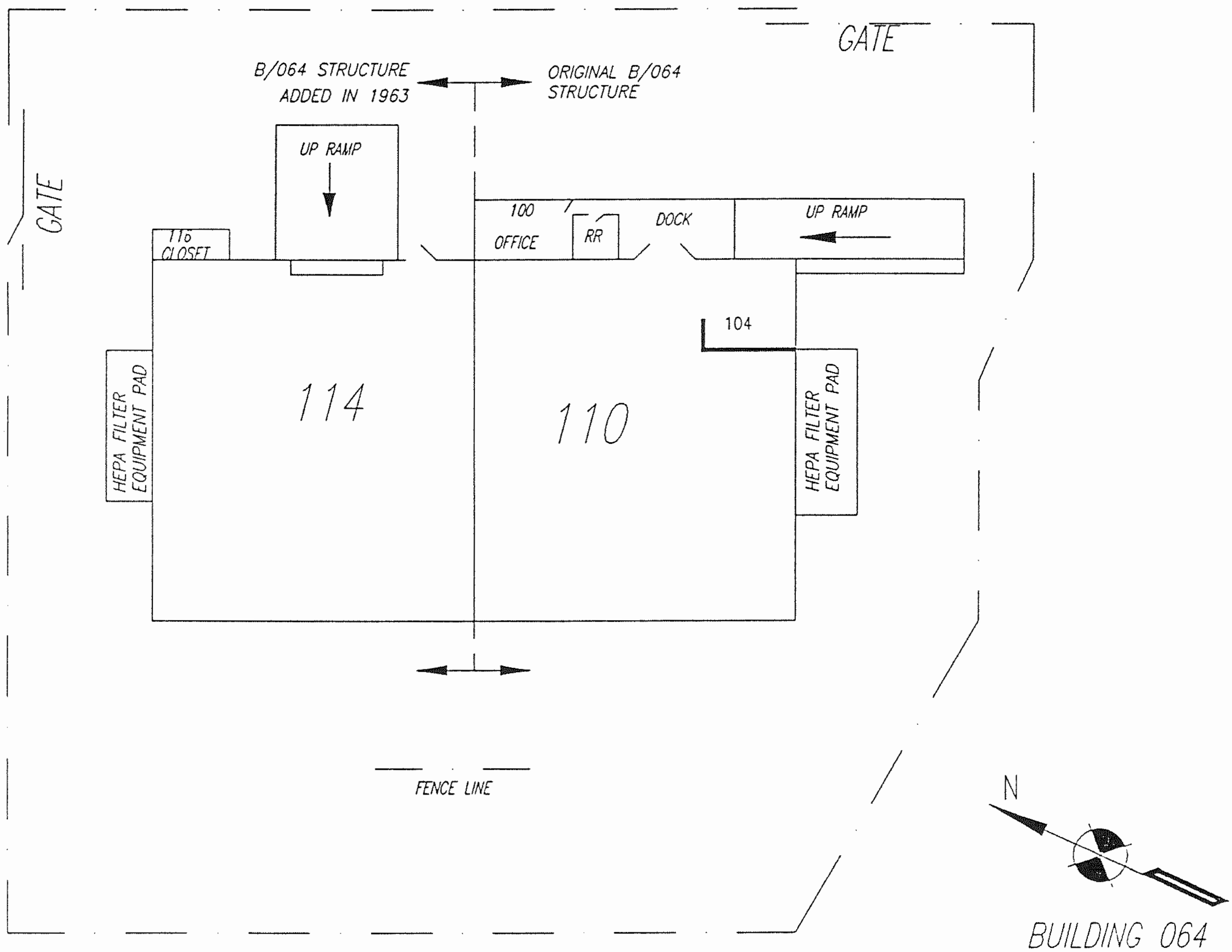

Figure I Building 064

2.1 Facility Status Prior To D&D

A radiological survey of the facility structure and yard was performed in 1987/88, that survey revealed low level contamination on most of the fixtures inside room 110 and in the two exhaust systems that were serving room 110 and 114. The office, restroom and a janitors closet showed no signs of contamination and were not included as a part of the radiological D&D of the facility, however the floor tiles were removed from these rooms during the asbestos containing material (ACM) abatement of the facility.

3.0 SUMMARY OF WORK PERFORMED

To release the facility for use without radiological restrictions all contaminated equipment and fixtures had to be removed in preparation for a final radiological survey. In addition, all hazardous materials and wastes in the facility had to be properly disposed. Where practical and cost effective, equipment was decontaminated and either disposed as non R/A waste or surplused. Some equipment required disassembly in order to remove hazardous materials such as oils, grease and lead. Most of the items, however, could not be readily decontaminated and some equipment had areas that could not be surveyed with the confidence level necessary for release without radiological restrictions. Analysis of the floor tiles indicated that the tiles and mastic glue throughout the facility contained asbestos and would require removal and disposal.

3.1 Room 114

The work performed in room 114 consisted of the removal of miscellaneous packaged components and approximately 195 cubic yards of containerized soil (photo #5). All of the items stored in room 114 were brought to the facility for storage after work had ceased at B/064 and had been properly packaged to prevent release of contamination. During the removal of the equipment and boxes of soil, frequent area contamination surveys were performed by Radiation Protection and Health Physics Services (RP&HPS) representatives to assure that container integrity and contamination control were maintained. All contaminated equipment, components and soil that had been stored in room 114 were transported to the RMDF for temporary storage and eventual disposal at an approved DOE burial site.

3.2 Room 110

Most of the items in room 110 had been used for operations B/064 and were contaminated to varying degrees. When practical, size reduction and packaging were performed on site. However, some of the equipment required more aggressive techniques for size reduction and contamination control. These items included: a fume hood that had been used to package enriched uranium powders and source materials, (photo #1) two large balances (photo #1) and several 6 in. diameter X 5 ft. long steel shipping drum inserts. All of these items were transferred to the RMDF for size reduction and packaging for disposal. The fluorescent light fixtures in this room were also contaminated. The fixtures were taken down, disassembled and the PCB containing ballasts removed. The fixtures less ballasts and bulbs were packaged and disposed of as R/A waste, the ballasts were surveyed and found to be radiologically clean and were disposed of as hazardous PCB waste, the florescent bulbs were decontaminated and disposed of as conventional waste. The storage racks (photo #2 & 4) contained fixed R/A contamination and were disassembled, size reduced and packaged on site and transferred to the RMDF for eventual shipment to an approved disposal facility.

3.3 HEPA Filtered Exhaust Systems

To maintain contamination control during the size reduction of the HEPA filter plenums, size reduction was done at the RMDF. The plenums were detached from the buildings and blowers as intact units and transported to the RMDF. Because of the large size of the exhaust plenums this effort required the fabrication of custom boxes to assure contamination containment during transport. Inlet (photo #3) and outlet openings were sealed, the units were disconnected from the building, placed in the boxes and transferred to the RMDF. The plenums were cut into manageable size pieces using a plasma torch and packaged for disposal as R/A waste.

EXHIBIT IV

FACILITY 4064 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
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Approvals		Date
R. D. Meyer	R D Meyer	8-25-99
P. H. Horton	[signature]	8/26/99
S. E. Reeder	[signature]	8-27-99
P. D. Rutherford	[signature]	8/25/99
M. E. Lee	[signature]	8/27/99

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Abstract

This document summarizes the D&D process for the former Fuel Storage Facility, including building 4064, the fenced-in area, the Side Yard and the Surroundings.

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APPENDICES

1.0 INTRODUCTION and SUMMARY

This report summarizes the Decontamination and Decommissioning (D&D) process for the former Fuel Storage Facility. The facility consisted of the building, B4064, and a fenced-in area (See Figure 1-4). This building is referred to in this document as Building 4064. In other documentation and references this building can be called T064, 064 or B/064 depending on the designation at the time. The D&D process of this facility included the building, the fenced-in area, and "Surrounding Areas", that were found to be slightly contaminated (Fig. 1-4). The surrounding areas included a "Side Yard", which was an approximately 4,500 ft^2 area east of the building, of which approximately 4,000 ft^2 was outside the security fence.

1.1 Building 4064

Constructed in 1958, the Fuel Storage Facility was a vault, built to provide secure storage for non-irradiated fissionable nuclear materials (enriched uranium and plutonium) used to make reactor fuel. The building was constructed aboveground of concrete and concrete blocks, to meet the Atomic Energy Commission (AEC) criteria for vaults for storage of fissionable material. It was equipped with intrusion alarms. Closed containers of radioactive waste were also stored outside on a concrete pad within the locked, fenced facility perimeter.

All nuclear materials were removed from the building by 1993. The building was decontamiminated and a final survey of the building was performed in 1993 (Ref. 3). In 1996, the building was released for demolition by the Department of Energy (DOE) and the California Department of Health Services (DHS) Radiation Branch. The building was demolished in 1997 and the waste was shipped off-site as clean waste.

Key Milestones, B4064:

Period of operation	1958 - 1993
Decontamination and decommissioning	1993
Rocketdyne Final Survey of B/4064 interior	January 1994
Rocketdyne Final Survey of B/4064 fenced-in yard	January 1994
ORISE verification survey	October 1994
DHS verification survey	1994
DOE approval to demolish building	June 1996
DHS approval to demolish building	August 1996
Demolition complete	August 1997

1.2 Side Yard and Surrounding Areas of B/4064

During the operating history of Building 4064, the concrete pad northeast of the building had been built to store sealed containers of radioactive material. During this period of handling containers of radioactive material, the side yard became contaminated with Cs-137 (Ref. 8).

In 1988, a Characterization Survey (Ref. 1) was performed which identified the location of contaminated soil. Remedial excavation was performed and a subsequent Rocketdyne survey was conducted. A follow-up verification survey was performed by ORISE (Oak Ridge Institute of Science & Education) in 1992 and additional excavation was performed in 1993.

The Area IV Survey, performed in 1994 and 1995, identified two more locations above release limits. These areas, including a septic tank and the leach field, were excavated in 1997. Subsequent scoping surveys indicated the area was below release limits.

In May 1998, sub-surface core sampling down to bedrock was performed under the original building, in the side yard, under the main access road, "G" street, and east of "G" street (Ref. 10). All sample results proved to be within the range of background levels.

The Rocketdyne Final Status Survey of the entire 2 acre-area (Ref. 10), and the ORISE verification survey were conducted in September 1998. In October 1998, the California Department of Health Services (DHS) also performed a verification survey.

Key Milestones, 4064 Side Yard & Surroundings

Characterization survey	July 1988
Remediation	1989
Interim final survey	October 1990
ORISE verification survey	December 1992
Remediation	1993
Revision to Interim final survey report	1993
Area IV survey	1995
Remediation of septic tank and leach field	1997
Sub-surface core sampling	May 1998
Rocketdyne final status survey	September 1998
ORISE verification survey	September 1998
DHS verification survey	October 1998

2.0 LOCATION

Facility 4064 was located within the former Rockwell International Santa Susana Field Laboratories (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. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 2-1. An enlarged map of neighboring SSFL communities is shown in Figure 2-2. Figure 2-3 is a plot plan of the western portion of SSFL, known as Area IV, where Building 4064 was located. Figure 2-4 shows the relative locations of the building, the Side Yard and the surrounding areas including the locations of a septic tank and its leach field. A drawing (plan view) of Building 4064 and its adjoining areas is shown in Figure 2-5. Figure 2-6 shows the former building in the Area IV of SSFL and the surrounding area. Building 4064 was totally fenced in with a chain-link fence (Ref. 1). An aerial photograph of the 4064 site prior to demolition is shown in Figure 2-7.

Using USGS terminology, the USGS description for the Building 4064 is: Township T2N; Range RI 7W; and Section 30, Calabasas Quadrangle.

SOUTHERN CALIFORNIA REGION

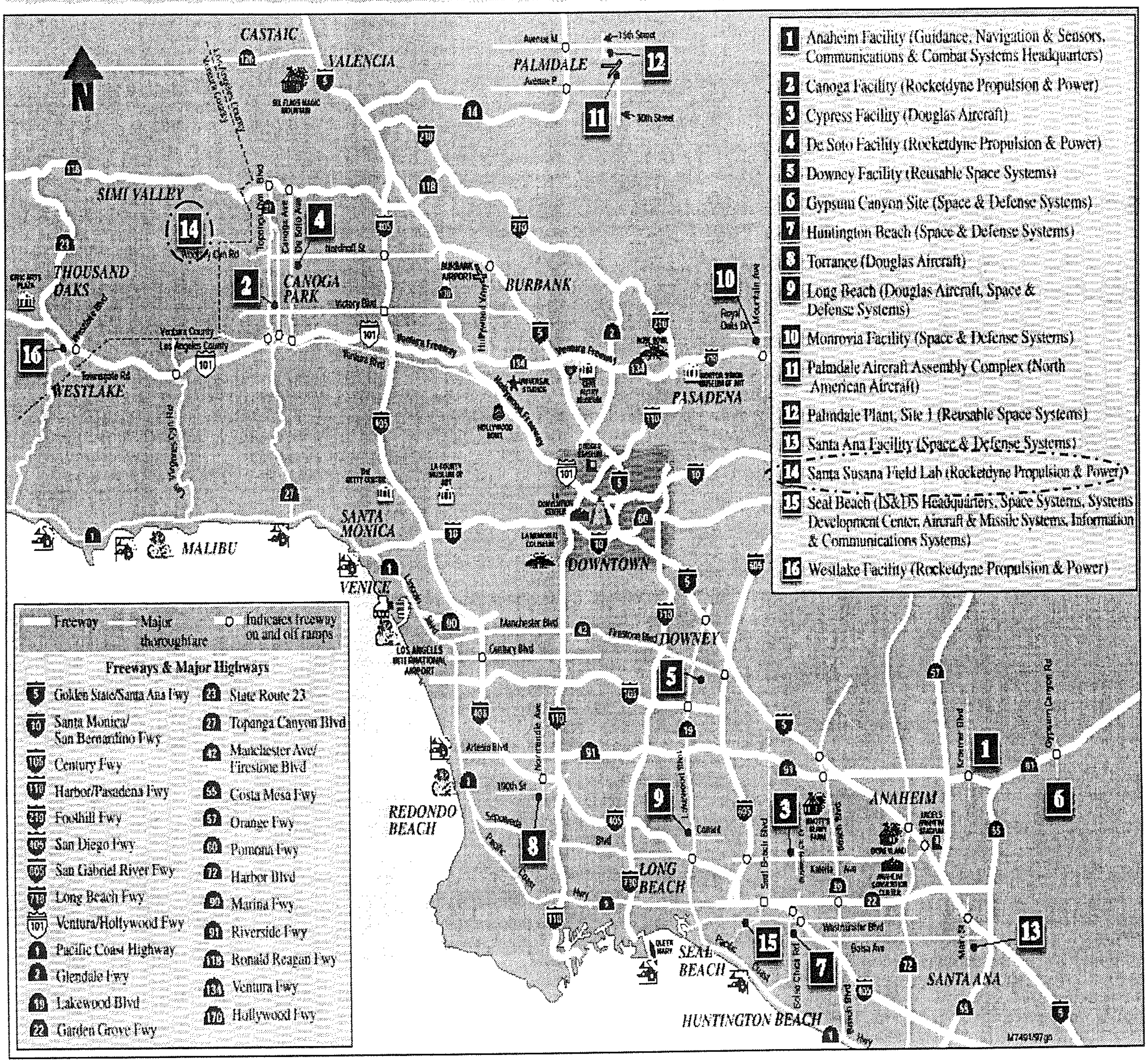


Figure 2-1. Map of Los Angeles Area

Figure 2-2. Map of Neighboring SSFL Communities

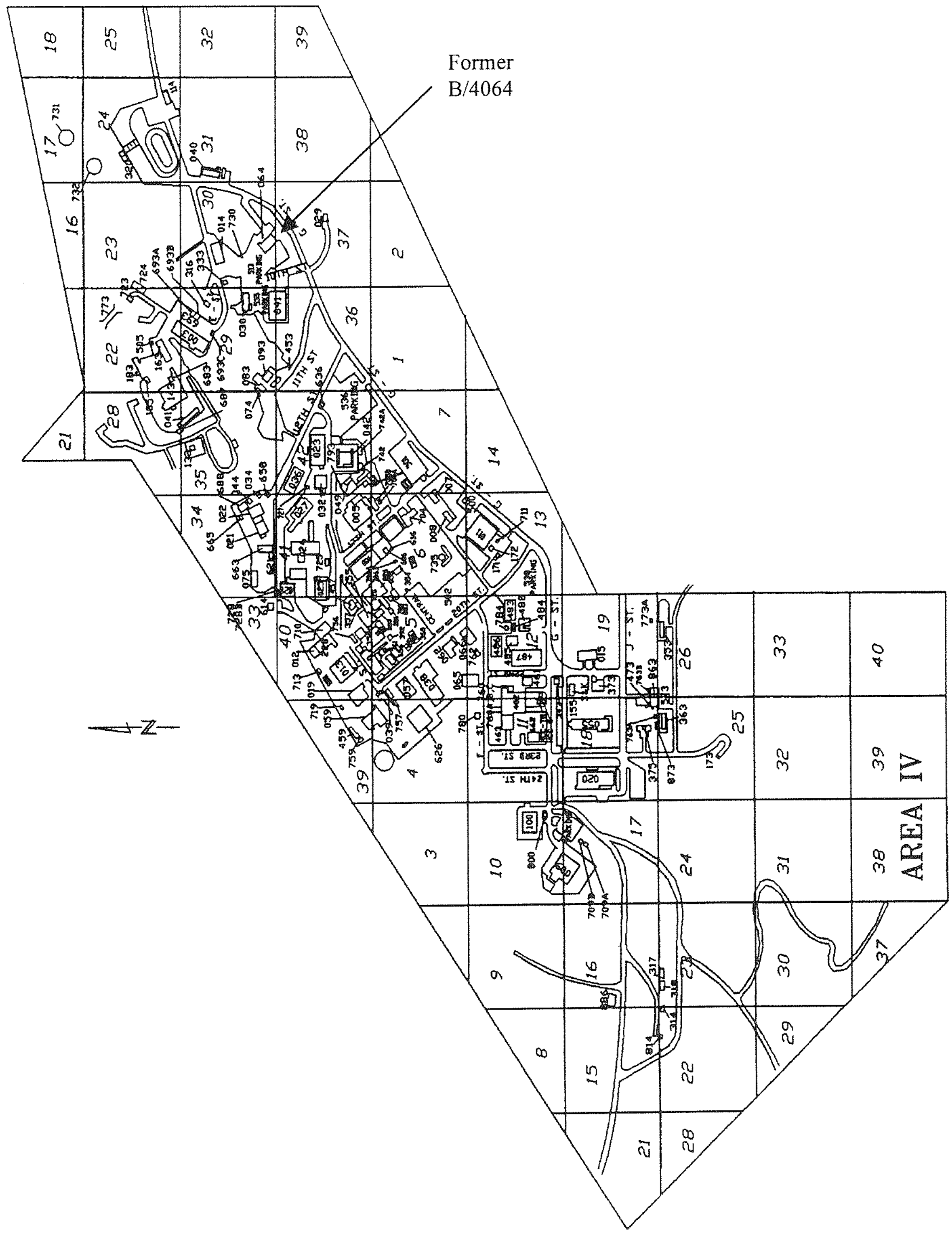


Figure 2-3. SSFL Layout Showing Location of the Former Building 4064

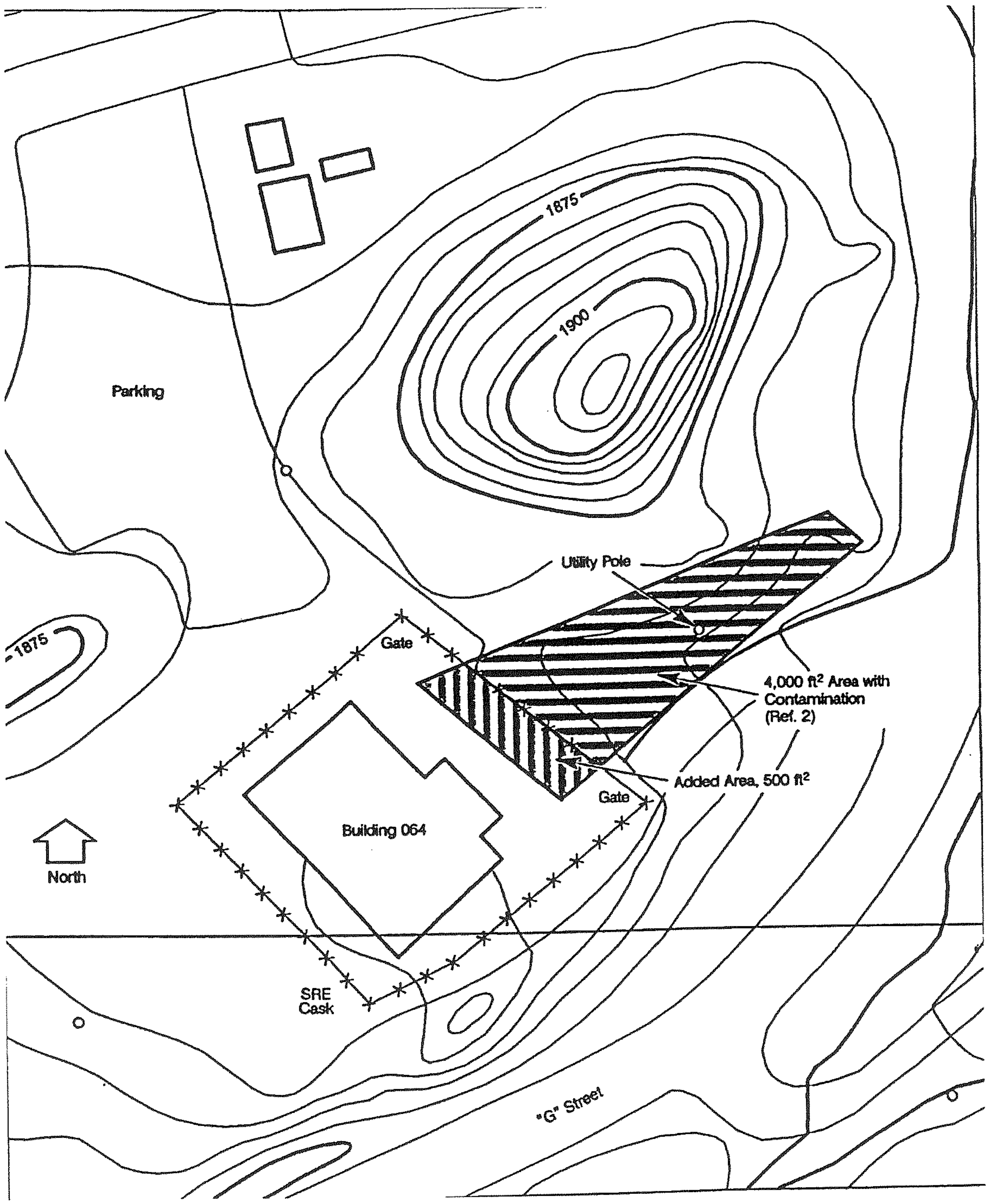


Figure 2-4. Former Facility 4064, Side Yard and Surrounding Area

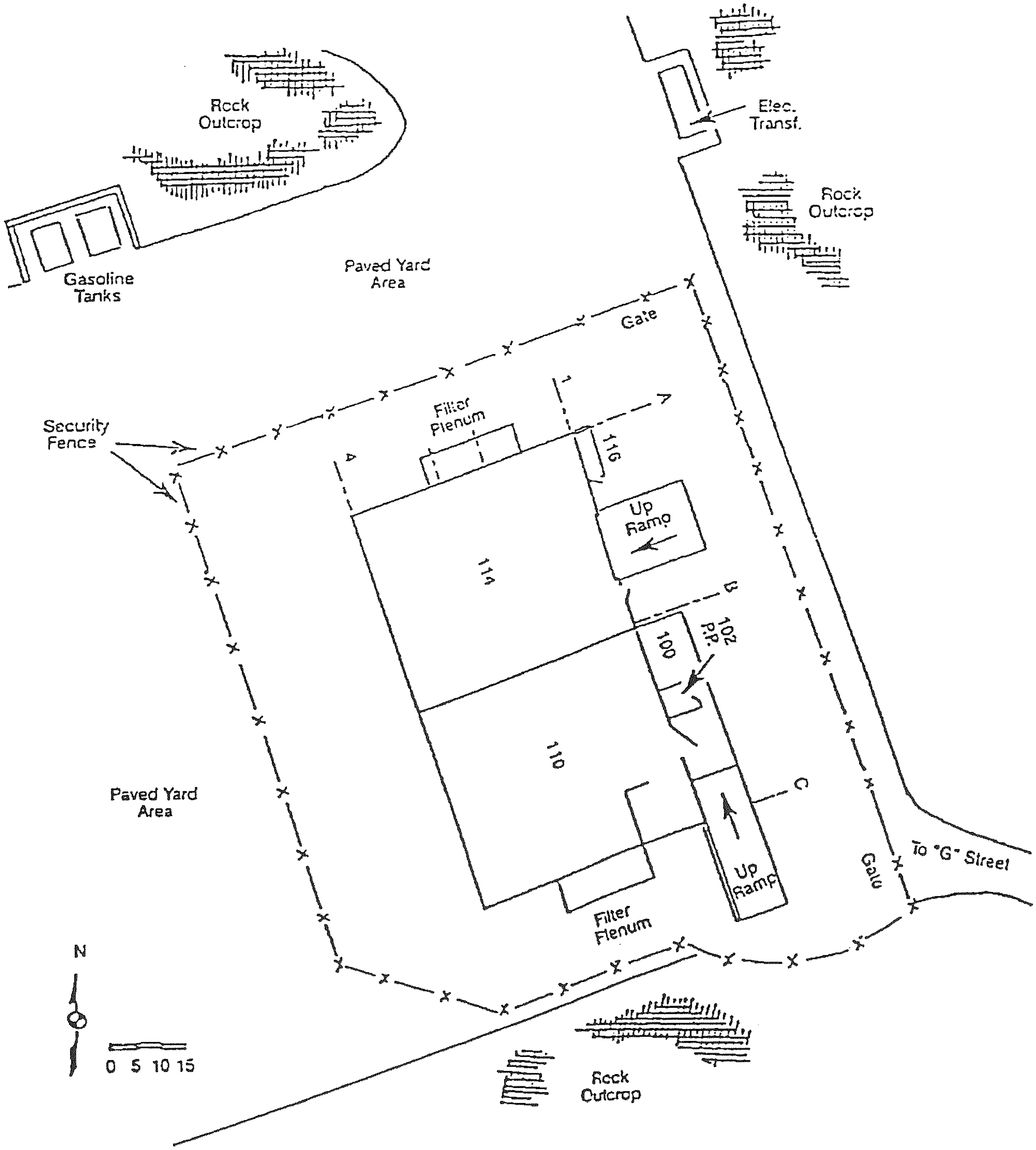


Figure 2-5. Plot plan - Former Building 4064

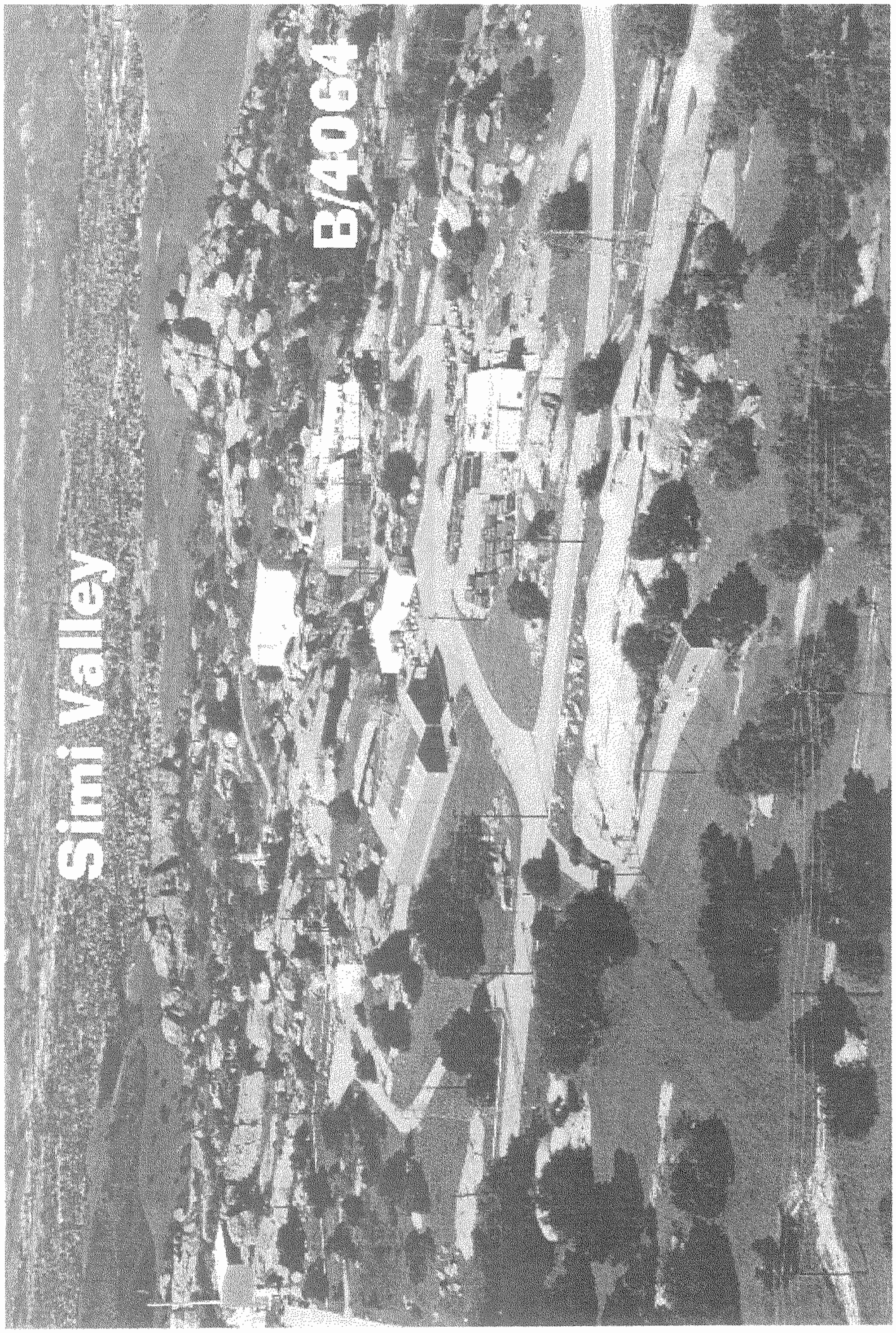


Figure 2-6. Location of B/4064 in Area IV and Surroundings

Figure 2-7. Aerial View of Former Building 4064 Site

3.0 FACILITY DESCRIPTION AND SITE TOPOGRAPHY

3.1 Building and Site

Building 4064 was designed and built as a special nuclear material and source radioactive material storage building. It was constructed in two phases. The first phase was constructed in 1958. This 2137 ft^2 portion (Room 110) was a reinforced concrete structure with 11-in. thick walls on a concrete slab. The building eaves height was 16 ft and the structure was open bay except for a 12 ft x 13 ft material handling area in the southeast corner of the building. A fume hood was installed in this small southeast corner (Room 104).

In 1963, the building was enlarged by adding a bay to the north (Room 114) bringing the total square footage of the building to 4418 ft^2. This addition used 12-in. concrete block construction with cores filled with concrete. Total square footage included a small 150 ft^2 office (Room 100) and a 50 ft^2 restroom (Room 102), both located on the dock on the east side of the building. On the northwest corner was a small supply and storage room, about 50 ft^2 (Room 116). Room 114 was accessible from the east through a 20 ft x 15 ft electrically driven rollup door and a conventional hinged door. Room 110 was accessible from the east through a heavy secured door. Ramps leading to each room allowed easy transport of materials via forklift.

The concrete slab floors were covered with 12-in. square vinyl-asbestos tiles. The concrete-block walls were painted. In 1980, the entire facility was reroofed; interior wall surfaces were patched and painted; floor tile was removed and replaced; the restroom and office were restored; plumbing was repaired; heating and ventilation was repaired; a window air-conditioner was installed in the office; and yard asphalt was patched. New fluorescent lights were installed. Storage racks were constructed to accommodate fuel.

Since nuclear material was only stored here, there was no processing equipment within the building. No sinks were installed in the storage areas. The only water supply was to the restroom (Room 102). Initially sanitary waste water was discharged to a septic tank and leach field. In about 1960 the facility was connected to the local sewage system. The facility was not air-conditioned. Each room was ventilated by dedicated blowers through a plenum containing pre-filters and HEPA filters. Room 104 had a fume hood that exhausted through the south filter plenum.

A disconnected sanitary leach field existed just north of the access road to "G" Street on the southeast section of the property. The building was surrounded by a chain link fence, located from 20 to 30 ft from the exterior walls of the building. The area enclosed, including the building, was about 11,000 ft^2.

There were three points of access to the site location of Building 4064. One access was directly from the north through the 513 parking area, which was on the east side of 10th Street. A second point of access was directly off 10th Street at the northwest corner of the facility, and the third was a paved roadway connecting the southeast corner of the facility with "G" Street to the east. There were two gates for accessing the fenced-in storage yard; one from the northeast corner off the 513 parking lot, and the other from the southeast corner off "G" Street.

The facility sat atop a plateau about 25 ft above "G" Street and slightly above the 513 parking lot. Figure 3-1 shows the building and surrounding area during demolition (half of the building was demolished at the time of this picture). Rock outcroppings exist up slope to the north-northeast and down slope in every other direction. Water runoff was primarily due east at the southern end of the facility.

3.2 Fenced-in Yard, Side Yard and the Surrounding Areas

The "fenced-in yard" was a 6,580 square foot area within the security fence as shown in Figure 2-5.

The "Building 4064 Side yard" was a designation given to approximately 4500 square foot trapezoidal area near building 4064 for D&D (Fig. 2-4).

The "Surrounding Areas" included a 2-acre area of the former 4064 facility, including drainage pathways, former parking lot areas, surrounding areas, and the Side yard area (Ref. 10). The septic tank, and the leach field that had serviced the Building 4064, were located within the Surrounding Areas (Fig. 2-4). Figure 3-2 shows the septic tank in the ground after the surrounding soil was removed.

Figure 3-1. North Half of Building 4064 during Demolition

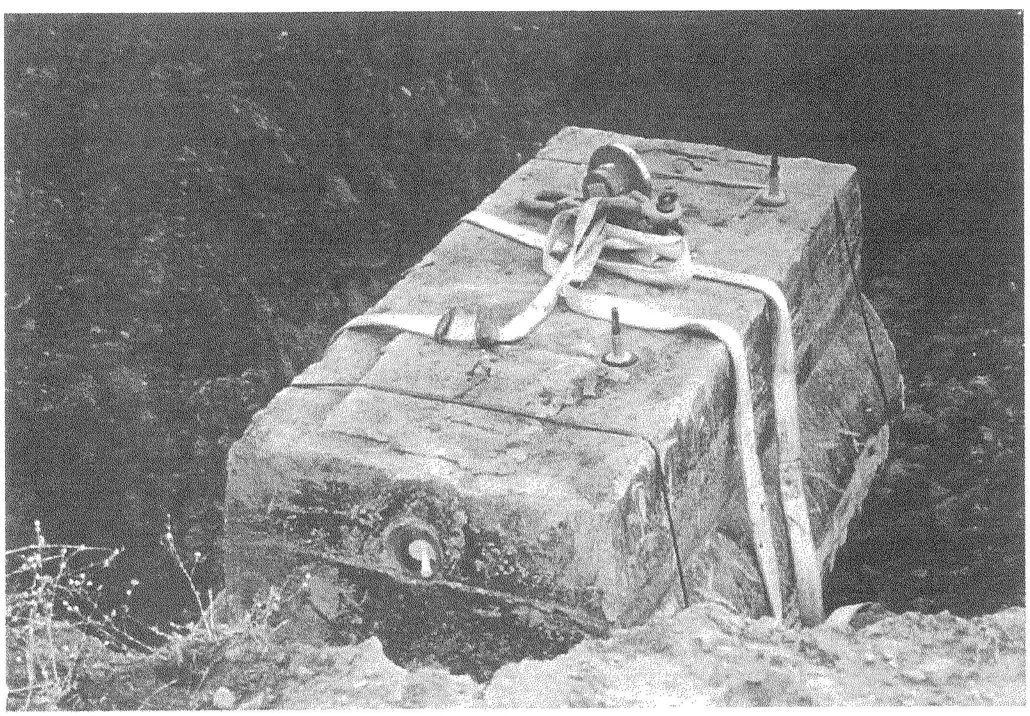


Figure 3-2. Uncovered Septic Tank for Former Building

4.0 OPERATING HISTORY

4.1 Building 4064

Building 4064 was used primarily for storage of packaged items of source material (normal uranium, depleted uranium, and thorium), and packaged special nuclear material (enriched uranium, plutonium, U-233) of various forms and configurations. Originally Room 114 and Room 110 contained steel racks for storing material. Room 110 was primarily used for storage of highly enriched uranium and plutonium; Room 114 was primarily used for source material and low enriched uranium storage.

Enriched uranium powders and source material powder packages were split into smaller units or combined into larger units in a glove box located in the small work area alcove (Room 104) in the southeast corner of Room 110. Plutonium was handled only in packaged form; never in a loose form. No plutonium handling was done other than transferring sealed packages between containers. Transfers of solid metallic forms of material generally were handled in the glove box; however, on occasion, larger solid metallic pieces were transferred and repackaged within the room.

During the early 1960's, a changed storage configuration was required. The metal racks from the south half of Room 110 were removed in order to store material in storage containers and drums. This storage included large quantities of special nuclear material recoverable scrap.

During this time, recoverable scrap storage space was needed. As a result, the yard area in front of the building (east), the side (north), and the back (west) was used to store 55-gallon drums of low enriched recoverable scrap. This material was shipped off-site from Rocketdyne to various government sites in the mid-to-late 1960's and early 1970's.

No plutonium or U-233 packages were ever opened in this facility. Any residual radioactive contamination was enriched uranium, normal uranium, depleted uranium, or thorium and came from handling bare metallic pieces (Ref. 1).

During the mid-1970's to early-1980's, most of the major DOE nuclear development and reactor contracts had ended. Later, following removal of all fissionable material, miscellaneous equipment and containers of radioactive waste (principally soil) were stored in the building. The building was emptied of all contents (both radioactive and non- radioactive) by 1993 (Ref. 5).

The building was decontamiminated and a Rocketdyne final survey of the building interior and also the fenced-in yard was performed in 1993 and was documented in 1994. The Oak Ridge Institute of Science and Education (ORISE) and the California Department of Health Services (DHS) performed verification surveys in 1994. In 1996, the building was released for demolition by the Department of Energy (DOE) (Appendix 1) and the California DHS (Appendix 2).

In May, 1997, the alarm system was removed from the building to prepare for demolition. The asbestos and paint were removed from the building by a contractor specializing in asbestos abatement. The building demolition process was completed in August, 1997, and the waste was shipped off-site as conventional waste.

4.2 Side yard and Surrounding Areas of B/4064

In 1988, a Characterization Survey was performed which confirmed the location of contaminated soil. Remedial excavation was performed to remove the contaminated soil. A subsequent Rocketdyne survey comprising of one-meter gridded exposure measurements and soil sampling was documented in 1990. A follow-up verification survey was performed by ORISE in 1992. Further excavation was performed in two locations in 1993, following imposition of more stringent clean-up standards by the Department of Energy, and documented in a revision to Rocketdyne's 1990 survey report (Ref. 6).

During the Area IV Survey in 1994 through 1995, two locations, one in the original side yard and one located across the other side of "G" Street were identified as remaining above release limits. These areas were excavated in 1997 including the removal of an abandoned septic tank and leach field that had serviced Building 4064. Scoping surveys and soil samples conducted during and after excavation proved the 4064 area beneath the previous building foundations, and surrounding yard areas were non-contaminated.

In May, 1998, sub-surface core sampling down to bedrock was performed under the original building, in the side yard, under the main access road, "G" street, and east of "G" street (Ref. 10). All sample results proved to be within the range of background.

In September, 1998, the Final Status Survey was conducted in the entire 2 acre site, including drainage pathways, former parking lot areas, surrounding areas, and the side yard area. One hundred and thirty one (131) soil samples were taken, 553 one-meter gridded exposure measurements were taken and a surface exposure survey of all two acres was performed. All measurements demonstrated that the facility met cleanup standards for release for unrestricted use. The Final Status Survey Report was issued in April, 1999 (Ref. 10).

In September, 1998, the Oak Ridge Institute of Science and Education (ORISE) performed a verification survey (Reference 9). In October, 1998, the California Department of Health Services (DHS) performed a verification survey.

5.0 PROJECT ACTIVITIES

5.1 Building 4064

A radiological survey of the facility structure and yard was performed in 1987/88 (Ref. 1). That survey revealed low level contamination on most of the fixtures inside Room 110 and in the two exhaust systems that were serving Rooms 110 and 114. The office, restroom and a janitor's closet showed no signs of contamination. The floor tiles were surveyed for radiological contamination, none was found, and the tiles were removed from these rooms during the asbestos containing material (ACM) abatement of the facility.

5.1.1 Room 114

After work had ceased at Building 4064, miscellaneous packaged components and approximately 125 cubic yards of containerized soil were stored in Room 114. The remediation work performed in Room 114 consisted of the removal of these stored items. During the removal of the equipment and boxes of soil, frequent area contamination surveys were performed by radiation protection personnel to assure that container integrity and contamination control were maintained. All contaminated equipment, components and soil that had been stored in Room 114 were transported to the Radioactive Materials Handling Facility (RMHF) for temporary storage and eventual disposal at an approved DOE burial site.

5.1.2 Room 110

Most items in Room 110 had been used for operations at Building 4064 and were contaminated to varying degrees. When practical, size reduction and packaging were performed on site. However, some of the equipment required more aggressive techniques for size reduction and contamination control. These items included: a fume hood that had been used to package enriched uranium powders and source materials, two large balances (Fig. 5-1), and several 6 in. diameter x 5 ft. long steel shipping drum inserts. All of these items were transferred to the RMHF for size reduction and packaging for disposal. The fluorescent light fixtures in this room were also contaminated. The fixtures were taken down, disassembled and the PCB containing ballasts removed. The fixtures less ballasts and bulbs were packaged and disposed of as radioactive waste, the ballasts were surveyed and found to be radiologically clean and were disposed of as hazardous PCB waste, the fluorescent bulbs were decontaminated and disposed of as conventional waste. The storage racks (Fig. 5-2) contained fixed radioactive contamination and were disassembled, size reduced and packaged on site and transferred to the RMHF for eventual shipment to an approved disposal facility.

5.1.3 HEPA Filtered Exhaust Systems

To maintain contamination control during the size reduction of the HEPA filter plenums, size reduction was done at the RMHF. The plenums were detached from the buildings and blowers as intact units and transported to the RMHF. Because of the large size of the exhaust plenums this effort required the fabrication of custom boxes to assure contamination containment during transport. Inlet (Fig. 5-3) and outlet openings were sealed, the units were disconnected from the building, placed in the boxes and transferred to the RMHF. The plenums were cut into manageable size pieces using a plasma torch and packaged for disposal as radioactive waste.

Because the facility had been used for storage for several years, special attention was given to identifying hazardous or potentially hazardous materials requiring disposition. Two scales were found to contain oil and one also contained lead. A 4-oz quantity of oil from one of the scales was determined to contain radioactive contamination and was effectively treated during the Molten Salt Oxidation (MSO) Bench Scale Unit tests being performed at the RMHF. The other oil and the lead were certified as "Containing no DOE-Added Radioactivity," in accordance with ER-SP-0001 (Ref. 2) and were disposed of in accordance with the Rocketdyne Environmental Control procedures. The ballasts removed from the light fixtures in Room 110 were hermetically sealed units and after a thorough radiological survey were also certified as "Containing No DOE-Added Radioactivity" and were disposed of in accordance with the Rocketdyne Environmental Control procedures.

Because the floor tiles throughout the facility had been determined to contain asbestos, and were in a deteriorated state, their removal was required. A sampling plan was developed and implemented in accordance with ER-SP-0001. Randomly selected tiles were removed and the tiles and subfloor were surveyed for total contamination. The results of this survey sampling concluded that the tiles and subfloor had no detectable activity (NDA) above background; therefore, all tiles were certified as "Containing No DOE-Added Radioactivity." An asbestos abatement contractor was employed to remove a total of 4,352 ft^2 of tile. The tile and abatement-related ACM wastes were packaged and placed in an approved hazardous waste container and were disposed at an approved disposal facility. Copies of certifications were forwarded to the DOE.

5.2 Side yard and Surrounding Areas

The characterization survey of 1988 indicated areas of contaminated soil, which were subsequently removed. In 1993, the Department of Energy imposed stricter clean-up standards, and soil was excavated from two additional locations (Ref. 6). The demolition of building 4064 was placed on hold until removal of all contaminated soil was completed.

The Area IV survey of 1994-95 identified two more locations with elevated readings, one in the original Side yard, and the other located across the other side of "G" street. The remediation of these locations was performed in 1995. Soil samples from these locations were taken to determine the amount of soil needed to be removed. Roll-off containers were used for interim storage of contaminated soil. The removal of soil areas with elevated readings was completed by the end of 1995.

The location of the abandoned septic tank was confirmed during the above-described excavations.
A methodology was developed to determine the extent of side yard contamination. It was decided to auger holes 18" deep and measure activity using a NaI detector. Additional side yard samples were taken using this methodology. The removal of elevated radiological spots was completed by the end of 1995. In April, the leach field distribution box was surveyed in detail and contamination was found in both the inlet and outlet lines. The distribution box was removed in June and sent to the Radioactive Materials Handling Facility (RMHF) for further processing. The box was packaged at the RMHF for shipment to the DOE-Hanford disposal site. It was shipped in March, 1999.

The radiological boundary determination showed that an area inside of the drip line of an oak tree needed to be excavated. In January, 1996, a radiological survey of the buried septic tank showed no radioactivity. In February, the water and sludge samples from the tank were analyzed and found to be non-hazardous. The tank then was decanted and the non-contaminated water was allowed to evaporate. Permits to remove the septic tank and to excavate around oak trees were obtained in June 1996. The Critical Lift procedure was modified for the septic tank, and the tank and piping were removed in July 1996 (see Fig. 5-4) and sent to RMHF for processing. Low Level contamination was detected in the sludge in the tank. The sludge was absorbed in diatomaceous earth. The tank was size reduced (rubblized) and packaged for shipment to the DOE-Hanford disposal site. Figure 5-5 shows the locations of the tank and its leach field after excavation.

The soil sampling based on the boundary determination methodology was completed in 1996. The soil defined by this methodology was excavated and was shipped to the Envirocare facility in Utah.

Figure 5-1. Room 110, Fume Hood (left) and Voland Balance

Figure 5-2. Room 110, Storage Racks

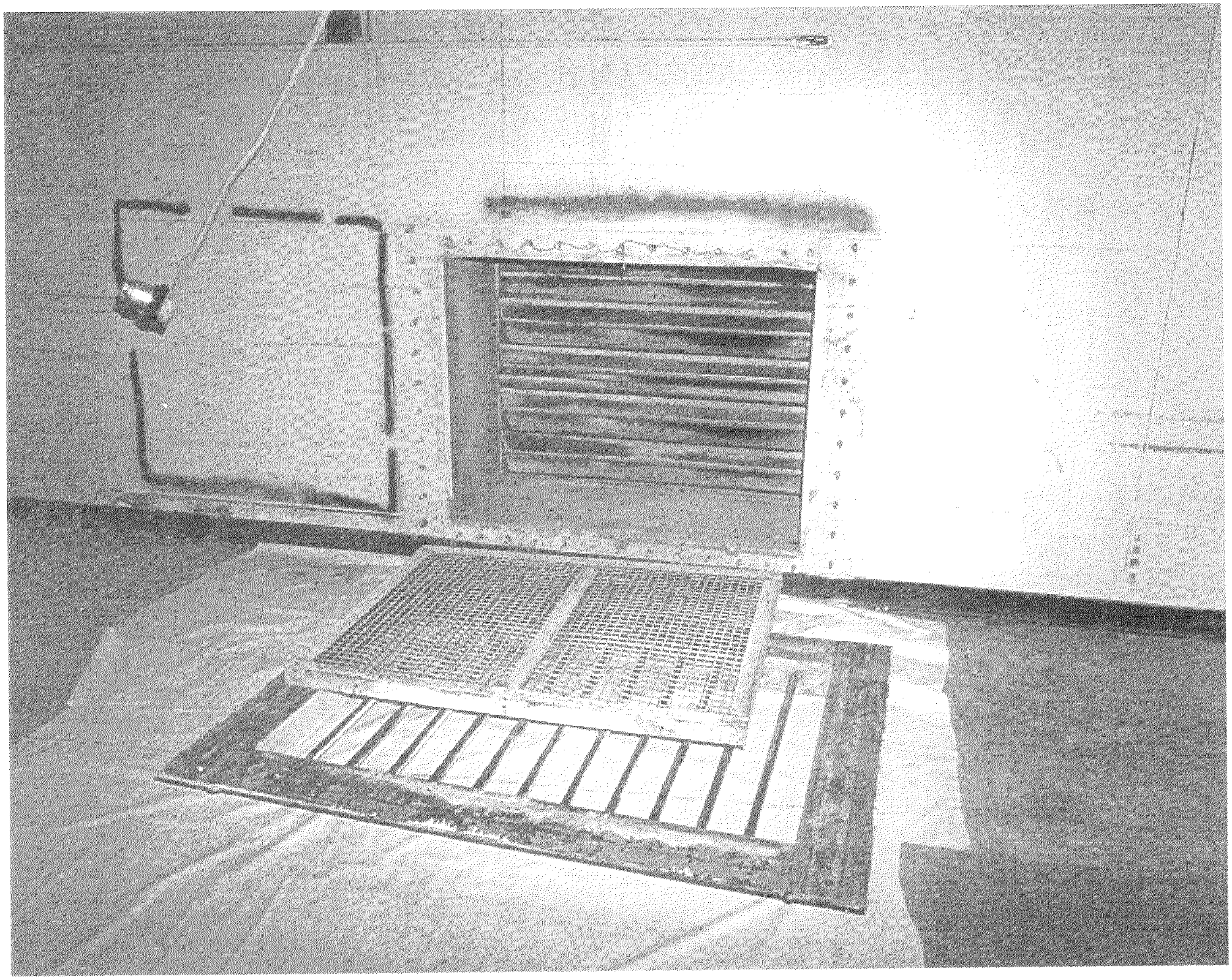


Figure 5-3. HEPA Filtered Exhaust Inlet (Typical Rooms 110 and 114)

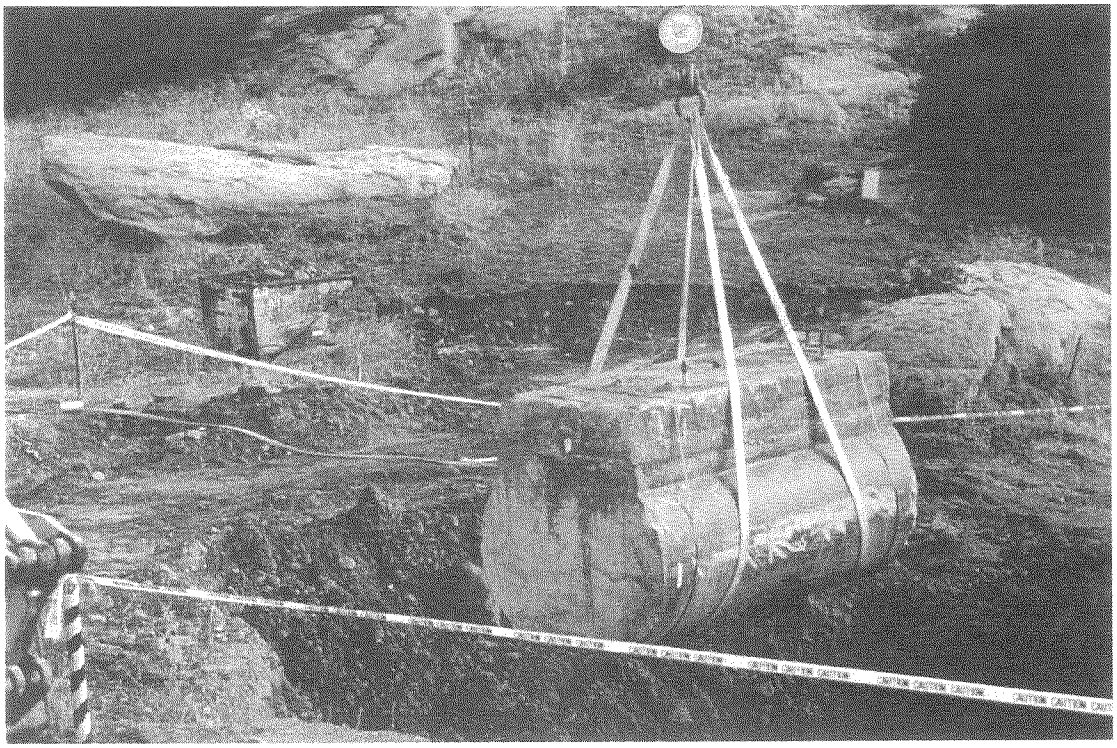


Figure 5-4. Removal of the 4064 Septic Tank

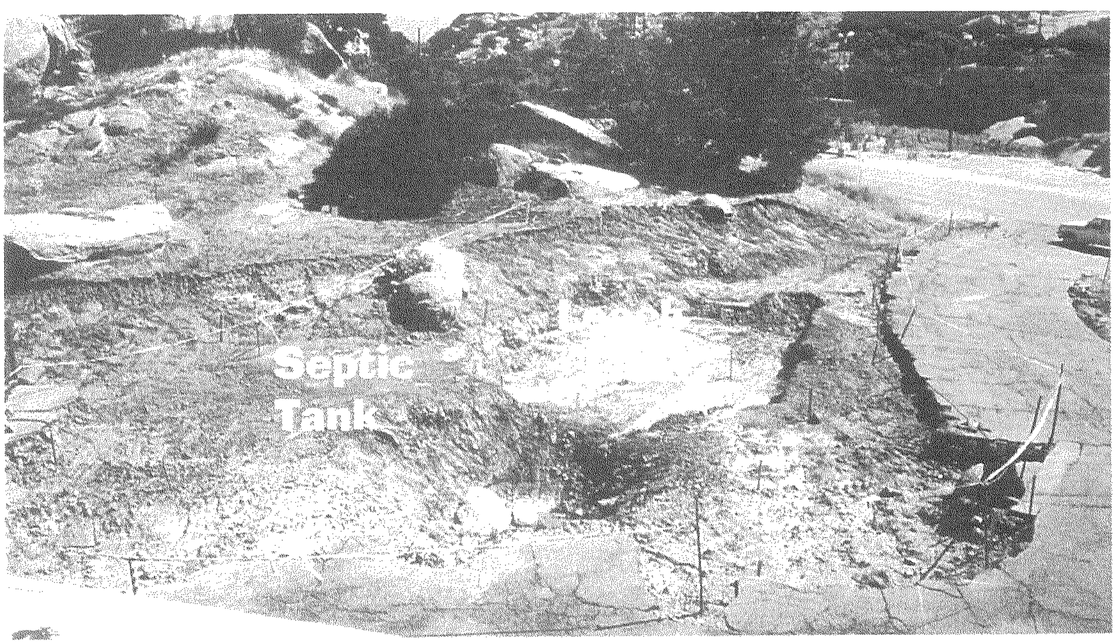


Figure 5-5. Locations of the Septic Tank and the Leach Field after Excavation

6.0 SURVEY RESULTS

6.1 Overview

Upon D&D of radioactive constituents, releasing a facility or area for unrestricted use requires a formal radiation survey to demonstrate that the applicable regulatory limits for such a release are met. The survey is performed under an established plan, and a statistical interpretation of the resulting data is made to verify that the regulatory release criteria have been met. References 3, 8 and 10 provide information that demonstrates that Building 4064 and the Area 4064, which includes the Side yard and the "Surrounding Areas", meet DOE, NRC, and State of California criteria for release of the facility for unrestricted use.

6.2 Scope of the Survey

6.2.1 Building 4064

For the final radiological survey of Building 4064, the interior rooms and office were separated into sample lots. These sample lots are graphically shown in Figure 6 of Reference 3. Sample lots were treated separately for the purposes of statistical data analyses. Distinguishable properties for selecting the sample lots were areas or rooms, which contained contaminated components that were recently decontaminated. The chosen sample lots or areas are shown in Table 1 of Reference 3 with the corresponding type of survey performed.

6.2.2 Area 4064 (Side yard and the Surrounding Areas)

The entire 2-acre lot was surveyed and sampled including a direct qualitative surface gamma scan (100%) for contamination, ambient gamma exposure measurements at 1 meter above the ground at 10 ft by 10-ft grids, and both surface and subsurface soil sampling (Ref. 10).

6.3 Survey Summary and Conclusions

6.3.1 Building 4064

Survey measurements were made for surface contamination (alpha and beta) on the interior walls, floors, and ceilings in Building 4064, and for ambient gamma exposure rate at 1 meter above the interior floors. These measurements were tested statistically for compliance with acceptable contamination limits for enriched uranium, activation products, and mixed fission products, and for ambient exposure rate.

All tests for surface contamination showed that the facility was suitable for release without radiological restrictions. Interpretation of the gamma exposure rate measurements for the Building 4064 interior is based on the average gamma exposure rate background value (15.76 μR/hr) for a building of similar construction (Building S445) that has never been used for any radiological purposes. The probability distributions for the comparisons between these measurements shows no local contamination, except for two measurements that were affected by the near proximity of smoke alarm units containing approximately 80 μCi Am-241. The results indicate a natural/normal background distribution for the building, with an average value of 14.7 μR/hr. Therefore, the Building 4064 interior average gamma exposure rate was consistent with the average gamma exposure rate for Building S445.

A confirmatory survey of the building was performed by ORISE (Ref. 4). The results of the final survey and the confirmatory survey showed that the building was suitable for release for use without radiological restrictions.

An inspector from the State of California, Department of Health & Services-Radiologic Health Branch (DHS-RHB) accompanied the confirmatory survey team and also made independent measurements. The results of these measurements were consistent with the confirmatory survey. (see attached letters in the Appendix).

6.3.2 Area 4064 (Side yard and the Surrounding Areas)

The test statistic for the distribution of the background –subtracted gamma exposure rate is 4.1 μR/hr, which is below the acceptance limit of 5 μR/hr.

The [post-remediation] soil samples indicate that the Cs-137 contamination, historically observed at Area 4064, has been remediated and is now below the clean-up standard of 9.2 pCi/gm. Most samples indicated no Cs-137, while a small number of samples showed trace levels of Cs-137 above background levels with a maximum level of 3.1 pCi/gm.

All soil sample and radiation exposure measurements are below the Department of Energy's and California Department of Health Services' approved release limits. The 4064 area, including surrounding areas, is suitable for release for unrestricted use (Ref. 10).

6.4 Verification Surveys

A verifcation survey of Area 4064 was performed by ORISE (Ref. 9). This report concludes that the 4064 Side Yard satisfies the criteria for release for unrestricted use. A verification survey of Area 4064 was performed by DHS-RHB and confirmed the Rocketdyne and ORISE conclusions.

7.0 WASTE VOLUME GENERATED AND DISPOSAL

The types of waste materials generated during the D&D of Building 4064 included steel (exhaust hoods, parts, and storage racks) and miscellaneous items (HEPA, filters, fiberboards, and glass, etc.). Table 7-1 lists actual amounts of generated waste.

TABLE 7-1

Source	lb.	Ft^3
Piping/Miscellaneous Steel	5,600	150
Misc. Items	31,600	930
Total	37,200	1,080

Additionally, the demolition contractor disposed of several tons of non-hazardous building material, such as walls and roof, in 1997. The contractor also disposed of some asbestos containing materials.

The excavation from the Side yard and the Surrounding Areas include soil, asphalt and concrete from the distribution box. Table 7-2 lists the amounts of waste.

TABLE 7-2

Source	lb.	Ft^3
Soil	1,270,600	15,820
Asphalt	313,000	3,700
Soil & asphalt	684,400	8,560
Concrete (From Distribution Box)	6,000	140
TOTAL	**2,274,000**	**28,220**

Additionally, the size-reduced septic tank, weighing approximately 25,000 lb., is in a roll-off (~405 Ft^3) awaiting shipment to the DOE-Hanford Disposal Facility.

8.0 PERSONNEL RADIATION EXPOSURE

No personnel radiation exposure was anticipated or encountered from the D&D activities for Building 4064, the Side yard or the Surrounding Areas.

9.0 PROJECT COST SUMMARY

The total cost associated with the decontamination and decommissioning of Building 4064 in Table 9-1.

TABLE 9-1

D&D plans and performance	$154,000
Burial and transportation	$ 54,000
Survey & Reporting	$ 45,000
Building structure demolition & disposal	$ 35,000
Asbestos abatement/paint removal	$ 13,000
TOTAL	**$301,000**

The cost associated with sampling, excavating, packaging and disposing the debris from the Side yard and the Surrounding Areas is given in Table 9-2.

TABLE 9-2

Labor including overhead (Radiation Protection Department - approx. 40% of total)	$114,000
Roll-off rental for soil storage	$ 92,000
Soil sampling	$ 9,000
Disposal including transportation & fees	$310,000
Misc. Materials, leases	$ 21,000
TOTAL	**$546,000**

10.0 REFERENCES

1. GEN-ZR-0005, "Radiological Survey of the Source and Special Nuclear Materials Storage Vault - Building 064" (8/19/88)

2. ER-SP-0001, "Management and Disposition of Known or Potentially Hazardous Wastes Originating in a RMMA" (10/22/91)

3. SSWA-ZR-0001, "Final Radiological Survey Report of Building 064 Interior" (1/14/94)

4. "Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California", T. J. Vitkus, ORISE (October 1994)

5. SSWA-SR-0002, "Building 064 D&D Operations Final Report" (8/13/93)

6. N704SRR990031, "Final Decontamination and Radiological Survey of the Building T064 Side Yard", Revision A (9/10/93)

7. "Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California", T. J. Vitkus, ORISE (October 1993)

8. N704SRR990035, "Radiological Assessment of the Building T064 Fenced-in Yard" (1/12/94)

9. "Second Addendum to the Verification Survey of the Building T064 Side Yard, Santa Susana Field Laboratory, Ventura County, California (ORISE 1993 and 1994)", from Tim Vitkus, ORISE, to Anand Gupta, US DOE (EM-43), January 25, 1999

10. RS-00003, "Area 4064, Final Status Survey Report" (4/13/99)

APPENDIX 1. DOE LETTER, DEMOLITION BIULDING T064

Department of Energy
Oakland Operations Office
1301 Clay Street, N700
Oakland, CA 94612-5208

June 25, 1996

Majelle Lee
Program Manager
Environmental Programs
Energy Technology Engineering Center
Rocketdyne Division
Rockwell International Corporation
P.O. Box 7930
Canoga Park, CA 91309-7930

Subject: Demolition of Building 064

Dear Ms. Lee:

The cleanup of radioactive decontamination at Building 064 is complete. ORISE has verified the condition of the building. Consequently, approval is given for the demolition of B064. The empty site (the land) will be combined with the B064 Sideyard into one release site. This release site is expected to be ready for a release for unrestricted use in FY97, after the remediation of the Sideyard is completed.

Sincerely,

Michael Lopez
ETEC PM
Environmental
Restoration Division

W022-003.

APPENDIX 2. STATE OF CALIF. H&S LETTER TO ETEC.

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

August 19, 1996

SEP 1996
RECEIVED

Mr. Phil Rutherford, Manager
Environmental Remediation
Rocketdyne Division
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309-7930

Subject: Demolition and Disposal of Structural Material from Building T064 at SSFL

Dear Mr. Rutherford:

This letter is to acknowledge the receipt of your letter dated July 30, 1996, with attachments, requesting concurrence of the above subject. Based on the review of your submittal and the results of the surveys performed by the inspection staff of our Los Angeles office, the Radiologic Health Branch (RHB) concurs that you may proceed with the demolition of the Building T064 and that you also may dispose of the structural material resulting from such demolition as conventional waste.

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

W022-003.DOC

ENERGY TECHNOLOGY ENGINEERING CENTER

OPERATED FOR THE U.S. DEPARTMENT OF ENERGY
ROCKETDYNE DIVISION, ROCKWELL INTERNATIONAL

No. SSWA-AR-0002 Rev. NEW
Page 1 of 13
Orig. Date August 13, 1993
Rev. Date NEW

DRR 25061 DS

TITLE: Building 064 D&D Operations Final Report

- APPROVALS -

Originator: P. Waite

G. Gaylord

Facility Mgr: R. Meyer

RP&HPS: P. Rutherford

QA

REV. LTR.	REVISION	APPROVAL/DATE

OFFICIAL COPY
MAY 3 1994
NOTICE: WILL NOT BE UPDATED

1.0 INTRODUCTION

This report summarizes the recent (post 1990) activities performed during the decontamination and decommissioning (D&D) of Building 064. This facility, known as the Source and Special Nuclear Materials Storage Vault, is located in Area IV of the Santa Susana Field Laboratory. Cleanup performed in the early 1960's (ref. 1) and in the late 1980's (ref. 1) has been previously documented and is not addressed in this report.

2.0 BACKGROUND

Building 064 was a high security facility originally consisting of a ~ 2100 ft^2 "vault" (Room 110) and a small office area. In 1963, a second ~ 2100 ft^2 "warehouse" (Room 114) was added (Figure I). The facility was utilized for support of Atomic Energy Commission (AEC), Energy Research and Development Administration (ERDA) and Department of Energy (DoE) related nuclear programs for the storage and repackaging of source and special nuclear materials, and for sectioning and repackaging fresh fuel elements. Plutonium was also handled at the facility in packaged form but never as "loose" powder. The yard area was also used for storage of drums of low enriched uranium recoverable scrap.

As public acceptance and funding for nuclear research programs and related activities waned in the late 1970's and early 1980's the facility was relegated to the storage of radioactively contaminated equipment and as an "overflow" waste container storage facility for the RMDF.

Room 110 contained several pieces of contaminated equipment including weighing scales, tools, a fume hood, empty storage containers and empty shipping drums. There were also four floor to ceiling, earthquake reinforced, "safe" storage racks in the northern portion of the room. Items stored in room 114 were containerized and consisted of contaminated pumps, equipment control consoles and packaged soil that had been excavated during the 1980's cleanup of the eastern yard and adjacent area. Both rooms' 110 and 114 were equipped with high efficiency particulate air (HEPA) filtered exhaust systems which were operational during fuel handling operations at the facility.

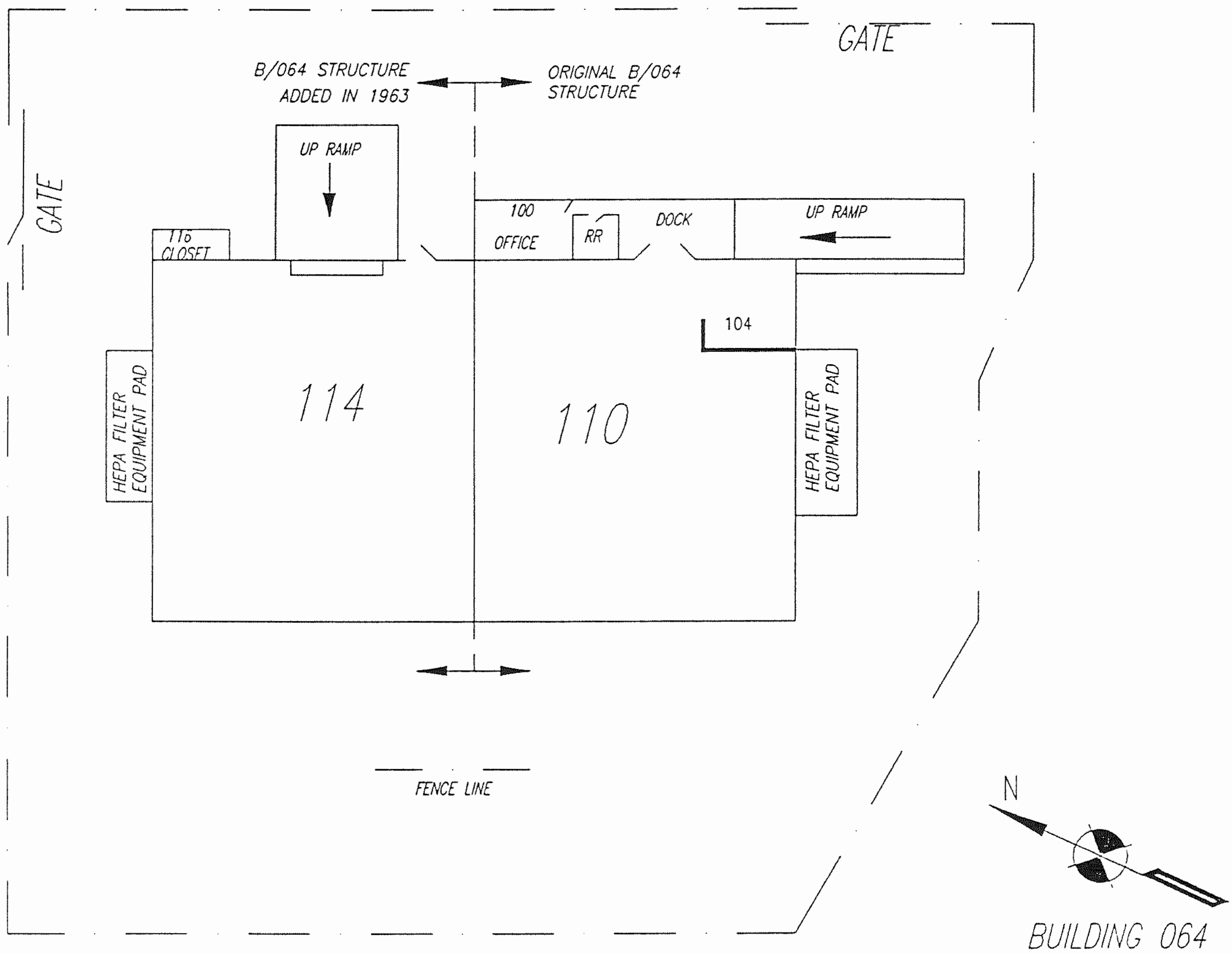


Figure I Building 064

2.1 Facility Status Prior To D&D

A radiological survey of the facility structure and yard was performed in 1987/88, that survey revealed low level contamination on most of the fixtures inside room 110 and in the two exhaust systems that were serving room 110 and 114. The office, restroom and a janitors closet showed no signs of contamination and were not included as a part of the radiological D&D of the facility, however the floor tiles were removed from these rooms during the asbestos containing material (ACM) abatement of the facility.

3.0 SUMMARY OF WORK PERFORMED

To release the facility for use without radiological restrictions all contaminated equipment and fixtures had to be removed in preparation for a final radiological survey. In addition, all hazardous materials and wastes in the facility had to be properly disposed. Where practical and cost effective, equipment was decontaminated and either disposed as non R/A waste or surplused. Some equipment required disassembly in order to remove hazardous materials such as oils, grease and lead. Most of the items, however, could not be readily decontaminated and some equipment had areas that could not be surveyed with the confidence level necessary for release without radiological restrictions. Analysis of the floor tiles indicated that the tiles and mastic glue throughout the facility contained asbestos and would require removal and disposal.

3.1 Room 114

The work performed in room 114 consisted of the removal of miscellaneous packaged components and approximately 195 cubic yards of containerized soil (photo #5). All of the items stored in room 114 were brought to the facility for storage after work had ceased at B/064 and had been properly packaged to prevent release of contamination. During the removal of the equipment and boxes of soil, frequent area contamination surveys were performed by Radiation Protection and Health Physics Services (RP&HPS) representatives to assure that container integrity and contamination control were maintained. All contaminated equipment, components and soil that had been stored in room 114 were transported to the RMDF for temporary storage and eventual disposal at an approved DOE burial site.

3.2 Room 110

Most of the items in room 110 had been used for operations B/064 and were contaminated to varying degrees. When practical, size reduction and packaging were performed on site. However, some of the equipment required more aggressive techniques for size reduction and contamination control. These items included: a fume hood that had been used to package enriched uranium powders and source materials, (photo #1) two large balances (photo #1) and several 6 in. diameter X 5 ft. long steel shipping drum inserts. All of these items were transferred to the RMDF for size reduction and packaging for disposal. The fluorescent light fixtures in this room were also contaminated. The fixtures were taken down, disassembled and the PCB containing ballasts removed. The fixtures less ballasts and bulbs were packaged and disposed of as R/A waste, the ballasts were surveyed and found to be radiologically clean and were disposed of as hazardous PCB waste, the florescent bulbs were decontaminated and disposed of as conventional waste. The storage racks (photo #2 & 4) contained fixed R/A contamination and were disassembled, size reduced and packaged on site and transferred to the RMDF for eventual shipment to an approved disposal facility.

3.3 HEPA Filtered Exhaust Systems

To maintain contamination control during the size reduction of the HEPA filter plenums, size reduction was done at the RMDF. The plenums were detached from the buildings and blowers as intact units and transported to the RMDF. Because of the large size of the exhaust plenums this effort required the fabrication of custom boxes to assure contamination containment during transport. Inlet (photo #3) and outlet openings were sealed, the units were disconnected from the building, placed in the boxes and transferred to the RMDF. The plenums were cut into manageable size pieces using a plasma torch and packaged for disposal as R/A waste.

3.4 Hazardous Materials And Wastes

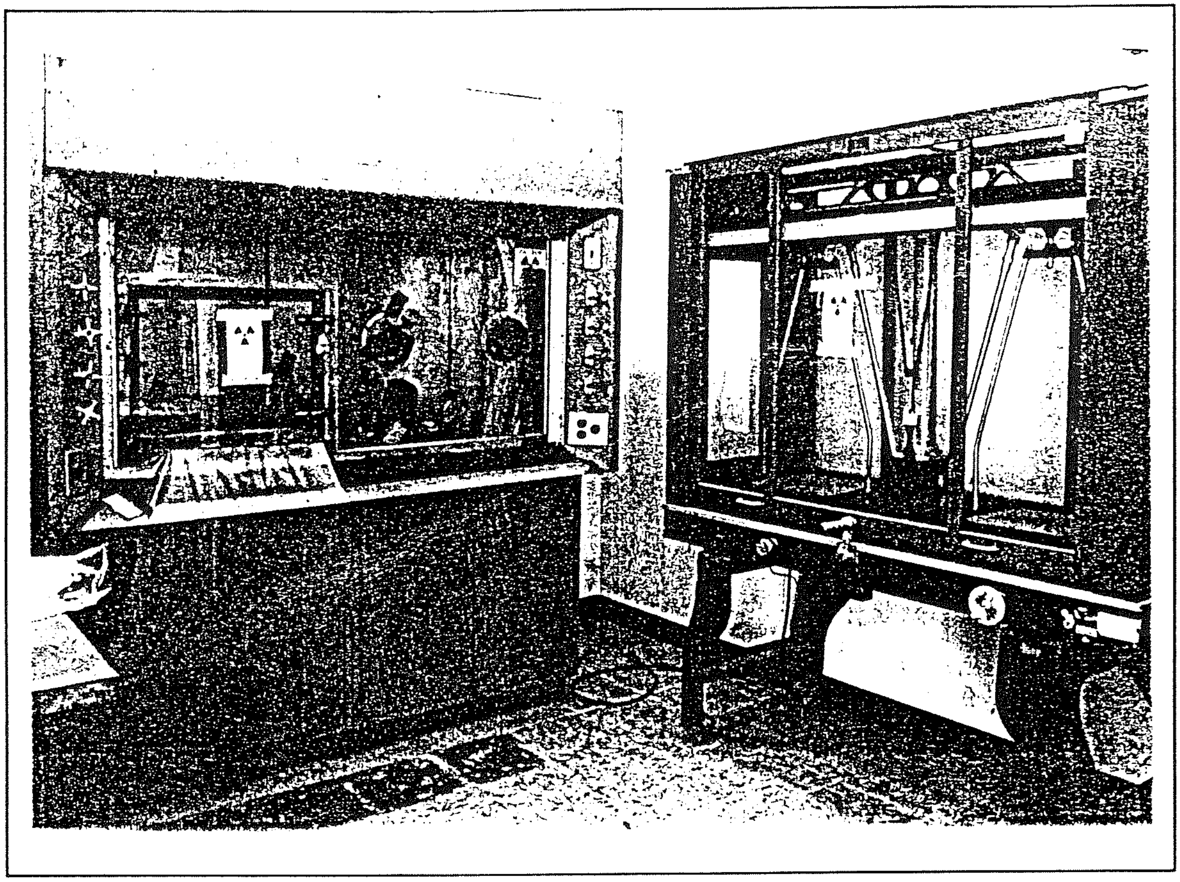
Because of the potential of discovering removable contamination during the D&D, process rooms 110 and 114 were designated as Radioactive Material Management Areas (RMMA). In accordance with the DOE Performance Objectives established for the removal of hazardous materials from a (RMMA) an established procedure for defining and dispositioning hazardous wastes from a RMMA was implemented. This procedure, ER-SP-0001 "Management and Disposition of Known or Potentially Hazardous Wastes Originating in a RMMA," provides step by step direction for determining if a material is; 1) a hazardous material, and 2) if so does it contain any DOE added radioactivity.

Because the facility had been used for storage for a number of years, special attention was given to identifying hazardous or potentially hazardous materials requiring disposition. Two scales were found to contain oil and one also contained lead. A four ounce quantity of oil from one of the scales was determined to contain radioactive contamination and was safely treated during the Molten Salt Oxidation (MSO) Bench Scale Unit tests being performed at the RMDF. The other oil and the lead were certified as "Containing No DOE Added Radioactivity," in accordance with ER-SP-0001 and were disposed of in accordance with the Rocketdyne Environmental Control Manual. The ballasts removed from the light fixtures in room 110 were hermetically sealed units and after a thorough radiological survey were also certified as "Containing No DOE Added Radioactivity" and were disposed of in accordance with the Rocketdyne Environmental Control Manual.

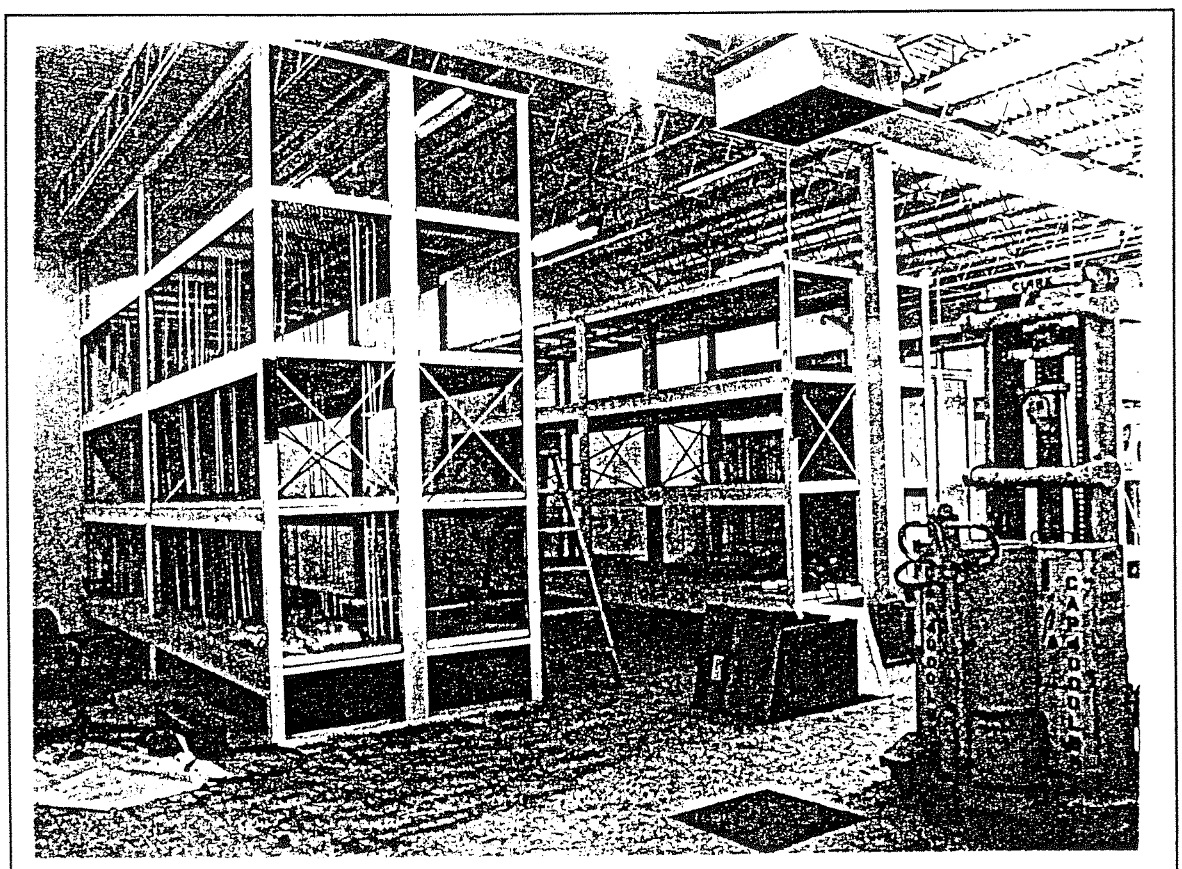
Because the tiles throughout the facility had been determined to contain asbestos and were in a deteriorated state their removal was required. A sampling plan was developed and implemented in accordance with ER-SP-0001. Randomly selected tiles were removed and the tiles and subfloor were surveyed for total contamination. The results of this survey sampling concluded that the tiles and subfloor had No Detectable Activity (NDA) above background, therefore, all tiles were certified as "Containing No DOE Added Radioactivity." An asbestos abatement contractor was employed to remove a total of 4,352 $ft.^2$ of tile (photo #6 & 7). The tile and abatement related ACM wastes have been packaged and placed in an approved hazardous waste container and will be disposed at an approved disposal facility. Copies of certifications were forwarded to the DOE.

REFERENCES

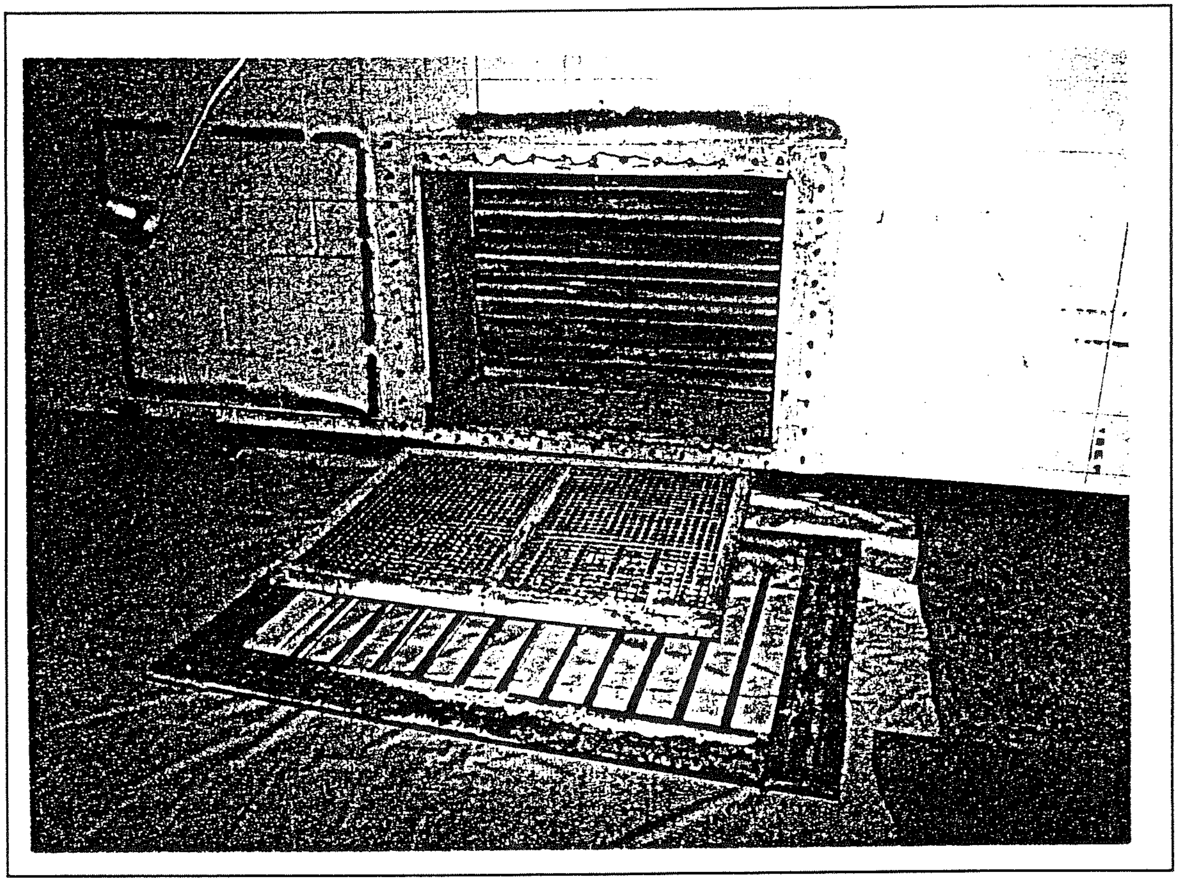
1. GEN-ZR-0005, "Radiological Survey of the Source and Special Nuclear Materials Storage Vault - Building 064"
2. SSWA-SOP-0001, "Building 064 Radiological Survey and sampling"
3. SSWA-SOP-0002, "Building 064 Removal of Contaminated Fixtures and Equipment"
4. SSWA-SOP-0003, "Building 064 Removal of Filter Plenums"
5. SSWA-SOP-0004, "Building 064 Structural Surfaces, Final Cleaning"
6. 064-OI-0002, "Building 064 Floor Tile Sampling Plan"
7. ER-SP-0001, "Management and Disposition of Known or Potentially Hazardous Wastes Originating in a RMMA"
8. Environmental Control Manual, Rocketdyne Publication 572-Z
9. N001SRR140119, "Analysis of Hazardous Wastes for Radioactivity"
10. N7045RR990031, "Final Decontamination and Radiological Survey of the Building 064 Side Yard"
11. SSWA-AN-0001, "D&D Work Plan for Building 064, Environmental Restoration"



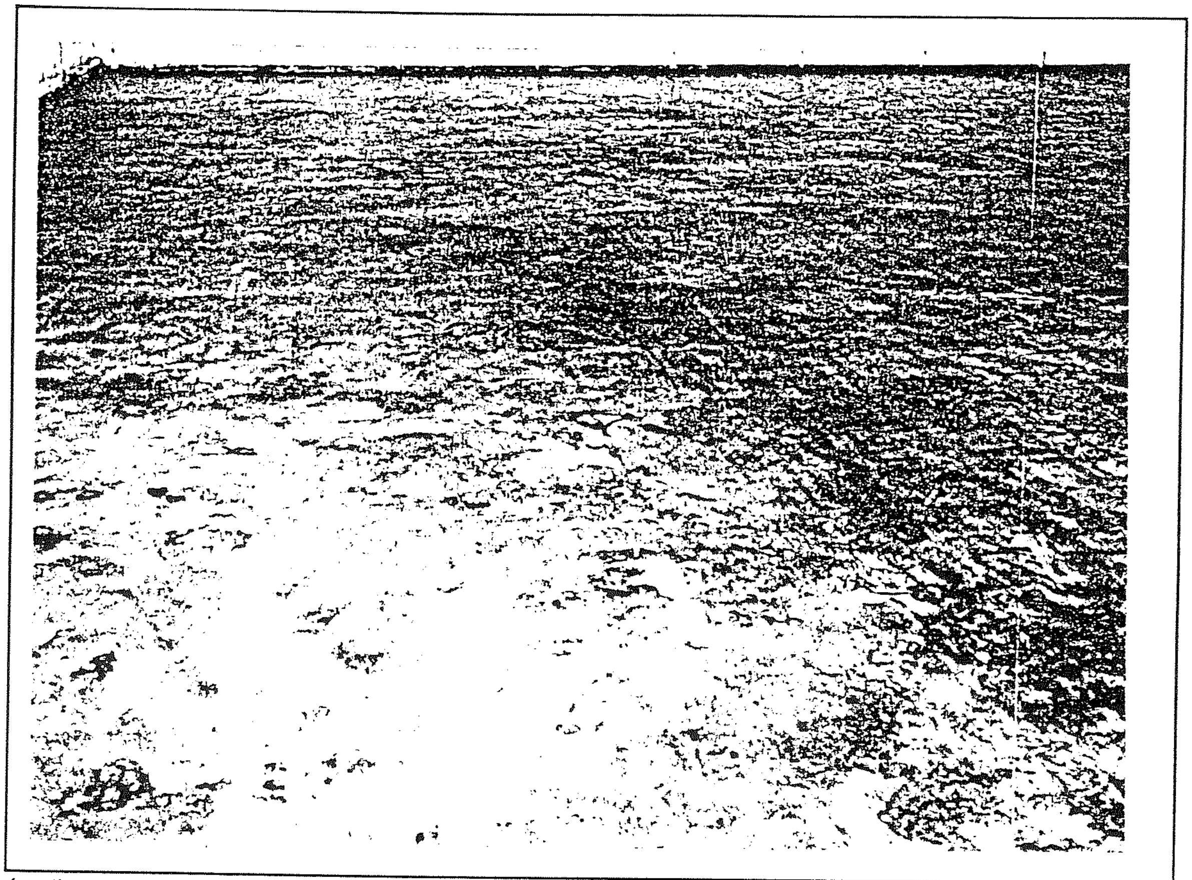
(#1) Room 110, Fume Hood (left) and Voland Balance



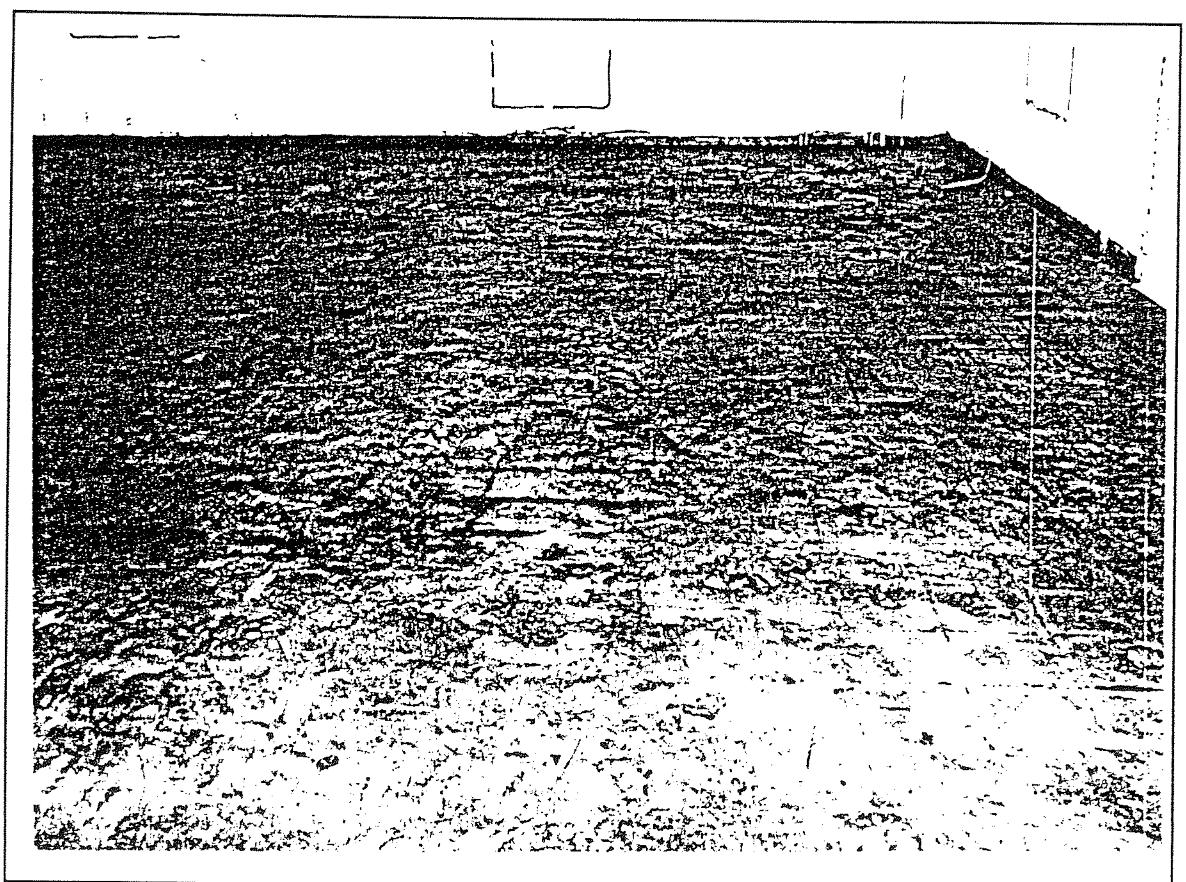
(#2) Room 110, Storage Racks



(#3) HEPA Filtered Exhaust Inlet (Typical Room 110 & 114)



(#6) Room 110, After D&D



(#7) Room 114, After D&D

EXHIBIT V

FINAL DOCUMENTATION AND RADIOLOGICAL SURVEY OF FACILITY 4064 AFTER DECONTAMINATION AND DECOMMISSIONING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	35620	62	62	NEW	RS-00003

Program Title
Closure of ETEC (R21-RF)

Document Title
Area 4064, Final Status Survey Report

Document Type
Final Report

Related Documents

Original Issue Date 3/30/99

Release Date 4-13-99

RELEASE TDC

Prepared By/Date: P. Liddy — P. Liddy 4/2/99

Dept.: 641

Mail/Addr: T487

Approvals		Date
P. Rutherford	[signature]	4/8/99
S. Reeder	[signature]	4/9/99
M. Lee	RD Meyer for M. Lee	4/13/99

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

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Abstract

This Report presents the report of the Final Status Survey of Area 4064 of the Santa Susana Field Laboratory. All radiation exposure measurements and soil sample analyses confirm that the facility meets 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
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Rocketdyne Form 651-F REV. 2-97

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EXECUTIVE SUMMARY

On September 1998, A Final Status Survey was completed in Area 4064 at the Santa Susana Field Laboratory confirming that the facility meets release limits approved by the Department of Energy and the State Department of Health Services. Accordingly, the facility is suitable for release for "unrestricted use".

The 4064 building at the SSFL was decontaminated, surveyed and released; then demolished and shipped off site in 1996. After all soil decontamination efforts were completed, a comprehensive Final Status Survey of the facility concluded in September 1998.

This report presents an extent of information regarding the Final Status Survey. The entire 2-acre lot was surveyed and sampled including a direct qualitative surface gamma scan (100%) for contamination and ambient gamma exposure measurements at 1 meter above the ground at 10-ft by 10-ft grids. Surrounding areas were surveyed. All measurements were tested statistically for compliance within the regulatory acceptable derived concentration guideline limits (DCGLs) of activation products, mixed fission products, and ambient exposure rates.

In soil samples taken after the excavation, the highest Cs-137 activity was 3.1 pCi/g, or 28% of the cleanup standard of the Cs-137 9.2 pCi/g guideline limits. All tests for soil concentrations confirmed that Area 4064 is suitable for release without radiological restrictions and posses no threat to the safety and health of the public.

1.0 BACKGROUND

1.1 LOCATION AND STRUCTURE

Area 4064 is located between 10th street and G Street within Area IV of the Santa Susana Field Laboratory (see Reference 1) on 2 acres of land. Originally Building 4064, a 175-feet by 150-feet facility used for storage existed on the site. The building itself consisted of galvanized steel walls and roof, with various types of internal walls and partitions. There was also a 25-ft by 50-ft loading dock, and parking lot access as shown in Figure 1.

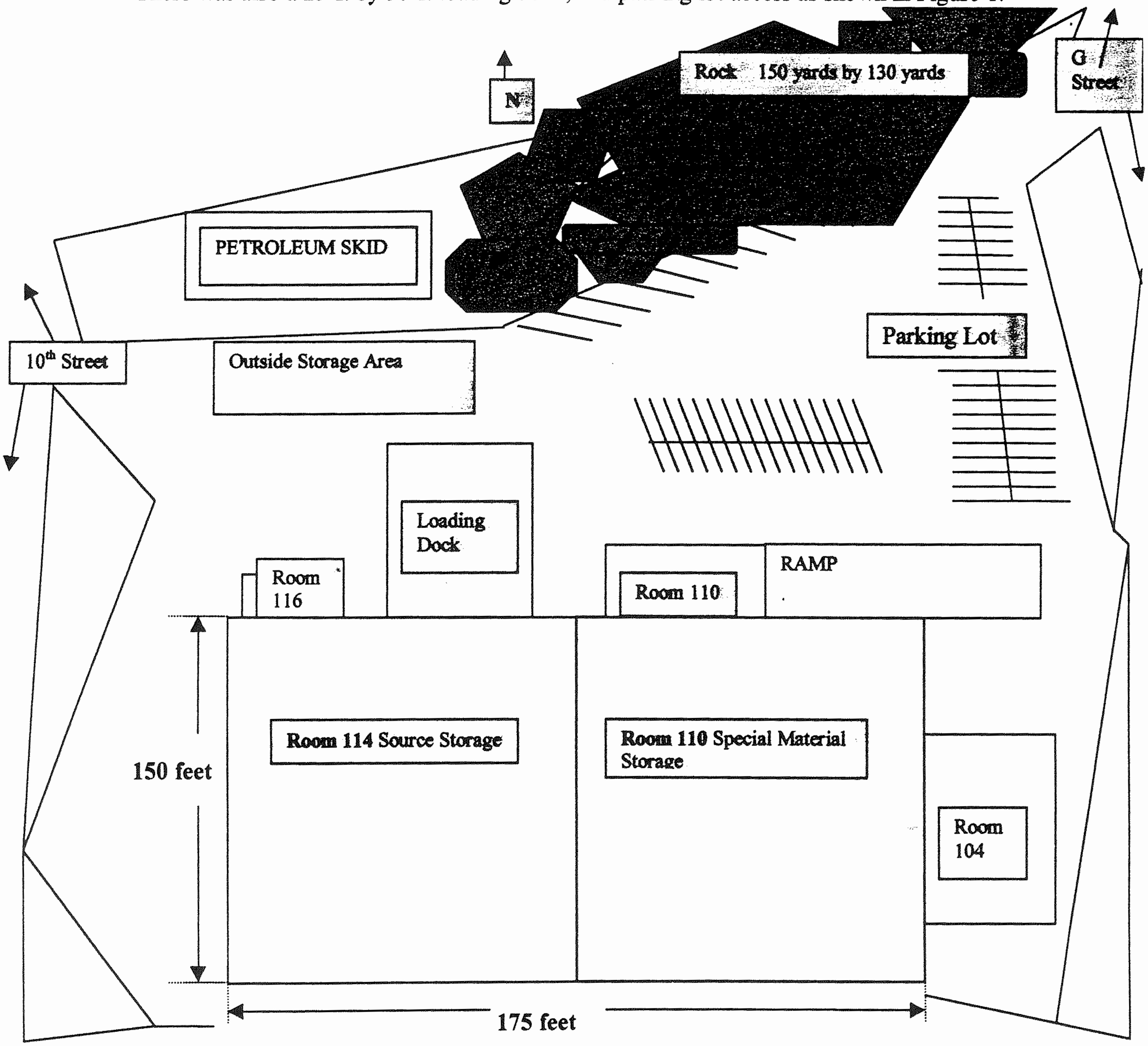


FIGURE 1: LAYOUT OF PRE-EXISTING BUILDING 4064

1.2 OPERATING HISTORY OF BUILDING 4064

Building 4064 was a facility used for the storage of non-irradiated uranium, fuel material, and fuel elements manufactured at the De Soto and Santa Susana Field Laboratories (see Reference 2). Equipment and containers of radioactive material were periodically stored in the building's side yard (see Reference 3). In 1989, operations at the facility were terminated. The building was emptied of all contents (both radioactive and non-radioactive) in 1993. In 1993, the building was decontaminated, the building and fenced yard were then surveyed (see References 7 and 19). In 1994, ORISE performed a verification survey (see Reference 6). In 1996, the building was approved for demolition by the United States Department of Energy (USDOE) (see Reference 8), the State of California Department of Health Services (CSDHS) (see Reference 9), and completely demolished, packaged and shipped off site in 1997.

1.3 RADIOLOGICAL ASSESSMENT OF BUILDING 4064 SIDE YARD

During the Building 4064 operating history, the concrete pad northeast of the building had also been built to store containers of radioactive material. At one time, a cask containing spent nuclear fuel and contaminated water, developed a leak and the side yard northeast of Building 4064 became contaminated with Cs-137.

In 1988, a Characterization Survey was performed (see Reference 3) which confirmed the location of contaminated soil. Remedial excavation was performed to remove the contaminated soil. A subsequent survey comprising of one meter (grided) exposure measurements and soil sampling was documented in 1990 (see Reference 4). A follow-up verification survey was performed by ORISE in 1992, and documented in October, 1993 (see Reference 5). Further excavation was performed in two locations in 1993, following imposition of more stringent clean-up standards by the Department of Energy, and documented in (see Reference 20).

During the Area IV Survey in 1994 through 1995 (see Reference 21), two locations, one in the original side yard and one located across the "G" Street road were identified as remaining above release limits. These areas were excavated in 1997 including the removal of an abandoned septic tank and leach field that had serviced Building 4064. Scoping surveys and soil samples conducted after excavation proved the 4064 area beneath the previous building foundations, and surrounding yard areas were below release limits.

In May 1998, core sampling and soil sampling were performed under the main access road, "G" street, and a 50-yard diameter area around "G" street. The soil sampling results proved free of radioactive contamination (see Reference 10 and Appendix C).

In September 1998, the Final Status Survey was conducted in the entire 2 acres of area 4064, including drainage pathways, former parking lot areas, surrounding areas, and the side yard area (see Reference 11). The soil sampling results were documented in Reference 12, which is provided in Appendix B.

This report, (R21-RF) RS-00003, documents the results of the Final Status Survey and results of sampling performed in September 1998; including the results of the core sampling performed in May 1998 .

2.0 SURVEY PREPARATION

2.1 Identifying Survey Units

In preparation for the Final Status Survey, it was necessary to use the geodetic land survey maps drawn by the State of California Geodetic Agency in 1983. Wood or plastic stake markers (bench marks) on a grid map of two hundred feet by two hundred feet square (200-ft x 200-ft) land sectors were established throughout SSFL by geodetic surveys.

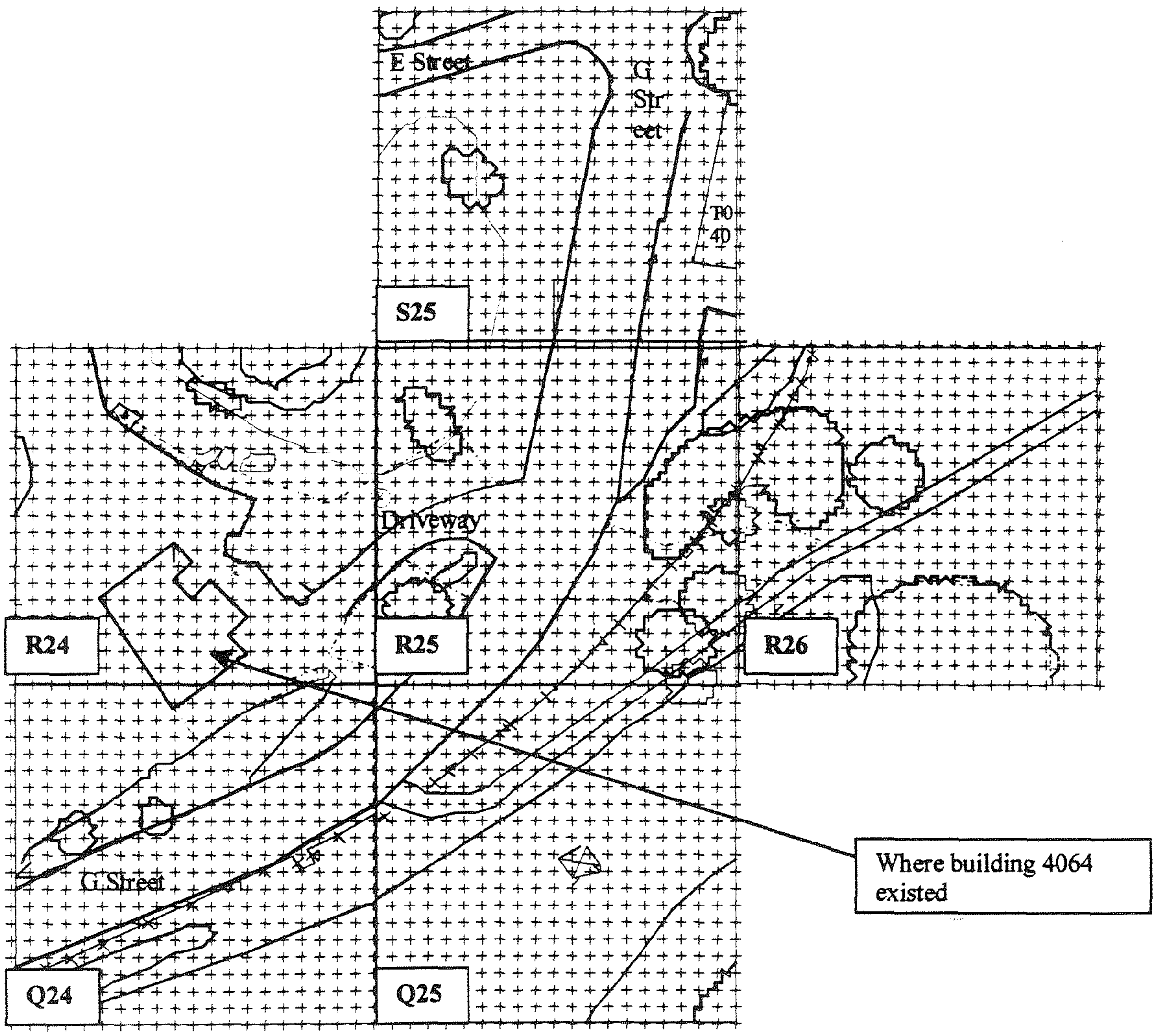


FIGURE 2: AREA 4064 GEODETIC SURVEY GRID LOCATIONS

Locations within each grid block were identified (described below) using block R-24 as an example. The survey team laid a measuring tape between two grid stake markers from R-24 to R-25. This line depicted a south boundary line of the block being surveyed. A second tape was placed at the R-24 to S-24 stakes to establish the west boundary line of the survey block (see Figure 3). The survey team then laid a third measuring tape from R-25 to S-25 to form the east boundary line. This action located the boundary of a 200-ft x 200-ft. square ***survey block***. Figure 3 shows a concept of the method used. The location of the survey points within the *survey block* were described in terms of rectangular distance coordinates of feet north and feet east from the southwest corner of the grid block to the survey location.

Within this *survey block*, the radiological survey measurements were made at 10-ft intervals of north/south, and east/west grid lines superimposed upon the grid. At each survey location, one-minute gamma dose rates were measured a 1-meter height from the ground.

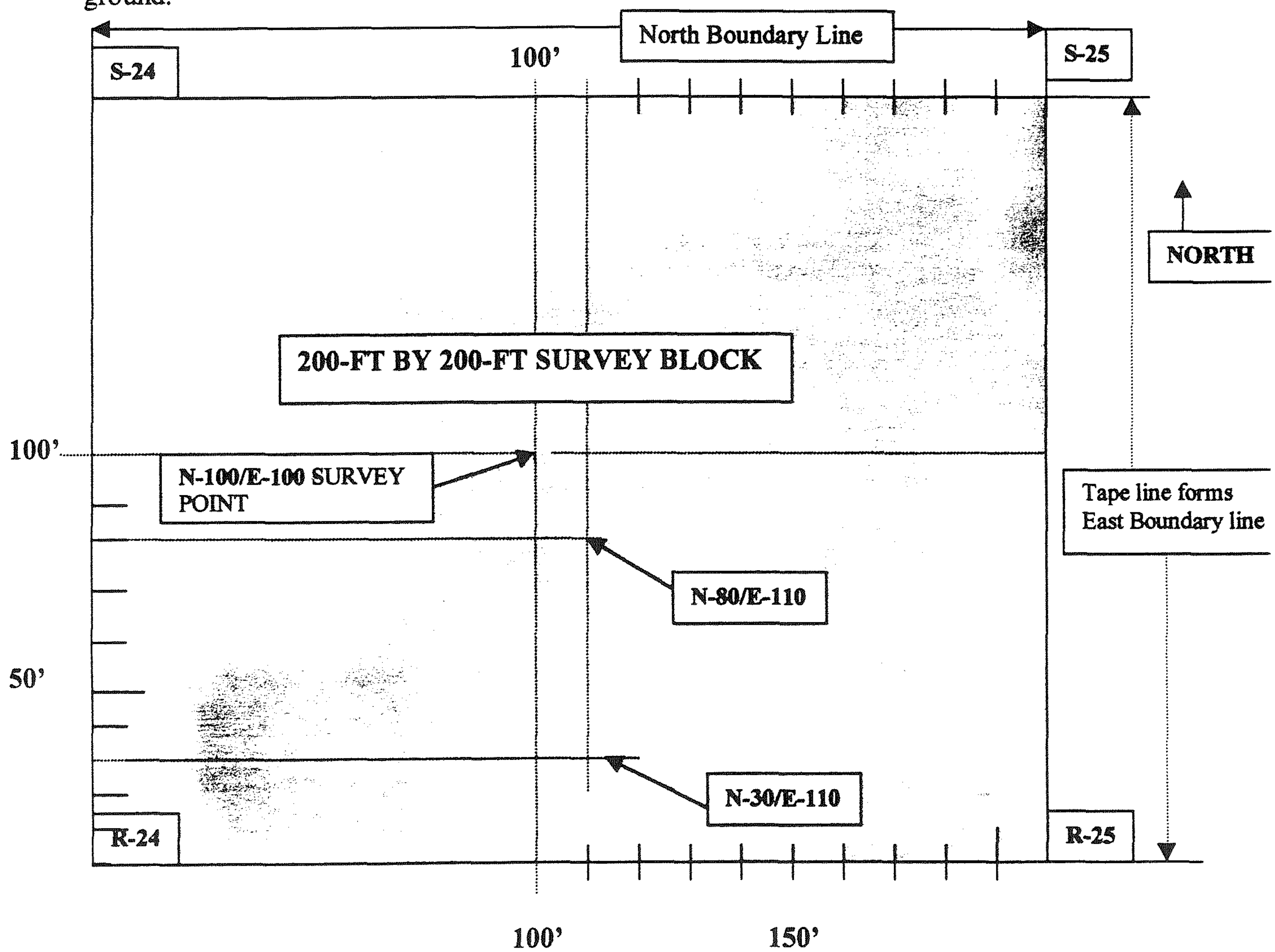


FIGURE 3: EXAMPLE OF BOUNDARY LINES AND RECTANGULAR DISTANCE COORDINANTS WITHIN A SURVEY BLOCK

2.2 Sampling Locations

The gamma activity of any hot spot located was measured at the ground surface and at a 1- meter height above the ground. If the ambient gamma activity at any potential hot spot was greater than 4040cpm (equivalent to 5μR/hr) over the normal background, measured at a 1-meter, or gamma peaks greater than 4100cpm, measured at the surface, then the location of that activity peak was marked. The coordinates were recorded using the measuring tape method described above. All hot spot data was entered on a Walk-about Survey Hot Spot Data Record. If an indicated hot spot prompted a marker during the ambient gamma survey, the HP noted this fact on the "Hot-Spot" Data Record for that survey block.

As the walk-about survey of ground surface gamma activity was an active search for "hot spots" or peaks in the gamma count-rate, wire stakes with colored flags were used to mark hot spots and coordinates. An iridescent pink hot spot flag marked any location where a local peak in gamma activity occurred. Locations where these flags were used were considered radiological suspect locations that required soil sampling and analysis.

2.3 Sample Collection

Several sampling locations were identified during the gamma survey that had elevated exposure levels. Soil samples were taken at these locations. The "hot spot" soil samples were in addition to a set of 133 surface samples taken at regular 25-ft intervals over the entire 4064 and surrounding area including south of "G" Street. (Refer to map in Appendix B). The location of the soil samples were centered around Building 4064, it's side yard and south of G street. In addition, soil samples were taken down the slope of 4064 to ensure that migration of contamination had not occurred. Areas with indications of contamination were investigated further to determine the need for additional remediation. Soil was collected into half-liter, maranelli beakers, labeled with a sample identifier, 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.

The soil sample information was provided for each sample obtained, entered in the Field Logbook, and tracked by Chain of Custody by the Health Physics technician listed as follows:

- Bag Number
- Sample Location
- Sample Depth
- Sample Date
- Sample Personnel
- Sample Description
- Location/Soil Observation - recorded observations and information pertinent to the interpretation of results of the soil sample analyses (e.g. soil coloration, presence of foreign objects nearby, proximity to Geological features, etc.).

2.4 Survey Instrumentation and Techniques

Ambient Gamma Survey

To accurately obtain 1-meter survey measurements in the ambient gamma survey, the Ludlum Model 2221-ESG Scalar/Rate meter was used, with a Model 44-2 sodium iodide detector probe mounted on a lightweight PVC fixture tripod oriented towards the ground at a 1-meter height. Its use eliminated errors due to detector distance or orientation.

Walk-about Survey

The Ludlum Model 44-2 High-Energy Gamma, sodium iodide detector probe was also mounted at the end of a balanced boom, to enable the surveyor to sweep the detector over a large area while walking along the survey path. The fixture for this survey has a length of stainless steel tubing for the boom, with a bracket at one end to hold the detector upright to the ground, and a counterbalance weight at the other end, with a shoulder strap attached to the balance point of the fixture. The arrangement allowed the surveyor to sweep the detector over an area about 5 feet wide while stepping along a straight line.

2.5 Calibration and Checks

The gamma survey instruments are calibrated quarterly and measurement integrity of the instruments were monitored throughout all parts of gamma surveys by daily checks of the instrument's response to normal background radiation and to the Cs-137 check source. The conversion factor used was 215 cpm per mR/hr, based on comparisons with a Reuter-Stokes High Pressure Ion Chamber (HPIC). The daily records of Instrument Qualification Reports are maintained in Building 4487.

2.6 Detection

The principal contaminant of concern in the soil at Area 4064 has been Cs-137 as documented in References 4 and 5. Although other radionuclides including Uranium, Thorium, Plutonium, Strontium-90, Cobalt-60, Europium-152 and Europium154 had been stored in Building 4064, none of these isotopes had been found in the soil, without the accompanying presence of Cs-137. Cesium was therefore used as a tracer for all potential contaminants and MDCs for the scanning portion of the survey based on Cs-137 detectability.

The $DCGL_W$ for Cs-137 in soil is 9.2 pCi/g above background. Background Cs-137 in the vicinity of the site has an upper range of 0.2 to 0.8 pCi/ which is sufficiently less than the $DCGL_W$ that gross (not net or background subtracted) Cs-137 data is used.

3.0 SOIL RELEASE LIMITS

Acceptable contamination limits for releasing Area 4064 for unrestricted use are described in Table 1.

Radionuclide	Soil Guidelines (pCi/g)
Am-241	5.44
Co-60	1.94
Cs-134	3.33
Cs-137	9.20
Eu-152	4.51
Eu-154	4.11
Fe-55	629,000
H-3	31,900
K-40	27.6
Mn-54	6.11
Na-22	2.31
Ni-59	151,000
Ni-63	55,300
Pu-238	37.2
Pu-239	33.9
Pu-240	33.9
Pu-241	230
Pu-242	35.5
Ra-226	5 and 15
Sr-90	36.0
Th-228	5 and 15
Th-232	5 and 15
U-234	30
U-235	30
U-238	35

TABLE 1: SOIL GUIDELINE RELEASE LIMITS

4.0 DATA ANALYSIS

4.1 Ambient Gamma Analysis

The Final Status Survey had to confirm that Area 4064 and surrounding areas 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 13). A statistical procedure was used to validate the applicability of the raw Ambient 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 (see Reference 14).

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:

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

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, 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.

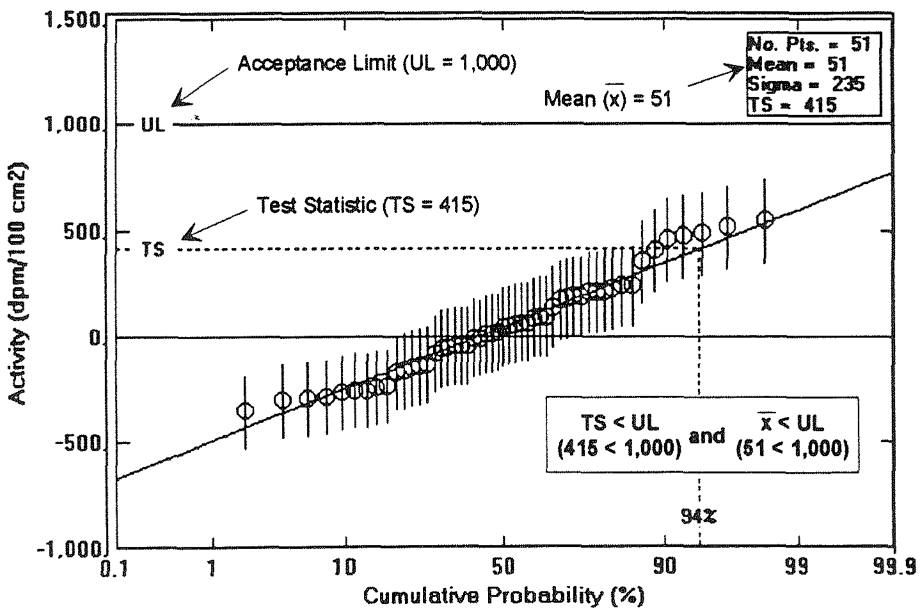
Assigning values for LTPD and β, and given the sample size ***n***, a value for ***k*** can be calculated as follows:

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

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 b,
n = number of samples.

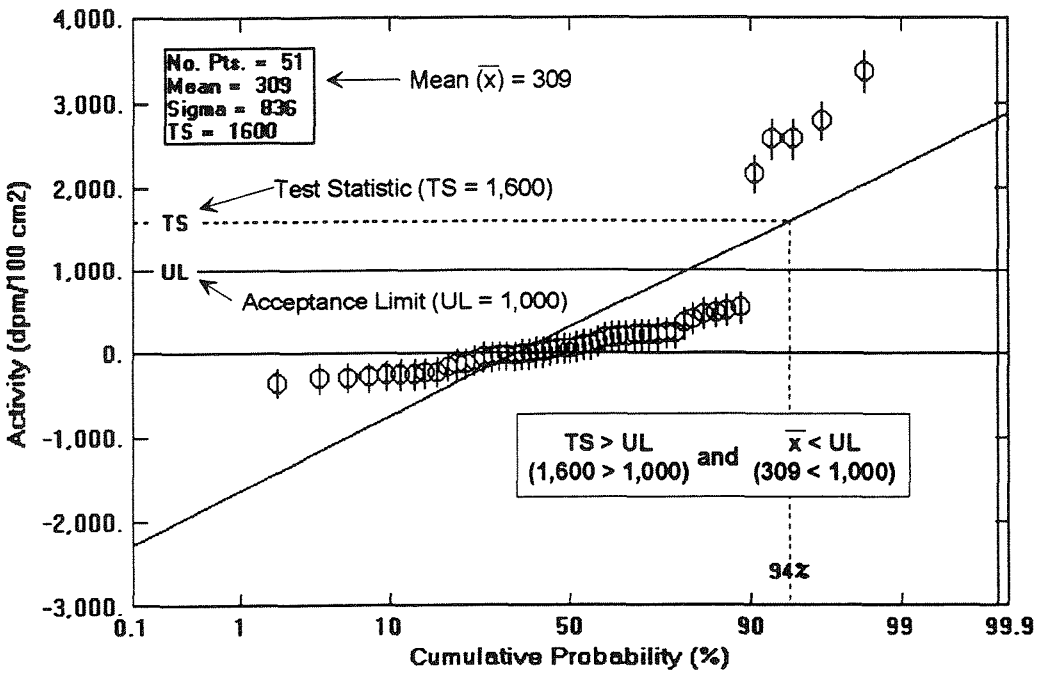
Depending on the data collected, the statistical test may result in one of three conclusions illustrated below:

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.



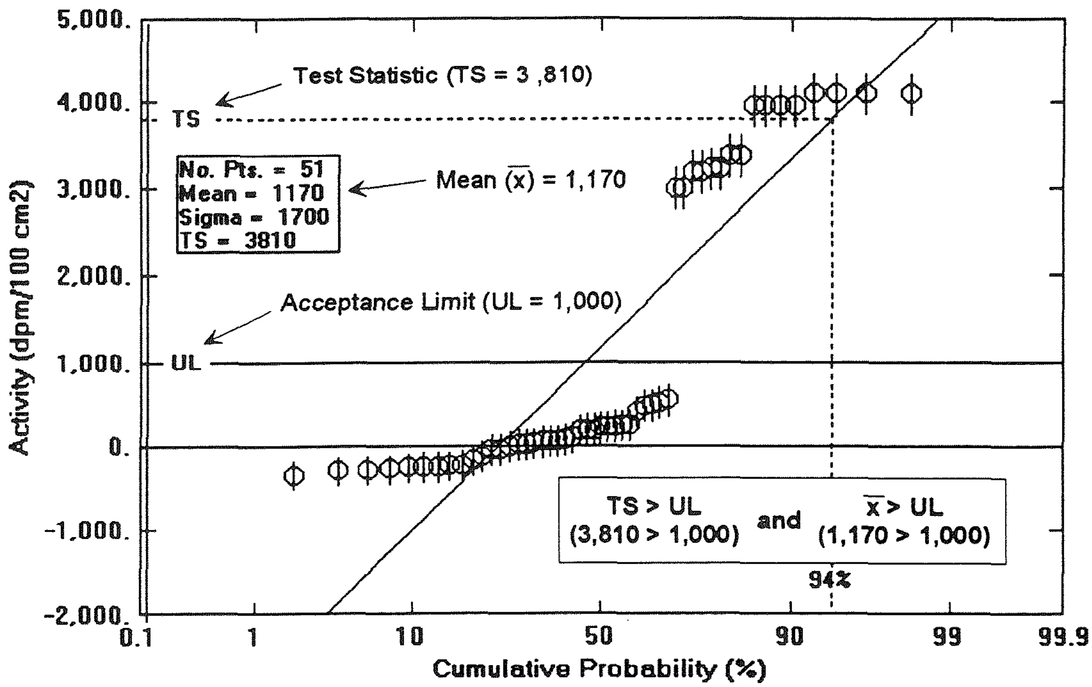
GRAPH A: EXAMPLE OF SAMPLE LOT ACCEPTANCE, WHERE TS (=$\bar{x} + k \cdot s$) ≤ UL and $\bar{x}$ ≤ UL

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 Area 4064 ambient gamma 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 in the example is more conservative than the 10% LTPD Consumer Risk (see Reference 15) used by the USNRC [Regulatory Guide 6.6], and State of California (see Reference 16).

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. 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. This is referred to as the (95/95/100) test (see Reference 14).

Ambient gamma counts were tested against the acceptance criteria for gamma radiation. Measurements for the survey were taken over the period from 8/5/98 through 9/5/98, based on entries from the D&D logbook from Area 4064. Raw data measurements were adjusted for daily instrument background and statistically tested using the Cumplot method. Data was plotted on a cumulative probability graph (Refer to Appendix A). The more linear the data, the closer it approached normal distribution. The test statistic ($TS = \bar{x} + k \cdot s$) was calculated and applicable exposure acceptance limits were compared.

4.2 Soil Collection and Analysis

The minimum number of samples collected was determined through statistical analysis using the following equation from *The Hazardous Waste Consultant November/December 1992*:

$$n = t_\alpha^2 CV^2 / p^2$$

where:

n = number of samples

t_α = two tailed t-value at an α level of significance and (n-1) degrees of freedom (obtained from standard statistical tables) = approximately 1.99 for 95% confidence level

CV = coefficient of variation = 95%

p = allowable margin of error = 20% (suggested by *Mason, Benjamin J., Preparation of Soil Sampling Protocol: Techniques and Strategies, EPA-600/4-83-020, August 1983*)

Using the above equation and assumptions, the *minimum* number of soil samples is 90 regardless of area size. More sampling locations were added based on past history practice and further ambient or walkabout survey results. A total of one hundred thirty three (133) grid systematic soil samples were taken in addition to six samples at hot spot areas identified by exposure measurement.

5.0 SURVEY RESULTS

5.1 Subsurface Core Sampling

In April 1998, fifty-two (52) subsurface core samples were obtained from Area 4064 and analyzed. No contamination was found. The results are presented in Appendix C.

5.2 Ambient Gamma Measurements

Prior to the systematic soil sampling, five-hundred fifty three (553) ambient gamma survey points were taken from sectors R-24, R-25, R-26, Q-24, Q-25: wherever Area 4064 was located in those sectors. The ambient gamma background corrected measurements ranged from 0.1 μR/hr to 6.2 μR/hr (see Appendix A) with four potential hot spots shown in Table 2 below, which exceeded 5μR/hr. The potential hot spots required further analysis.

AMBIENT GAMMA MEASUREMENTS		COUNTS/MIN	
Location	GRID SECTOR	**Exposure Rate (minus background)**	**1" NaI Probe @ 1 meter**
N130/E130	R-24	6.2 μR/hr	4239
N140/E130	R-24	5.9 μR/hr	4187
N150/E130	R-24	5.3 μR/hr	4051
N110/E180	R-24	5.1 μR/hr	3876

TABLE 2: AMBIENT GAMMA MEASUREMENTS (CORRECTED) FOR POTENTIAL HOT SPOTS

The statistical analysis of the highest ambient gamma measurements (>5.0 μR/hr) or hot spots revealed a slight deviation from normal distribution (Refer to Appendix A). Soil samples were subsequently taken from these locations and measured in a one-minute count using a 3"x3" NaI probe attached to a multi-channel analyzer (MCA). During the one-minute survey, each sample was placed in a half cylindrical lead pig with the NaI probe pointing down at the sample. All the samples were cooled to room temperature before conducting the radiation survey. The results of the NaI screening are shown in Table 3 (Table 1 of Appendix B: samples 064-98-0199 through 064-98-0202).

LOCATION	BAG NO. 064-98-	GRID SECTOR	SAMPLE DEPTH	3" NaI PROBE CTS/MIN
N130/E130	0199	R-24	<0.5 FEET	9095
N140/E130	0200	R-24	<0.5 FEET	9534
N150/E130	0201	R-24	<0.5 FEET	9188
N110/E180	0202	R-24	<0.5 FEET	8579

TABLE 3: GAMMA EXPOSURE MEASUREMENTS OF SOIL SAMPLES

Since each screening result is less than the mean value of all the samples screened, (see Appendix B) it can be concluded that all four ambient gamma samples in Table 5 were less then the cleanup level of 9.2 pCi/g. The high ambient gamma measurements at these locations were likely due to the nearby large rocks which have higher naturally occuring Thorium content than alluvial soil.

5.3 Ambient Gamma Test Statistic Results

The survey data results, shown in Figure A2 of Appendix A, demonstrates for the acceptance limit (UL), the corresponding test statistic (TS) value is less than the upper limit UL, (TS < UL). Therefore, the ambient measurements (lot) pass the "sampling inspection by variables" test and are "accepted" as radiologically clean. The Area 4064 background-subtracted gamma exposure corresponds with a 95% confidence that 95% of the ambient gamma measurements are below 100% (a 95/95/100 test) of the applicable DOE and State of California approved limit for radiation exposure shown in Table 4.

Criteria	Exposure Rates
Acceptance Limit (UL)	5 μR/h
Corrected Ambient Gamma Measurements (TS)	4 μR/h

TABLE 4: COMPARATIVE ACCEPTANCE LIMITS

5.4 Soil Sample Analysis Results

Appendix B shows the results of the systematic and "hot spot" soil sampling. A total of 133 soil samples were taken as shown in Appendix B, Figure 1. Three areas of slightly elevated Cs-137 levels were identified in Appendix B, Table 3. Cesium 137 levels were above background, but below the release limit for 9.2 pCi/gm. However, these locations were excavated to reduce Cs-137 levels even further. The highest post-excavation Cs-137 measured in the locations was 1.3 pCi/gm (14% of the clean-up standard of 9.2 pCi/gm).

5.5 ORISE Sample and Remediation

During the subsequent ORISE verification survey in September 1998, only one hot spot was discovered. The sloping area to the southwest of the Area 4064 parking lot, shown in Figure 4, revealed a hot spot at sector R-23, location N8/E114 with Cs-137 in the range of 7 to 5100 pCi/gm. This was immediately remediated and post-excavation soil samples were obtained. The post-excavation soil samples found a maximum of 3.1 pCi/gm of Cs-137 well below the clean-up standard of 9.2 pCi/gm.

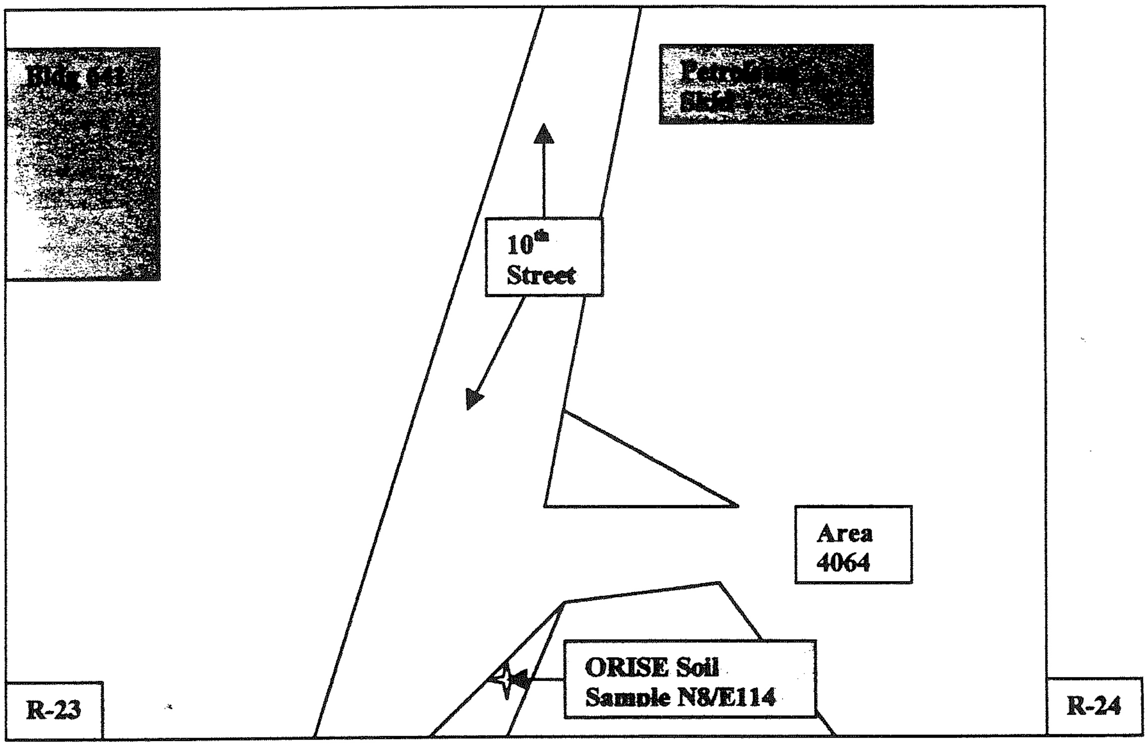


FIGURE 4: ORISE SOIL SAMPLE LOCATION

6.0 CONCLUSION

The test statistic for the distribution of the background-subtracted gamma exposure rate is 4.1 μR/hr, which is below the acceptance limit of 5μR/hr.

The [post-remediation] soil samples indicate that the Cs-137 contamination, historically observed at Area 4064, has been remediated and is now below the clean-up standard of 9.2 pCi/gm. Most samples indicated no Cs-137, while a small number of samples showed trace levels of Cs-137 above background levels with a maximum level of 3.1 pCi/gm.

All soil sample and radiation exposure measurements are below the Department of Energy's and California Department of Health Services' approved release limits. The 4064 area, including surrounding areas, is suitable for release for unrestricted use.

7.0 References

1. Aero Tech Surveys, Inc., Riverside, Ca, Map 197997000, Page 8 of 30, 10-8-92.

2. N001ER000017, ETEC Document, "Nuclear Operations at Rockwell's Santa susana Field Laboratory-A Factual Perspective", Rev C, R. Oldenkamp, September 16, 1991.

3. GEN-ZR-0005, ETEC Report, "Radiological Survey of the Source & Special Nuclear Material Storage Vault-Building T064" J. Chapman, July 1988.

4. N704SRR990031, "Final Decontamination and Radiological Survey of the Building T064 Side Yard", Safety Review Report, B. Oliver, October 1990.

5. ORISE Report 93/J-107, "Verification Survey of the Old Conservation Yard, Building T064 Sideyard, Building T028, SSFL, Rockwell International Canoga Park, CA, October 1993.

6. ORISE Report 94-K14, "Verification Surveys of Buildings 005, 023 and 064, Santa Susana Field Laboratories, Rockwell International, Ventura County, California, October 1994.

7. SSWA-ZR-0001, ETEC Document, "Final Radiological Report of Building 064 Interior", January 1994.

8. DRF0322, Letter from the Department of Energy, "Demolition of Building 064", M. Lopez, June 1996.

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10. SHEA-05099 "Building 4064 Sideyard and "G" Street Core Drilling Sample Analysis" Memorandum, F. Dahl, May 1998.

11. 064-SP-0002 Rocketdyne Procedure, "Area 4064 Final Survey Plan", August 1998.

12. SHEA-16228, Rev 1, "Soil Sampling Results for Building 4064 Area At SSFL", J. Shao, September 1998.

13. Cumplot, Rocketdyne Proprietary Statistical Program.

7.0 References Continued.....

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

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

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

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

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

19. N704SRR990035, "Radiological Assessment of the Building T064 Fenced-in Yard", January 12, 1994.

20. N704SRR990031"Final Decontamination and Radiological Survey of the Building T064 Side Yard", Rev. A, September 1993.

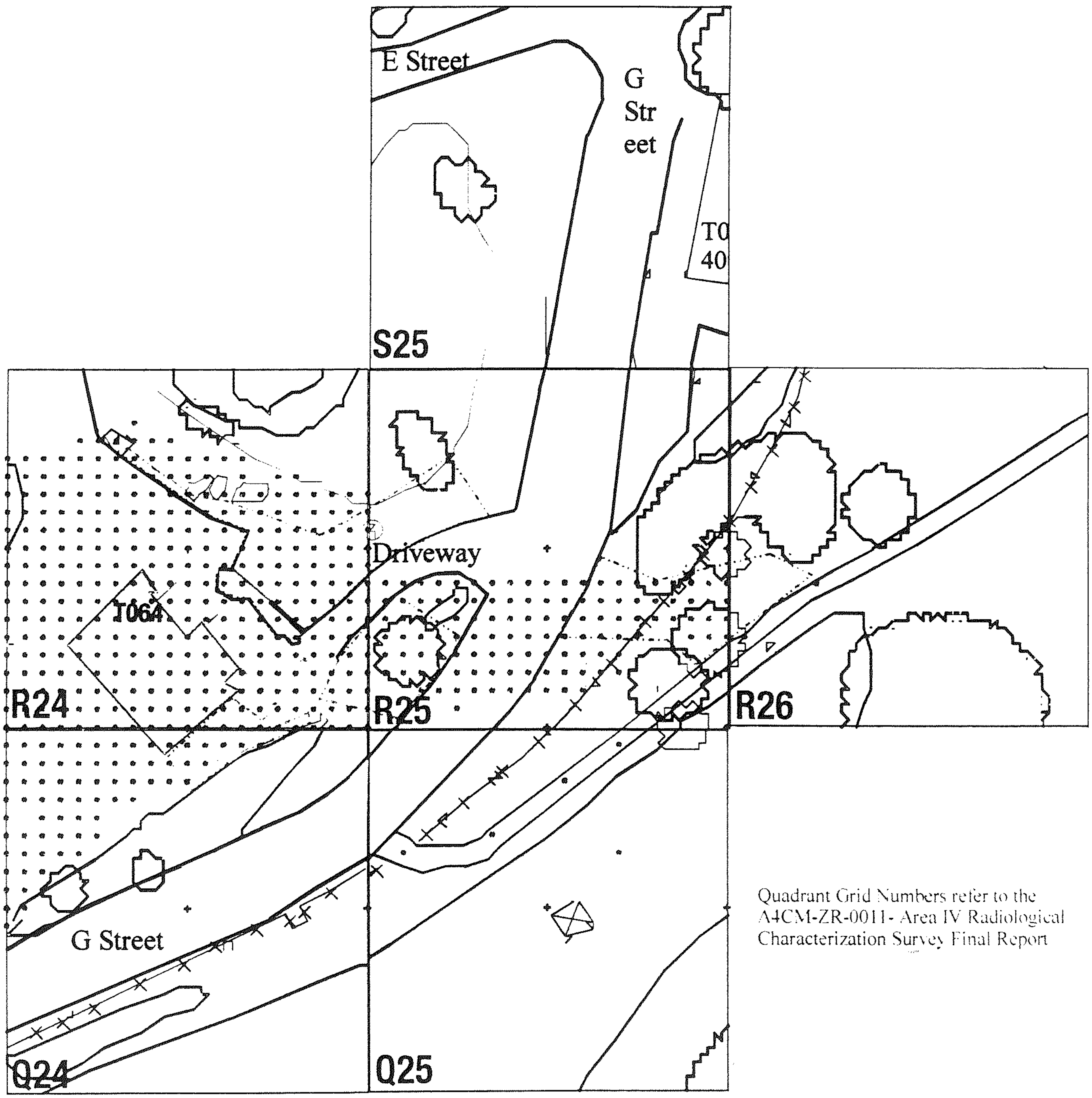
21. A4CM-2R-0011, "Area IV Radiological Characterization Survey", Rev. A, August 15, 1996.

8.0 APPENDICES

Appendix A

AMBIENT GAMMA SURVEY RESULTS

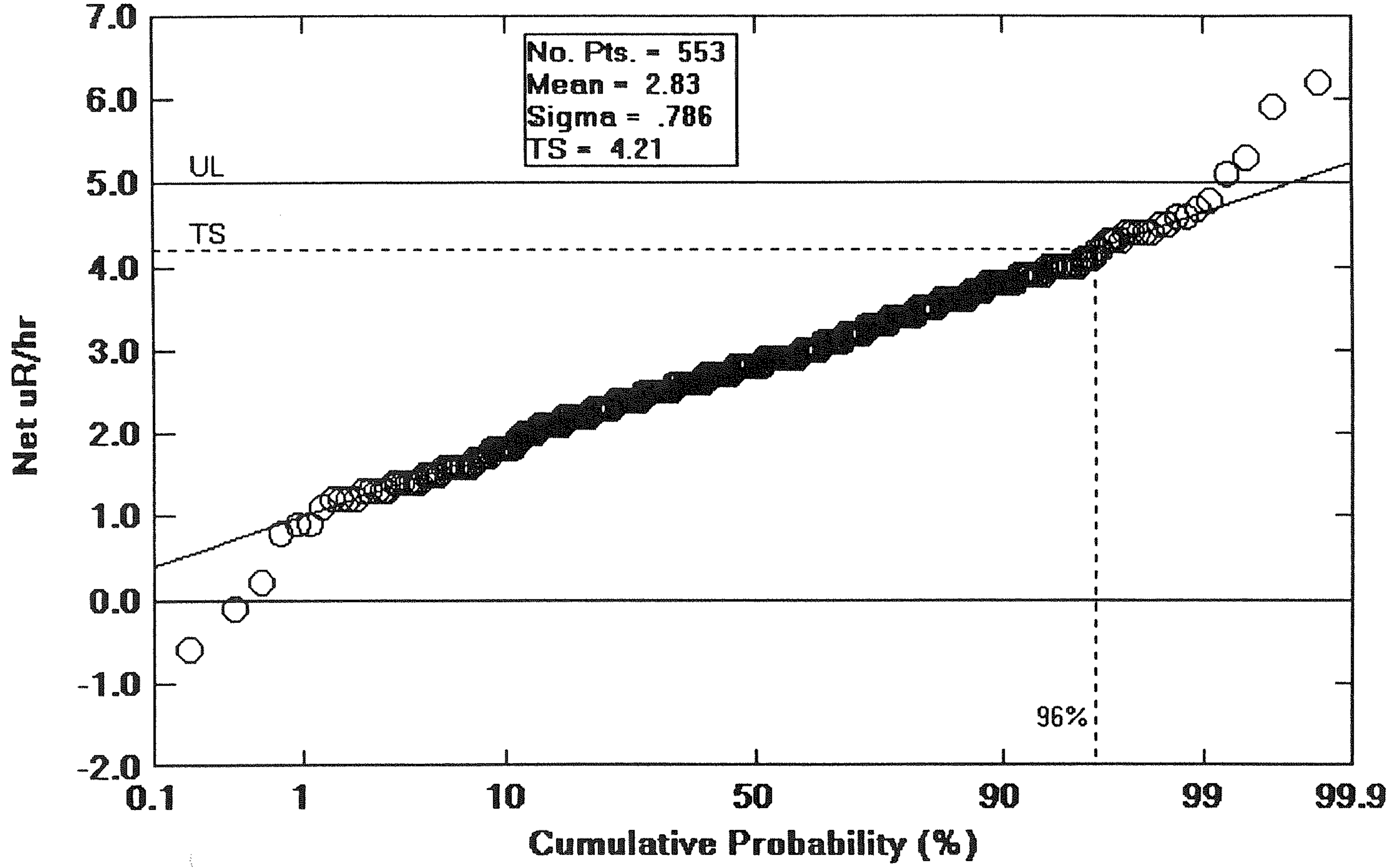
Figure A1: 4064 Sideyard and "G" Street Area Ambient Gamma Survey Locations



Quadrant Grid Numbers refer to the A4CM-ZR-0011- Area IV Radiological Characterization Survey Final Report

2-03-99
t064amb.dsf

Figure A2: Ambient Gamma Measurements (Area 4064)



C:\MYDOCU~1\EXCEL\GAM_QAN.CSV 03-04-99

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

AFFECTED AREA

GRID Q24

		COUNT DATA Counts Gross	Bkgd	Time (Min)	RESULT DATA Result	MDA	Limit	Result Units
N100 E0	08/03/1998	3479.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N100 E10	08/03/1998	3438.0	2744.5	1.0	3.2	0.60	5.0	uR/hr [net]
N110 E0	08/03/1998	3572.0	2744.5	1.0	3.8	0.60	5.0	uR/hr [net]
N110 E10	08/03/1998	3564.0	2744.5	1.0	3.8	0.60	5.0	uR/hr [net]
N110 E20	08/03/1998	3495.0	2744.5	1.0	3.5	0.60	5.0	uR/hr [net]
N120 E0	08/03/1998	3670.0	2744.5	1.0	4.3	0.60	5.0	uR/hr [net]
N120 E10	08/03/1998	3572.0	2744.5	1.0	3.8	0.60	5.0	uR/hr [net]
N120 E20	08/03/1998	3507.0	2744.5	1.0	3.5	0.60	5.0	uR/hr [net]
N130 E0	08/03/1998	3553.0	2744.5	1.0	3.8	0.60	5.0	uR/hr [net]
N130 E10	08/03/1998	3508.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N130 E20	08/03/1998	3467.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N130 E30	08/03/1998	3453.0	2744.5	1.0	3.3	0.60	5.0	uR/hr [net]
N130 E40	08/03/1998	3481.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N140 E0	08/03/1998	3517.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N140 E10	08/03/1998	3547.0	2744.5	1.0	3.7	0.60	5.0	uR/hr [net]
N140 E20	08/03/1998	3443.0	2744.5	1.0	3.2	0.60	5.0	uR/hr [net]
N140 E30	08/03/1998	3479.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N140 E40	08/03/1998	3377.0	2744.5	1.0	2.9	0.60	5.0	uR/hr [net]
N140 E50	08/03/1998	3370.0	2744.5	1.0	2.9	0.60	5.0	uR/hr [net]
N150 E0	08/03/1998	3481.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N150 E20	08/03/1998	3541.0	2744.5	1.0	3.7	0.60	5.0	uR/hr [net]
N150 E30	08/03/1998	3495.0	2744.5	1.0	3.5	0.60	5.0	uR/hr [net]
N150 E40	08/03/1998	3443.0	2744.5	1.0	3.2	0.60	5.0	uR/hr [net]
N150 E50	08/03/1998	3528.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N160 E0	08/03/1998	3259.0	2744.5	1.0	2.4	0.60	5.0	uR/hr [net]
N160 E10	08/03/1998	3454.0	2744.5	1.0	3.3	0.60	5.0	uR/hr [net]
N160 E20	08/03/1998	3526.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N160 E30	08/03/1998	3522.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N160 E40	08/03/1998	3527.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]
N160 E50	08/03/1998	3465.0	2744.5	1.0	3.4	0.60	5.0	uR/hr [net]
N160 E60	08/03/1998	3510.0	2744.5	1.0	3.6	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA Counts Gross	Bkgd	Time (Min)	RESULT DATA Result	MDA	Limit	Result Units
N190 E60	08/04/1998	3322.0	2807.0	1.0	2.4	0.60	5.0	uR/hr [net]
N190 E70	08/04/1998	3313.0	2807.0	1.0	2.4	0.60	5.0	uR/hr [net]
N190 E80	08/04/1998	3422.0	2807.0	1.0	2.9	0.60	5.0	uR/hr [net]
N190 E90	08/04/1998	3310.0	2807.0	1.0	2.3	0.60	5.0	uR/hr [net]
N200 E0	08/04/1998	3443,0	2807.0	1.0	3.0	0.60	5.0	uR/hr [net]
N200 E10	08/04/1998	3327.0	2807.0	1.0	2.4	0.60	5.0	uR/hr [net]
N200 E100	08/04/1998	3310.0	2807.0	1.0	2.3	0.60	5.0	uR/hr [net]
N200 E110	08/04/1998	3254.0	2807.0	1.0	2.1	0.60	5.0	uR/hr [net]
N200 E120	08/04/1998	3309.0	2807.0	1.0	2.3	0.60	5.0	uR/hr [net]
N200 E130	08/04/1998	3388.0	2807.0	1.0	2.7	0.60	5.0	uR/hr [net]
N200 E140	08/04/1998	3454.0	2807.0	1.0	3.0	0.60	5.0	uR/hr [net]
N200 E150	08/04/1998	3415.0	2807.0	1.0	2.8	0.60	5.0	uR/hr [net]
N200 E160	08/04/1998	3436.0	2807.0	1.0	2.9	0.60	5.0	uR/hr [net]
N200 E170	08/04/1998	3538.0	2807.0	1.0	3.4	0.60	5.0	uR/hr [net]
N200 E190	08/04/1998	3604.0	2807.0	1.0	3.7	0.60	5.0	uR/hr [net]
N200 E20	08/04/1998	3143.0	2807.0	1.0	1.6	0.60	5.0	uR/hr [net]
N200 E200	08/04/1998	3603.0	2807.0	1.0	3.7	0.60	5.0	uR/hr [net]
N200 E30	08/04/1998	3197.0	2807.0	1.0	1.8	0.60	5.0	uR/hr [net]
N200 E40	08/04/1998	3248.0	2807.0	1.0	2.1	0.60	5.0	uR/hr [net]
N200 E50	08/04/1998	3189.0	2807.0	1.0	1.8	0.60	5.0	uR/hr [net]
N200 E60	08/04/1998	3349.0	2807.0	1.0	2.5	0.60	5.0	uR/hr [net]
N200 E70	08/04/1998	3368.0	2807.0	1.0	2.6	0.60	5.0	uR/hr [net]
N200 E80	08/04/1998	3381.0	2807.0	1.0	2.7	0.60	5.0	uR/hr [net]
N200 E90	08/04/1998	3360.0	2807.0	1.0	2.6	0.60	5.0	uR/hr [net]
N90 E0	08/03/1998	3505.0	2744.5	1.0	3.5	0.60	5.0	uR/hr [net]
GRID Q25								
N130 E140	08/05/1998	3398.0	2807.0	1.0	2.7	0.60	5.0	uR/hr [net]
N130 E20	08/05/1998	3254.0	2807.0	1.0	2.1	0.60	5.0	uR/hr [net]
N140 E70	08/05/1998	3410.0	2807.0	1.0	2.8	0.60	5.0	uR/hr [net]
N170 E110	08/05/1998	3416.0	2807.0	1.0	2.8	0.60	5.0	uR/hr [net]
N190 E140	08/05/1998	3389.0	2807.0	1.0	2.7	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

GRID R24

		COUNT DATA Counts Gross	Bkgd	Time (Min)	RESULT DATA Result	MDA	Limit	Result Units
N0 E0	08/01/1998	3342.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N0 E10	08/01/1998	3382.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N0 E100	08/01/1998	3397.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N0 E110	08/01/1998	3322.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N0 E120	08/01/1998	3331.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N0 E130	08/01/1998	3405.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N0 E140	08/01/1998	3441.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N0 E150	08/01/1998	3511.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N0 E160	08/01/1998	3419.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N0 E170	08/01/1998	3397.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N0 E180	08/01/1998	3481.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N0 E190	08/01/1998	3625.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N0 E20	08/01/1998	3212.0	2782.7	1.0	2.0	0.60	5.0	uR/hr [net]
N0 E200	08/01/1998	3483.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N0 E30	08/01/1998	3309.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N0 E40	08/01/1998	3146.0	2782.7	1.0	1.7	0.60	5.0	uR/hr [net]
N0 E50	08/01/1998	3221.0	2782.7	1.0	2.0	0.60	5.0	uR/hr [net]
N0 E50	08/01/1998	3221.0	2782.7	1.0	2.0	0.60	5.0	uR/hr [net]
N0 E60	08/01/1998	3196.0	2782.7	1.0	1.9	0.60	5.0	uR/hr [net]
N0 E70	08/01/1998	3254.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N0 E80	08/01/1998	3352.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N0 E90	08/01/1998	3290.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N10 E0	08/01/1998	3539.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N10 E10	08/01/1998	3640.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N10 E100	08/01/1998	3265.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N10 E110	08/01/1998	3436.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N10 E120	08/01/1998	3167.0	2782.7	1.0	1.8	0.60	5.0	uR/hr [net]
N10 E130	08/01/1998	3257.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N10 E140	08/01/1998	3399.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N10 E150	08/01/1998	3318.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N10 E160	08/01/1998	3362.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N10 E170	08/01/1998	3409.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N10 E180	08/01/1998	3406.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]

TABLE: A1

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QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N10 E190	08/01/1998	3644.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N10 E20	08/01/1998	3640.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N10 E200	08/01/1998	3539.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N10 E30	08/01/1998	3401.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N10 E40	08/01/1998	3413.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N10 E50	08/01/1998	3168.0	2782.7	1.0	1.8	0.60	5.0	uR/hr [net]
N10 E60	08/01/1998	3244.0	2782.7	1.0	2.1	0.60	5.0	uR/hr [net]
N10 E70	08/01/1998	3349.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N10 E80	08/01/1998	3377.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N10 E90	08/01/1998	3445.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N100 E0	08/01/1998	3445.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N100 E10	08/01/1998	3322.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N100 E100	08/01/1998	3416.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N100 E110	08/01/1998	3441.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N100 E120	08/01/1998	3454.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N100 E130	08/01/1998	3465.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N100 E140	08/01/1998	3496.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N100 E150	08/01/1998	3537.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N100 E160	08/01/1998	3750.0	2782.7	1.0	4.5	0.60	5.0	uR/hr [net]
N100 E170	08/01/1998	3818.0	2782.7	1.0	4.8	0.60	5.0	uR/hr [net]
N100 E180	08/01/1998	3619.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N100 E190	08/01/1998	3644.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N100 E20	08/01/1998	3423.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N100 E200	08/01/1998	3538.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N100 E30	08/01/1998	3372.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N100 E40	08/01/1998	3250.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N100 E50	08/01/1998	3249.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N100 E60	08/01/1998	3254.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N100 E70	08/01/1998	3279.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N100 E80	08/01/1998	3369.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N100 E90	08/01/1998	3236.0	2782.7	1.0	2.1	0.60	5.0	uR/hr [net]
N110 E0	08/01/1998	3405.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N110 E10	08/01/1998	3299.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N110 E100	08/01/1998	3601.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N110 E110	08/01/1998	3553.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]

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TABLE A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

Location	Date	COUNT DATA Counts Gross	Bkgd	Time (Min)	RESULT DATA Result	MDA	Limit	Result Units
N110 E120	08/01/1998	3624.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N110 E130	08/01/1998	3631.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N110 E140	08/01/1998	3797.0	2782.7	1.0	4.7	0.60	5.0	uR/hr [net]
N110 E150	08/01/1998	3560.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N110 E160	08/01/1998	3765.0	2782.7	1.0	4.6	0.60	5.0	uR/hr [net]
N110 E170	08/01/1998	3566.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N110 E180	08/01/1998	3876.0	2782.7	1.0	5.1	0.60	5.0	uR/hr [net]
N110 E190	08/01/1998	3696.0	2782.7	1.0	4.2	0.60	5.0	uR/hr [net]
N110 E20	08/01/1998	3337.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N110 E200	08/01/1998	3646.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N110 E30	08/01/1998	3290.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N110 E40	08/01/1998	3241.0	2782.7	1.0	2.1	0.60	5.0	uR/hr [net]
N110 E50	08/01/1998	3279.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N110 E60	08/01/1998	3376.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N110 E70	08/01/1998	3354.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N110 E80	08/01/1998	3284.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N110 E90	08/01/1998	3362.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N120 E0	08/02/1998	3455.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N120 E10	08/02/1998	3388.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N120 E100	08/02/1998	3628.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net]
N120 E110	08/02/1998	3663.0	2909.3	1.0	3.5	0.60	5.0	uR/hr [net]
N120 E120	08/02/1998	3779.0	2909.3	1.0	4.0	0.60	5.0	uR/hr [net]
N120 E130	08/02/1998	3838.0	2909.3	1.0	4.3	0.60	5.0	uR/hr [net]
N120 E140	08/02/1998	3762.0	2909.3	1.0	4.0	0.60	5.0	uR/hr [net]
N120 E150	08/02/1998	3848.0	2909.3	1.0	4.4	0.60	5.0	uR/hr [net]
N120 E160	08/02/1998	3603.0	2909.3	1.0	3.2	0.60	5.0	uR/hr [net]
N120 E170	08/02/1998	3736.0	2909.3	1.0	3.8	0.60	5.0	uR/hr [net]
N120 E180	08/02/1998	3733.0	2909.3	1.0	3.8	0.60	5.0	uR/hr [net]
N120 E190	08/02/1998	3861.0	2909.3	1.0	4.4	0.60	5.0	uR/hr [net]
N120 E20	08/02/1998	3318.0	2909.3	1.0	1.9	0.60	5.0	uR/hr [net]
N120 E200	08/02/1998	3700.0	2909.3	1.0	3.7	0.60	5.0	uR/hr [net]
N120 E30	08/02/1998	3448.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N120 E40	08/02/1998	3222.0	2909.3	1.0	1.5	0.60	5.0	uR/hr [net]
N120 E50	08/02/1998	3343.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [net]
N120 E60	08/02/1998	3454.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts Gross	Bkgd	Time (Min)	Result	MDA	Limit	Result Units
N140 E60	08/02/1998	3450.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N140 E70	08/02/1998	3506.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N140 E80	08/02/1998	3626.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net]
N140 E90	08/02/1998	3691.0	2909.3	1.0	3.6	0.60	5.0	uR/hr [net]
N150 E0	08/02/1998	2783.0	2909.3	1.0	-0.6	0.60	5.0	uR/hr [net]
N150 E10	08/02/1998	2948.0	2909.3	1.0	0.2	0.60	5.0	uR/hr [net]
N150 E100	08/02/1998	3863.0	2909.3	1.0	4.4	0.60	5.0	uR/hr [net]
N150 E110	08/02/1998	3800.0	2909.3	1.0	4.1	0.60	5.0	uR/hr [net]
N150 E120	08/02/1998	3738.0	2909.3	1.0	3.9	0.60	5.0	uR/hr [net]
N150 E130	08/02/1998	4051.0	2909.3	1.0	5.3	0.60	5.0	uR/hr [net]
N150 E20	08/02/1998	3145.0	2909.3	1.0	1.1	0.60	5.0	uR/hr [net]
N150 E30	08/02/1998	3255.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N150 E40	08/02/1998	3381.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N150 E50	08/02/1998	3262.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N150 E60	08/02/1998	3343.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [net]
N150 E70	08/02/1998	3659.0	2909.3	1.0	3.5	0.60	5.0	uR/hr [net]
N150 E80	08/02/1998	3716.0	2909.3	1.0	3.8	0.60	5.0	uR/hr [net]
N150 E90	08/02/1998	3790.0	2909.3	1.0	4.1	0.60	5.0	uR/hr [net]
N160 E40	08/02/1998	3232.0	2909.3	1.0	1.5	0.60	5.0	uR/hr [net]
N160 E50	08/02/1998	3379.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N160 E60	08/02/1998	2880.0	2909.3	1.0	-0.1	0.60	5.0	uR/hr [net]
N160 E70	08/02/1998	3380.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N160 E80	08/02/1998	3717.0	2909.3	1.0	3.8	0.60	5.0	uR/hr [net]
N160 E90	08/02/1998	3754.0	2909.3	1.0	3.9	0.60	5.0	uR/hr [net]
N170 E70	08/02/1998	3680.0	2909.3	1.0	3.6	0.60	5.0	uR/hr [net]
N20 E0	08/01/1998	3394.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N20 E10	08/01/1998	3409.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N20 E100	08/01/1998	3265.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N20 E110	08/01/1998	3397.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N20 E120	08/01/1998	3391.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N20 E130	08/01/1998	3362.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N20 E140	08/01/1998	3367.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N20 E150	08/01/1998	3381.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N20 E160	08/01/1998	3374.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N20 E170	08/01/1998	3420.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N20 E180	08/01/1998	3516.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N20 E190	08/01/1998	3667.0	2782.7	1.0	4.1	0.60	5.0	uR/hr [net]
N20 E20	08/01/1998	3272.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N20 E200	08/01/1998	3767.0	2782.7	1.0	4.6	0.60	5.0	uR/hr [net]
N20 E30	08/01/1998	3371.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N20 E40	08/01/1998	3264.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N20 E50	08/01/1998	3305.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N20 E60	08/01/1998	3274.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N20 E70	08/01/1998	3279.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N20 E80	08/01/1998	3333.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N20 E90	08/01/1998	3336.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N30 E0	08/01/1998	3362.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N30 E10	08/01/1998	3398.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N30 E100	08/01/1998	3318.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N30 E110	08/01/1998	3370.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N30 E120	08/01/1998	3389.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N30 E130	08/01/1998	3393.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N30 E140	08/01/1998	3329.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N30 E150	08/01/1998	3335.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N30 E160	08/01/1998	3360.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N30 E170	08/01/1998	3414.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N30 E180	08/01/1998	3432.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N30 E190	08/01/1998	3595.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N30 E20	08/01/1998	3347.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N30 E200	08/01/1998	3719.0	2782.7	1.0	4.4	0.60	5.0	uR/hr [net]
N30 E30	08/01/1998	3301.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N30 E40	08/01/1998	3386.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N30 E50	08/01/1998	3448.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N30 E60	08/01/1998	3437.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N30 E70	08/01/1998	3357.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N30 E80	08/01/1998	3290.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N30 E90	08/01/1998	3283.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N40 E0	08/01/1998	3341.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N40 E10	08/01/1998	3360.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N40 E100	08/01/1998	3372.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]

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TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
Location	Date	Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N40 E110	08/01/1998	3331.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N40 E120	08/01/1998	3416.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N40 E130	08/01/1998	3410.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N40 E140	08/01/1998	3414.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N40 E150	08/01/1998	3361.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N40 E160	08/01/1998	3248.0	2782.7	1.0	2.2	0.60	5.0	uR/hr [net]
N40 E170	08/01/1998	3292.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N40 E180	08/01/1998	3325.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N40 E190	08/01/1998	3499.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N40 E20	08/01/1998	3327.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N40 E200	08/01/1998	3549.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N40 E30	08/01/1998	3385.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N40 E40	08/01/1998	3323.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N40 E50	08/01/1998	3342.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N40 E60	08/01/1998	3467.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N40 E70	08/01/1998	3419.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N40 E80	08/01/1998	3391.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N40 E90	08/01/1998	3403.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N50 E0	08/01/1998	3555.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N50 E10	08/01/1998	3494.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N50 E100	08/01/1998	3543.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N50 E110	08/01/1998	3459.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N50 E120	08/01/1998	3482.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N50 E130	08/01/1998	3472.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N50 E140	08/01/1998	3407.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N50 E150	08/01/1998	3441.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N50 E160	08/01/1998	3524.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N50 E170	08/01/1998	3457.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N50 E180	08/01/1998	3409.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N50 E190	08/01/1998	3514.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N50 E20	08/01/1998	3401.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N50 E200	08/01/1998	3624.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N50 E30	08/01/1998	3304.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N50 E40	08/01/1998	3339.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N50 E50	08/01/1998	3338.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N50 E60	08/01/1998	3491.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N50 E70	08/01/1998	3459.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N50 E80	08/01/1998	3608.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N50 E90	08/01/1998	3641.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N60 E0	08/01/1998	3288.0	2782.7	1.0	2.4	0.60	5.0	uR/hr [net]
N60 E10	08/01/1998	3443.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N60 E100	08/01/1998	3512.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N60 E110	08/01/1998	3317.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N60 E120	08/01/1998	3420.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N60 E130	08/01/1998	3524.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N60 E140	08/01/1998	3542.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N60 E150	08/01/1998	3607.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N60 E160	08/01/1998	3599.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N60 E170	08/01/1998	3413.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N60 E180	08/01/1998	3510.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N60 E190	08/01/1998	3565.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N60 E20	08/01/1998	3410.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N60 E200	08/01/1998	3475.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N60 E30	08/01/1998	3364.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N60 E40	08/01/1998	3425.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N60 E50	08/01/1998	3387.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N60 E60	08/01/1998	3328.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N60 E70	08/01/1998	3426.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N60 E80	08/01/1998	3591.0	2782.7	1.0	3.8	0.60	5.0	uR/hr [net]
N60 E90	08/01/1998	3617.0	2782.7	1.0	3.9	0.60	5.0	uR/hr [net]
N70 E0	08/01/1998	3356.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N70 E10	08/01/1998	3395.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N70 E100	08/01/1998	3410.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N70 E110	08/01/1998	3461.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E120	08/01/1998	3468.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E130	08/01/1998	3473.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E140	08/01/1998	3432.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N70 E150	08/01/1998	3442.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N70 E160	08/01/1998	3472.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E170	08/01/1998	3563.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N70 E180	08/01/1998	3492.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N70 E190	08/01/1998	3483.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N70 E20	08/01/1998	3530.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N70 E200	08/01/1998	3444.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N70 E30	08/01/1998	3351,0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N70 E40	08/01/1998	3395.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N70 E50	08/01/1998	3472.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E60	08/01/1998	3419.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N70 E70	08/01/1998	3451.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N70 E80	08/01/1998	3522.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N70 E90	08/01/1998	3395.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N80 E0	08/01/1998	3391.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N80 E10	08/01/1998	3386.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N80 E100	08/01/1998	3346.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N80 E110	08/01/1998	3342.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N80 E120	08/01/1998	3391.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N80 E130	08/01/1998	3458.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N80 E140	08/01/1998	3534.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N80 E150	08/01/1998	3491.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N80 E160	08/01/1998	3486.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N80 E170	08/01/1998	3470.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N80 E180	08/01/1998	3659.0	2782.7	1.0	4.1	0.60	5.0	uR/hr [net]
N80 E190	08/01/1998	3495.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N80 E20	08/01/1998	3315.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N80 E200	08/01/1998	3489.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N80 E30	08/01/1998	3378.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]
N80 E40	08/01/1998	3526.0	2782.7	1.0	3.5	0.60	5.0	uR/hr [net]
N80 E50	08/01/1998	3434.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N80 E60	08/01/1998	3357.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N80 E70	08/01/1998	3458.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N80 E80	08/01/1998	3414.0	2782.7	1.0	2.9	0.60	5.0	uR/hr [net]
N80 E90	08/01/1998	3363.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N90 E0	08/01/1998	3426.0	2782.7	1.0	3.0	0.60	5.0	uR/hr [net]
N90 E10	08/01/1998	3451.0	2782.7	1.0	3.1	0.60	5.0	uR/hr [net]
N90 E100	08/01/1998	3382.0	2782.7	1.0	2.8	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N90 E110	08/01/1998	3334.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N90 E120	08/01/1998	3478.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N90 E130	08/01/1998	3634.0	2782.7	1.0	4.0	0.60	5.0	uR/hr [net]
N90 E140	08/01/1998	3510.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N90 E150	08/01/1998	3549.0	2782.7	1.0	3.6	0.60	5.0	uR/hr [net]
N90 E160	08/01/1998	3460.0	2782.7	1.0	3.2	0.60	5.0	uR/hr [net]
N90 E170	08/01/1998	3576.0	2782.7	1.0	3.7	0.60	5.0	uR/hr [net]
N90 E180	08/01/1998	3503.0	2782.7	1.0	3.4	0.60	5.0	uR/hr [net]
N90 E190	08/01/1998	3568.0	2782.7	1.0	3.7	0.60	5.0	uR/hr [net]
N90 E20	08/01/1998	3360.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N90 E200	08/01/1998	3493.0	2782.7	1.0	3.3	0.60	5.0	uR/hr [net]
N90 E30	08/01/1998	3285.0	2782.7	1.0	2.3	0.60	5.0	uR/hr [net]
N90 E40	08/01/1998	3324.0	2782.7	1.0	2.5	0.60	5.0	uR/hr [net]
N90 E50	08/01/1998	3360.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
N90 E60	08/01/1998	3342.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N90 E70	08/01/1998	3232.0	2782.7	1.0	2.1	0.60	5.0	uR/hr [net]
N90 E80	08/01/1998	3335.0	2782.7	1.0	2.6	0.60	5.0	uR/hr [net]
N90 E90	08/01/1998	3364.0	2782.7	1.0	2.7	0.60	5.0	uR/hr [net]
GRID R25								
N10 E50	08/02/1998	3181.0	2909.3	1.0	1.3	0.60	5.0	uR/hr [net]
N20 E0	08/02/1998	3756.0	2909.3	1.0	3.9	0.60	5.0	uR/hr [net]
N20 E100	08/02/1998	3470.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net]
N20 E110	08/02/1998	3436.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N20 E120	08/02/1998	3361.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N20 E30	08/02/1998	3456.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N20 E40	08/02/1998	3342.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [net]
N20 E50	08/02/1998	3292.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net]
N20 E60	08/02/1998	3255.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N20 E70	08/02/1998	3299.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net]
N20 E80	08/02/1998	3276.0	2909.3	1.0	1.7	0.60	5.0	uR/hr [net]
N20 E90	08/02/1998	3298.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net]
N30 E0	08/02/1998	3645.0	2909.3	1.0	3.4	0.60	5.0	uR/hr [net]
N30 E10	08/02/1998	3775.0	2909.3	1.0	4.0	0.60	5.0	uR/hr [net]

(R21-RF) RS-00003

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N30 E100	08/02/1998	3447.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N30 E110	08/02/1998	3449.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N30 E120	08/02/1998	3343.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [net]
N30 E130	08/02/1998	3350.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [net]
N30 E140	08/02/1998	3410.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N30 E20	08/02/1998	3557.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N30 E30	08/02/1998	3539.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N30 E40	08/02/1998	3429.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N30 E50	08/02/1998	3391.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N30 E60	08/02/1998	3360.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N30 E70	08/02/1998	3375.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N30 E80	08/02/1998	3204.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
N30 E90	08/02/1998	3235.0	2909.3	1.0	1.5	0.60	5.0	uR/hr [net]
N40 E0	08/02/1998	3655.0	2909.3	1.0	3.5	0.60	5.0	uR/hr [net]
N40 E10	08/02/1998	3546.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N40 E100	08/02/1998	3262.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N40 E110	08/02/1998	3396.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N40 E120	08/02/1998	3537.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N40 E130	08/02/1998	3393.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net]
N40 E140	08/02/1998	3425.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N40 E20	08/02/1998	3591.0	2909.3	1.0	3.2	0.60	5.0	uR/hr [net]
N40 E30	08/02/1998	3247.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N40 E40	08/02/1998	3545.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N40 E50	08/02/1998	3510.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N40 E60	08/02/1998	3202.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
N40 E70	08/02/1998	3177.0	2909.3	1.0	1.2	0.60	5.0	uR/hr [net]
N40 E80	08/02/1998	3209.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [ne
N40 E90	08/02/1998	3248.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [ne
N50 E0	08/02/1998	3545.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [ne
N50 E10	08/02/1998	3446.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [ne
N50 E100	08/02/1998	3199.0	2909.3	1.0	1.3	0.60	5.0	uR/hr [ne
N50 E110	08/02/1998	3331.0	2909.3	1.0	2.0	0.60	5.0	uR/hr [n
N50 E120	08/02/1998	3497.0	2909.3	1.0	2.7	0.60	5.0	uR/hr [n
N50 E130	08/02/1998	3595.0	2909.3	1.0	3.2	0.60	5.0	uR/hr [n
N50 E140	08/02/1998	3496.0	2909.3	1.0	2.7	0.60	5.0	uR/hr [n

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N50 E150	08/02/1998	3565.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N50 E180	08/02/1998	3536.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N50 E190	08/02/1998	3610.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net]
N50 E20	08/02/1998	3434.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N50 E200	08/02/1998	3580.0	2909.3	1.0	3.1	0.60	5.0	uR/hr [net]
N50 E30	08/02/1998	3448.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N50 E40	08/02/1998	3505.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N50 E50	08/02/1998	3509.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N50 E60	08/02/1998	3368.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N50 E70	08/02/1998	3282.0	2909.3	1.0	1.7	0.60	5.0	uR/hr [net]
N50 E80	08/02/1998	3252.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N50 E90	08/02/1998	3222.0	2909.3	1.0	1.5	0.60	5.0	uR/hr [net]
N60 E0	08/02/1998	3404.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N60 E10	08/02/1998	3430.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N60 E100	08/02/1998	3291.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net]
N60 E110	08/02/1998	3284.0	2909.3	1.0	1.7	0.60	5.0	uR/hr [net]
N60 E120	08/02/1998	3404.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N60 E130	08/02/1998	3461.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net]
N60 E140	08/02/1998	3532.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N60 E150	08/02/1998	3541.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N60 E160	08/02/1998	3513.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N60 E170	08/02/1998	3526.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N60 E180	08/02/1998	3638.0	2909.3	1.0	3.4	0.60	5.0	uR/hr [net]
N60 E190	08/02/1998	3442.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N60 E20	08/02/1998	3469.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net]
N60 E200	08/02/1998	3501.0	2909.3	1.0	2.8	0.60	5.0	uR/hr [net]
N60 E30	08/02/1998	3481.0	2909.3	1.0	2.7	0.60	5.0	uR/hr [net]
N60 E50	08/02/1998	3569.0	2909.3	1.0	3.1	0.60	5.0	uR/hr [net]
N60 E60	08/02/1998	3479.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net]
N60 E70	08/02/1998	3210.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
N60 E80	08/02/1998	3207.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
N60 E90	08/02/1998	3290.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net]
N70 E0	08/02/1998	3439.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N70 E10	08/02/1998	3319.0	2909.3	1.0	1.9	0.60	5.0	uR/hr [net]
N70 E100	08/02/1998	3171.0	2909.3	1.0	1.2	0.60	5.0	uR/hr [net]

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N70 E110	08/02/1998	3188.0	2909.3	1.0	1.3	0.60	5.0	uR/hr [net]
N70 E120	08/02/1998	3274.0	2909.3	1.0	1.7	0.60	5.0	uR/hr [net]
N70 E130	08/02/1998	3706.0	2909.3	1.0	3.7	0.60	5.0	uR/hr [net]
N70 E140	08/02/1998	3772.0	2909.3	1.0	4.0	0.60	5.0	uR/hr [net]
N70 E150	08/02/1998	3695.0	2909.3	1.0	3.7	0.60	5.0	uR/hr [net]
N70 E160	08/02/1998	3615.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net]
N70 E170	08/02/1998	3597.0	2909.3	1.0	3.2	0.60	5.0	uR/hr [net]
N70 E180	08/02/1998	3562.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N70 E190	08/02/1998	3550.0	2909.3	1.0	3.0	0.60	5.0	uR/hr [net]
N70 E20	08/02/1998	3532.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N70 E200	08/02/1998	3620.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net]
N70 E30	08/02/1998	3359.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N70 E40	08/02/1998	3353.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N70 E50	08/02/1998	3539.0	2909.3	1.0	2.9	0.60	5.0	uR/hr [net]
N70 E60	08/02/1998	3368.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net]
N70 E70	08/02/1998	3253.0	2909.3	1.0	1.6	0.60	5.0	uR/hr [net]
N70 E80	08/02/1998	3190.0	2909.3	1.0	1.3	0.60	5.0	uR/hr [net]
N70 E90	08/02/1998	3188.0	2909.3	1.0	1.3	0.60	5.0	uR/hr [net]
N80 E0	08/02/1998	3400.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N80 E10	08/02/1998	3406.0	2909.3	1.0	2.3	0.60	5.0	uR/hr [net]
N80 E100	08/02/1998	3171.0	2909.3	1.0	1.2	0.60	5.0	uR/hr [net]
N80 E110	08/02/1998	3104.0	2909.3	1.0	0.9	0.60	5.0	uR/hr [net]
N80 E120	08/02/1998	3073.0	2909.3	1.0	0.8	0.60	5.0	uR/hr [net]
N80 E130	08/02/1998	3447.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net]
N80 E140	08/02/1998	3635.0	2909.3	1.0	3.4	0.60	5.0	uR/hr [net]
N80 E150	08/02/1998	3717.0	2909.3	1.0	3.8	0.60	5.0	uR/hr [net
N80 E160	08/02/1998	3610.0	2909.3	1.0	3.3	0.60	5.0	uR/hr [net
N80 E170	08/02/1998	3450.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net
N80 E180	08/02/1998	3462.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net
N80 E190	08/02/1998	3445.0	2909.3	1.0	2.5	0.60	5.0	uR/hr [net
N80 E20	08/02/1998	3472.0	2909.3	1.0	2.6	0.60	5.0	uR/hr [net
N80 E200	08/02/1998	3639.0	2909.3	1.0	3.4	0.60	5.0	uR/hr [net
N80 E30	08/02/1998	3358.0	2909.3	1.0	2.1	0.60	5.0	uR/hr [net
N80 E40	08/02/1998	3390.0	2909.3	1.0	2.2	0.60	5.0	uR/hr [net
N80 E50	08/02/1998	3305.0	2909.3	1.0	1.8	0.60	5.0	uR/hr [net

(R21-RF) RS-00003

TABLE: A1

QUANTITATIVE GAMMA MEASUREMENT
SUMMARY OF RESULTS
BUILDING 64 GROUNDS

		COUNT DATA			RESULT DATA			
		Counts		Time				
		Gross	Bkgd	(Min)	Result	MDA	Limit	Result Units
N80 E60	08/02/1998	3415.0	2909.3	1.0	2.4	0.60	5.0	uR/hr [net]
N80 E70	08/02/1998	3218.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
N80 E80	08/02/1998	3170.0	2909.3	1.0	1.2	0.60	5.0	uR/hr [net]
N80 E90	08/02/1998	3201.0	2909.3	1.0	1.4	0.60	5.0	uR/hr [net]
GRID R26								
N0 E0	08/05/1998	3355.0	2807.0	1.0	2.5	0.60	5.0	uR/hr [net]
N50 E10	08/05/1998	3650.0	2807.0	1.0	3.9	0.60	5.0	uR/hr [net]
N80 E50	08/05/1998	3406.0	2807.0	1.0	2.8	0.60	5.0	uR/hr [net]

APPENDIX B

SURFACE SOIL SAMPLE RESULTS

BOEING

The Boeing Company
Rocketdyne Propulsion & Power

6633 Canoga Ave.
P.O. Box 7922
Canoga Park, CA 91309-7922

Date: September 24, 1998

No.: SHEA-16228 (Revision)

To: Philip Rutherford
D/641, 055, T487
(818)586-6140

From: John Shao
D/641, 055, T487
(818)586-8024

Subject: Soil Sampling Results for Building 064 area at SSFL (Revision)

This report summarizes the findings from a radiation survey performed on samples from SSFL's Building 64 area following extensive excavation. The soil sampling method and the analytical techniques used are also described.

In the past, in order to ascertain the levels of radioactivity in soil, a relatively large series of soil samples was taken and then counted on a GeLi gamma spectroscopy system. This resulted in a significant investment of project schedule time for sample analysis. A technique using a screening process for preliminary sample selection was needed in order to reduce schedule impact. The screening process and the results of analysis are described below.

Screening Process Using Portable 3x3 NaI and MCA

All together, a total of 137 soil samples were screened from the Building 64 area. Each soil sample was placed in a plastic bag, uniquely numbered, and subsequently placed in a "B"-box in numerical order. The samples were then removed from the "B"-box and measured in a one-minute count using a 3"x3" NaI probe attached to a multi-channel analyzer (MCA). During the one-minute survey, each sample was placed in a half cylindrical lead pig with the NaI probe pointing down at the sample. All the samples were cooled to room temperature before the radiation survey.

The screening results from the NaI probe are presented in Table 1 and Drawing 064-01. The gamma measurements range from 8274 to 10857 counts/minute with the mean value at 9668 counts/minute. To better understand the results of the survey, further statistical analysis was performed. A cumulative probability chart was plotted using Cumplot Version 2.20[1] (see Cumulative Probability Plot). This chart shows that the gamma exposure results have nearly ideal normal distribution. Only minimal variance from normal distribution was detected at the lower extreme of the cumulative probability. Since the soil gamma exposure measurements suggested that the soil radioactive content was normally distributed, the highest, lowest, and mid-range samples were selected for analysis. Each sample was transferred to a marinelli, weighed, and analyzed in the lab using a high Ge(Li) gamma spectrometer. The highest, mid-range, and lowest samples were found to contain 2.69, 0.11, and 0.41 pCi/g of Cs-137 respectively (the location of the highest counts/minute sample is one of the areas excavated). Two additional samples were then selected (at the "1/4" point and the "3/4" point of the distribution). Both "1/4" point and the"3/4" point samples had 0.03 pCi/g of Cs-137. Table 2 summarizes the results from the gamma spectroscopy analysis.

Locations with High Ambient Gamma Measurements

Prior to soil sampling, the ambient gamma survey was performed every 10 ft^2 in the Building 64 area. Statistical analysis of the survey results revealed four locations with high ambient gamma measurements (>5.0 μR/hr) that deviated slightly from normal distribution. Soil samples were subsequently taken from these locations and were screened with a 3"x3" NaI probe. The results of the NaI screening are shown in Table 1 (samples 064-98-0199 thru 064-98-0202). Since each screening result is less than the mean value of all the samples screened, it can be concluded that all four samples are less then the cleanup level of 9.20 pCi/g. The high ambient gamma measurements at these locations are likely due to the nearby large boulder(s).

Excavation and Post-Excavation Sample Analysis

During the NaI screening process, samples from four locations (R24-37.5-190, R24-112.5-137.5, Q24-162.5-12.5, and Q24-159.5-12.5) revealed a Cs-137 peak on the portable multi-channel analyzer. These samples were therefore analyzed on the laboratory Ge(Li) gamma spectrometer and found to contain Cs-137 concentrations that ranged from 2.57 to 6.34 pCi/g (see Table 3).

A solid asphalt sample taken at R24-37.5-190 revealed a Cs-137 concentration of 13.68 pCi/g, which is higher than the release limit. To determine whether the radiological contamination was also in the soil, the asphalt from bag #064-98-0186 was separated from the soil by a sieve with 0.0331-inch mesh. After analyzing the two separated samples, the Cs-137 contamination was found to be in both the soil (7.36 pCi/g) and in the asphalt (3.93 pCi/g). The asphalt and soil from this location were removed. Subsequent sampling at R24-37.5-190 indicated only 0.53 pCi/g activity.

Areas surrounding the other three locations were also excavated and resampled. Table 3 summarizes the Cs-137 concentrations before and after excavation at all four locations. The highest post-excavation Cs-137 activity at Q24-162.5-12.5 and the neighboring Q24-159.5-12.5 is 1.30 pCi/g, or 14% of the cleanup standard of 9.2 pCi/g.

Background Determination

A soil sample representing the background at SSFL was taken approximately 150 feet west of Building 020, in an area unaffected by Building 20 operations. Using the same sodium iodine detector and the same method, ten measurements were taken. The mean background soil measurement was 8927 counts/minute, and the experimental standard deviation was 77 counts/minute (see Table 4). The gamma spectroscopy result confirms the background sample has less than the minimum detectable activity of Cs-137 (see Table 2).

Summary

In summary, four of the 137 samples screened have Cs-137 concentration higher than fall out concentration. Immediate areas surrounding these four samples were excavated and removed. Analysis of samples taken after the excavation indicates cesium-137 activity well below the release limit of 9.2 pCi/g. The remaining 133 samples can be concluded to be below the release limit based on: 1) the screening results are normally distributed, 2) all five representative samples are less than the release limit of Cs-137, and 3) the efficiency demonstrated by the 3"x3" NaI probe. The greater efficiency provided by the 3"x3"

NaI probe and the multi-channel analyzer is an improvement to the screening technique over the 1"x1" NaI detector. The results presented in this report suggest that the screening process technique used has a great potential for reducing the time and costs of field sample analysis.

If you have any questions regarding this report, please call me at (818) 586-8024.

John Shao

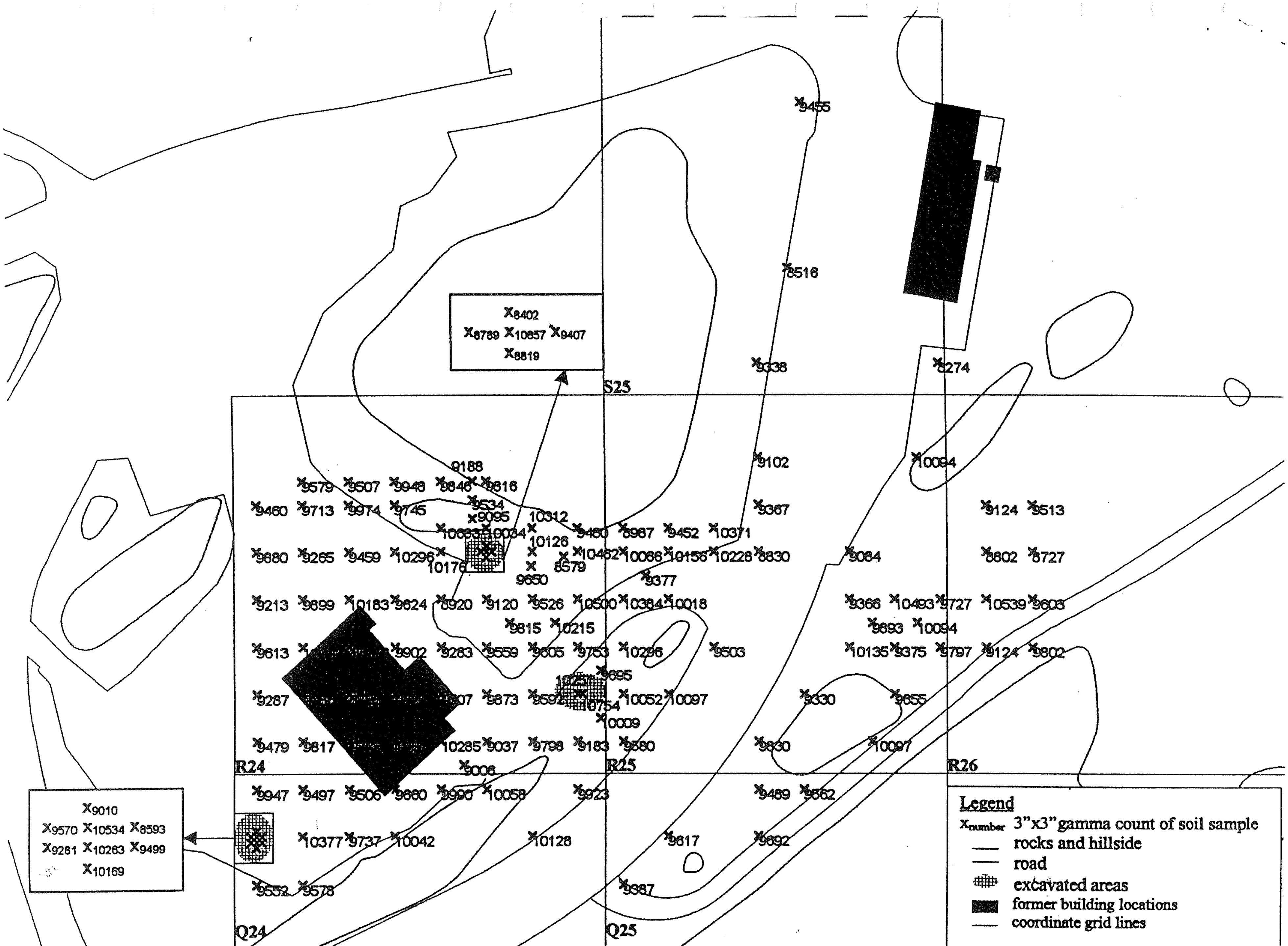
Radiation Safety

cc: Philip Horton

James Barnes

Building 64 File

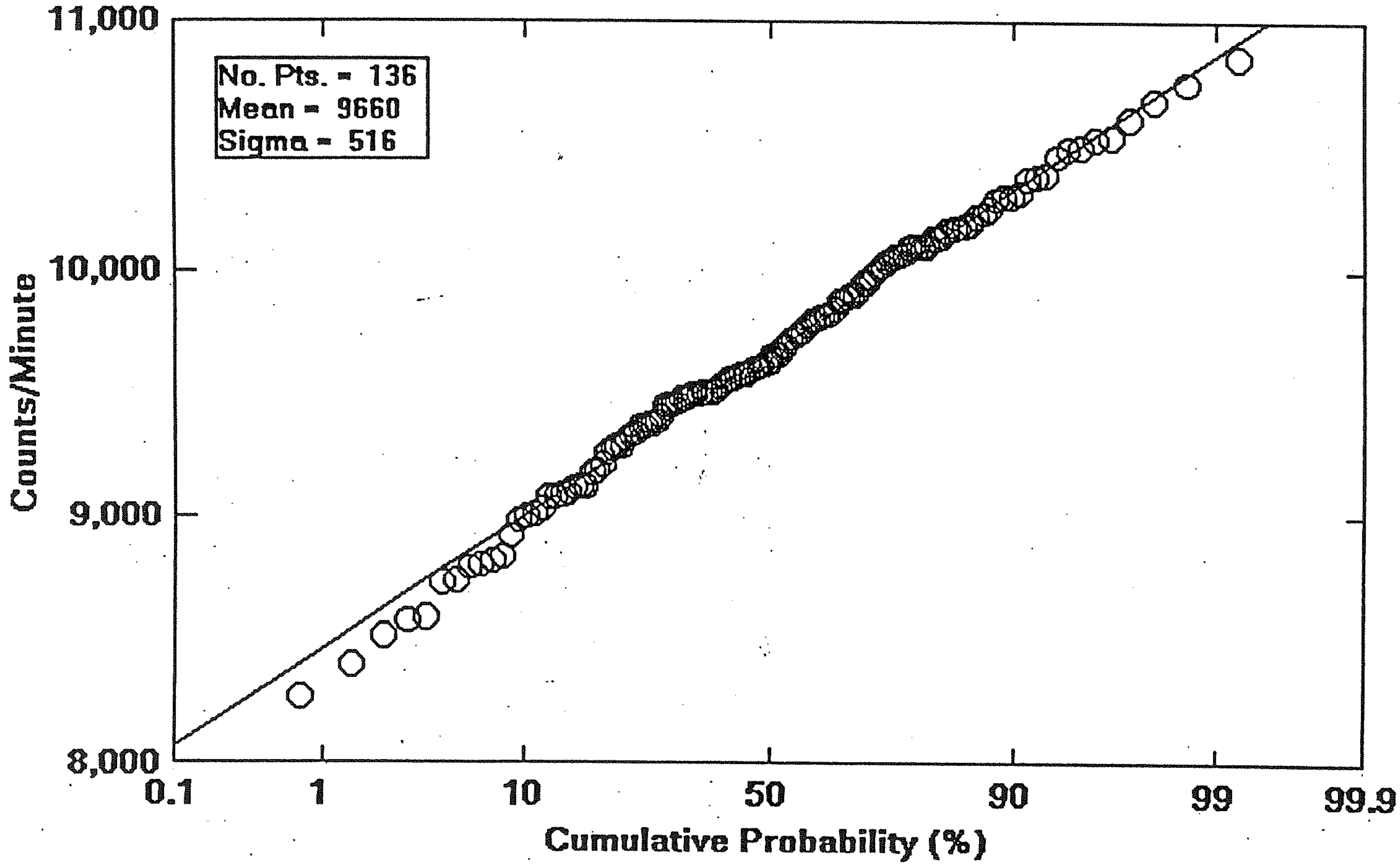
[1] Proprietary Software. Boeing



Santa Susana Field Laboratory
T064 Soil Samples - Gross Gamma Counts with 3"x3" NaI

Drawing: 064-01
Date: 9/23/98

Screening Results (Bldg 64 Soil Samples)



U:\DIR00005.CHK\RADIAT~1\BLDG64.CSV

09-21-98

TABLE 1. Gamma Exposure Measurements of Soil Samples from Building 064.

Bag #	Counts/Minute	Grid Number	Feet North	Feet East	Sample Depth (ft)
064-98-0053	9006	R24	0	125	<0.5
064-98-0054	9479	R24	12.5	12.5	<0.5
064-98-0055	9817	R24	12.5	37.5	<0.5
064-98-0056	9775	R24	12.5	62.5	<0.5
064-98-0057	10611	R24	12.5	87.5	<0.5
064-98-0058	10285	R24	12.5	112.5	<0.5
064-98-0059	9037	R24	12.5	137.5	<0.5
064-98-0060	9798	R24	12.5	162.5	<0.5
064-98-0061	9183	R24	12.5	187.5	<0.5
064-98-0062	9287	R24	37.5	12.5	<0.5
064-98-0063	9086	R24	37.5	37.5	<0.5
064-98-0064	8735	R24	37.5	62.5	<0.5
064-98-0065	9320	R24	37.5	87.5	<0.5
064-98-0066	9507	R24	37.5	112.5	<0.5
064-98-0067	9873	R24	37.5	137.5	<0.5
064-98-0068	9592	R24	37.5	162.5	<0.5
064-98-0069	10251	R24	37.5	187.5	<0.5
064-98-0070	9613	R24	62.5	12.5	<0.5
064-98-0071	10091	R24	62.5	37.5	<0.5
064-98-0072	10172	R24	62.5	62.5	<0.5
064-98-0073	9902	R24	62.5	87.5	<0.5
064-98-0074	9283	R24	62.5	112.5	<0.5
064-98-0075	9559	R24	62.5	137.5	<0.5
064-98-0076	9605	R24	62.5	162.5	<0.5
064-98-0077	9753	R24	62.5	187.5	<0.5
064-98-0078	9815	R24	75	150	<0.5
064-98-0079	10215	R24	75	175	<0.5
064-98-0080	9213	R24	87.5	12.5	<0.5
064-98-0081	9899	R24	87.5	37.5	<0.5
064-98-0082	10183	R24	87.5	62.5	<0.5
064-98-0083	9624	R24	87.5	87.5	<0.5
064-98-0084	8920	R24	87.5	112.5	<0.5
064-98-0085	9120	R24	87.5	137.5	<0.5
064-98-0086	9526	R24	87.5	162.5	<0.5
064-98-0087	10500	R24	87.5	187.5	<0.5
064-98-0088	9880	R24	112.5	12.5	<0.5
064-98-0089	**9265**	**R24**	**112.5**	**37.5**	**<0.5**
064-98-0090	9459	R24	112.5	62.5	<0.5
064-98-0091	10296	R24	112.5	87.5	<0.5
064-98-0092	10176	R24	112.5	112.5	<0.5
064-98-0093 *	**10857**	**R24**	**112.5**	**137.5**	**<0.5**
064-98-0094	10126	R24	112.5	162.5	<0.5
064-98-0095	10462	R24	112.5	187.5	<0.5
064-98-0096	10683	R24	125	112.5	<0.5
064-98-0097	10034	R24	125	137.5	<0.5
064-98-0098	10312	R24	125	162.5	<0.5
064-98-0099	9480	R24	125	187.5	<0.5
064-98-0100	9460	R24	137.5	12.5	<0.5
064-98-0101	9713	R24	137.5	37.5	<0.5
064-98-0102	9974	R24	137.5	62.5	<0.5
064-98-0103	9745	R24	137.5	87.5	<0.5
064-98-0104	9579	R24	150	37.5	<0.5
064-98-0105	9507	R24	150	62.5	<0.5
064-98-0106	9948	R24	150	87.5	<0.5
064-98-0107	9846	R24	150	112.5	<0.5

Bag #	Counts/Minute	Grid Number	Feet North	Feet East	Sample Depth (ft)
064-98-0108	9816	R24	150	137.5	<0.5
064-98-0109	9947	Q24	187.5	12.5	<0.5
064-98-0110	9497	Q24	187.5	37.5	<0.5
064-98-0111	9506	Q24	187.5	62.5	<0.5
064-98-0112	9660	Q24	187.5	87.5	<0.5
064-98-0113	9990	Q24	187.5	112.5	<0.5
064-98-0114	10058	Q24	187.5	137.5	<0.5
064-98-0115	9923	Q24	187.5	187.5	<0.5
064-98-0116 *	**10534**	**Q24**	**162.5**	**12.5**	**<0.5**
064-98-0117	10377	Q24	162.5	37.5	<0.5
064-98-0118	9737	Q24	162.5	62.5	<0.5
064-98-0119	10042	Q24	162.5	87.5	<0.5
064-98-0120	10128	Q24	162.5	162.5	<0.5
064-98-0121	9552	Q24	137.5	12.5	<0.5
064-98-0122	9578	Q24	137.5	37.5	<0.5
064-98-0123	10009	R25	25	0	<0.5
064-98-0124	9695	R25	50	0	<0.5
064-98-0125	9580	R25	12.5	12.5	<0.5
064-98-0126	10052	R25	37.5	12.5	<0.5
064-98-0127	**10296**	**R25**	**62.5**	**12.5**	**<0.5**
064-98-0128	10384	R25	87.5	12.5	<0.5
064-98-0129	10066	R25	112.5	12.5	<0.5
064-98-0130	8987	R25	125	12.5	<0.5
064-98-0131	9377	R25	100	25	<0.5
064-98-0132	10097	R25	37.5	37.5	<0.5
064-98-0133	10018	R25	87.5	37.5	<0.5
064-98-0134	10156	R25	112.5	37.5	<0.5
064-98-0135	9452	R25	125	37.5	<0.5
064-98-0136	9503	R25	62.5	62.5	<0.5
064-98-0137	10228	R25	112.5	62.5	<0.5
064-98-0138	10371	R25	125	62.5	<0.5
064-98-0139	8830	R25	112.5	87.5	<0.5
064-98-0140	9367	R25	137.5	87.5	<0.5
064-98-0141	9102	R25	162.5	87.5	<0.5
064-98-0142	9330	R25	37.5	112.5	<0.5
064-98-0143	9692	Q25	162.5	87.5	<0.5
~~064-98-0144~~	not sampled				
064-98-0145	9655	R25	37.5	162.5	<0.5
064-98-0146	10135	R25	62.5	137.5	<0.5
064-98-0147	9375	R25	62.5	162.5	<0.5
064-98-0148	9797	R25	62.5	187.5	<0.5
064-98-0149	9893	R25	75	150	<0.5
064-98-0150	10094	R25	75	175	<0.5
064-98-0151	9366	R25	87.5	137.5	<0.5
064-98-0152	10493	R25	87.5	162.5	<0.5
064-98-0153	**9727**	**R25**	**87.5**	**187.5**	**<0.5**
064-98-0154	9124	R26	62.5	12.5	<0.5
064-98-0155	9802	R26	62.5	37.5	<0.5
064-98-0156	10539	R26	87.5	12.5	<0.5
064-98-0157	9603	R26	87.5	37.5	<0.5
~~064-98-0158~~	not sampled				
064-98-0159	8802	R26	112.5	12.5	<0.5
064-98-0160	8727	R26	112.5	37.5	<0.5
~~064-98-0161~~	not sampled				
064-98-0162	9124	R26	137.5	12.5	<0.5
064-98-0163	9513	R26	137.5	37.5	<0.5

Bag #	Counts/Minute	Grid Number	Feet North	Feet East	Sample Depth (ft)
~~064-98-0164~~	not sampled				
064-98-0165	9489	Q25	187.5	87.5	<0.5
064-98-0166	9830	R25	12.5	87.5	<0.5
064-98-0167	9617	Q25	162.5	37.5	<0.5
064-98-0168	10097	R25	12.5	150	<0.5
064-98-0169	9562	Q25	187.5	112.5	<0.5
064-98-0170	9387	Q25	137.5	12.5	<0.5
064-98-0171	9084	R25	112.5	137.5	<0.5
064-98-0172	10094	R25	162.5	175	<0.5
064-98-0173	**8274**	**S25**	**12.5**	**187.5**	**<0.5**
064-98-0174	9338	S25	12.5	87.5	<0.5
064-98-0175	8516	S25	62.5	105	<0.5
064-98-0176	9455	S25	150	112.5	<0.5
~~064-98-0177~~	not sampled				
~~064-98-0178~~	not sampled				
~~064-98-0179~~	not sampled				
~~064-98-0180~~	not sampled				
~~064-98-0181~~	not sampled				
~~064-98-0182~~	not sampled				
~~064-98-0183~~	not sampled				
~~064-98-0184~~	not sampled				
~~064-98-0185~~	not sampled				
064-98-0186 *	**10754**	**R24**	**37.5**	**190**	**<0.5**
064-98-0187	9650	R24	105	162	<0.5
064-98-0188	9010	Q24	165.5	12.5	<0.5
064-98-0189 *	**10263**	**Q24**	**159.5**	**12.5**	**<0.5**
064-98-0190	9570	Q24	162.5	9.5	<0.5
064-98-0191	8593	Q24	162.5	15.5	<0.5
064-98-0192	8402	R24	115.5	137.5	<0.5
064-98-0193	8819	R24	109.5	137.5	<0.5
064-98-0194	8789	R24	112.5	134.5	<0.5
064-98-0195	9407	R24	112.5	140.5	<0.5
064-98-0196	10169	Q24	156.5	12.5	<0.5
064-98-0197	9281	Q24	159.5	9.5	<0.5
064-98-0198	9499	Q24	159.5	15.5	<0.5
064-98-0199	9095	R24	130	130	<0.5
064-98-0200	9534	R24	140	130	<0.5
064-98-0201	9188	R24	150	130	<0.5
064-98-0202	8579	R24	110	180	<0.5
maximum	10857				
minimum	8274				
mean	9668				
exp. stand. dev.	516				

* Samples that showed a Cs-137 peak when surveyed by a 3" x 3" NaI probe attached to a multi-channel analyzer.
Note: Samples selected for gamma spectroscopy analysis are in boldprint.

Table 2. Gamma Spectroscopy Results of Representative Samples.

Sample Name	Counts/Minute	Cs-137 (pCi/g) **	Sample Obervation	Bag #	Sample #
lowest	8274	0.41	contains few small asphalt pieces	064-98-0173	ENV980206
"1/4" point	9265	0.03	grey color sand	064-98-0089	ENV980207
mid-range	9727	0.11	sandy clay	064-98-0153	ENV980211
"3/4" point	10296	0.03	sandy clay	064-98-0127	ENV980210
highest *	10857	2.69	sandy clay	064-98-0093	ENV980208
background	8927	<MDA	sandy clay	N/A	ENV980213

* Sample that showed a Cs-137 peak when surveyed by a 3" x 3" NaI probe attached to a multi-channel analyzer.
** The minimum detectable activity (MDA) of Cs-137 is 0.02 pCi/g.

Table 3. Gamma Spectroscopy Results of Excavated Locations.

Sample Location	Before Excavation		After Excavation	
	Cs-137 (pCi/g)	Sample Number	Cs-137 (pCi/g)	Sample Number
R24-37.5-190	6.34	ENV980196 (Bag#064-98-0186)*	0.53	ENV980215 **
R24-112.5-137.5	2.69	ENV980208 (Bag#064-98-0093)*	0.43	ENV980227 **
Q24-162.5-12.5	2.57	ENV980209 (Bag#064-98-0116)*	1.30	ENV980236 ** : composite sample of Q24-162.5-12.5 & Q24-159.5-12.5
Q24-159.5-12.5	4.31	ENV980223 (Bag#064-98-0189)*	1.30	ENV980236 ** : composite sample of Q24-162.5-12.5 & Q24-159.5-12.5
R24-37.5-190 : Asphalt sample	13.68	ENV-98-0193 **	N/A	N/A
R24-37.5-190 : Particles from ENV980196 smaller than 0.0331 inch	7.36	ENV980220 **	N/A	N/A
R24-37.5-190 : Particles from ENV980196 larger than 0.0331 inch	3.93	ENV980219 **	N/A	N/A

* Samples that showed a Cs-137 peak when surveyed by a 3" x 3" NaI probe attached to a multi-channel analyzer.

** Samples analyzed directly by gamma spectroscopy without being surveyed by a NaI probe first.

TABLE 4. Gamma Exposure Measurements of Background Soil Sample.

Measurement #	Counts/Minute
1	8987
2	8939
3	8911
4	8933
5	8817
6	8882
7	9002
8	9043
9	8800
10	8951
Mean	8927
Experimental Standard Deviation (68% Confidence Limit)	77

APPENDIX C

SUBSURFACE CORE SAMPLE RESULTS

BOEING

The Boeing Company
Rocketdyne Propulsion & Power

6633 Canoga Ave.
P.O. Box 7922
Canoga Park, CA
91309-7922

Date: May 11, 1998

No.: SHEA-015099

To: Phil Rutherford
Manager, Radiation Safety
055-641, T487 x66140

From: Farley Dahl
SHEA Project Engineer
055-641, T100 x65788

Subject: Building 064 Sideyard and 'G' Street Core Drilling Sample Analyses

The Building 064 Sideyard and 'G' Street core drilling soil sampling was performed to verify the quality of the current cleanup activities, assess the depth to bedrock and sample underneath 'G' street. Core drilling was performed at 14 locations (see Figure 1). Location A was at the foundation of the previously demolished building. Location B was at the original 1963 contaminated zone and has been heavily excavated several times. Locations C and H are east and down slope of the building site and west of 'G" street. Locations D, E, F and G are in the sideyard proper to assess the excavated sanitary leach field. Locations I, J and K were drilled through the 'G' street road where the building 064 driveway connects. Locations L, M and N are located east of 'G' street across from the building 064 sideyard where contamination has been removed. All locations together adequately cover the affected areas.

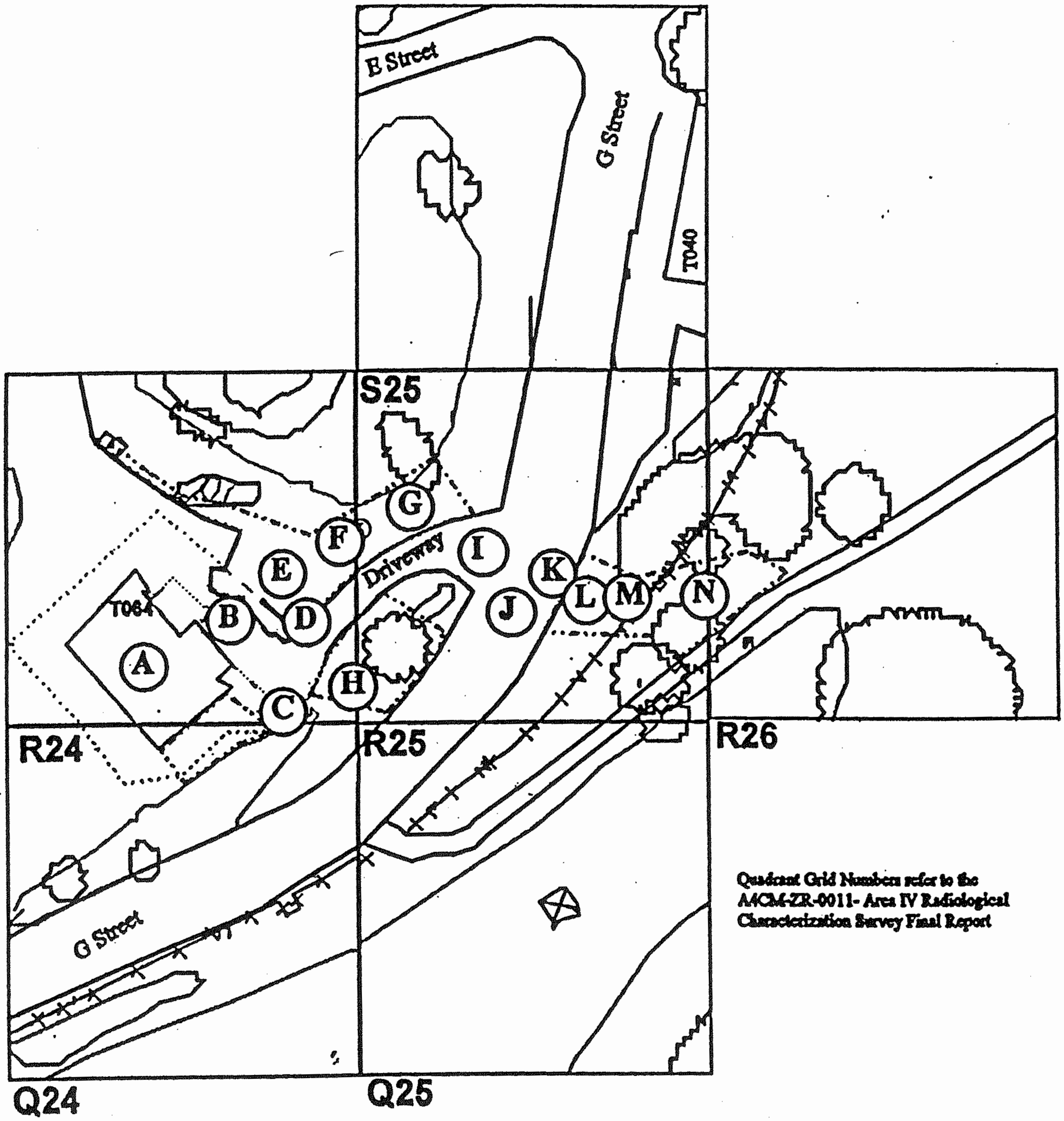
Fifty-two soil samples were taken at approximately 1.5 feet intervals until bedrock was encountered. Table 1 provides the sample numbers, locations, dates and depths of the samples. The samples were analyzed for gamma emitting radionuclides using a thin beryllium window High Purity Geranium (HPGe) Canberra gamma spectroscopy system. Results of the sample analyses for detected radionuclides are found in Table 2, which are all typical environmental background levels. The comparison with Site-wide Limits for Soil from N001SRR140127 are located in Table 3 where detected values and counting system MDA's for the analyses are listed. Figure 2 summarizes the natural K-40 in the soil as a comparison for the normal distribution of samples and homogeneity of the site soil. Additionally, Figure 3 plots the sample results for the primary isotope of interest Cs-137.

All samples underneath 'G' street lack the normal fallout levels of Cs-137 as expected and no excavation of the street for further sampling or remediation is required. Also, the samples fully support the quality of the current cleanup activities down to the bedrock and no further remediation of the exposed affected areas is required. In conclusion, the Building 064 Sideyard and 'G' Street core drilling soil sampling shows that the area has been remediated and is ready for the final survey and soil sampling, final survey report, third party verification phase and release.

Farley C. Dahl

Farley C. Dahl, PE

T064 SIDEYARD AND "G" STREET AREA DEEP SAMPLE LOCATIONS



Quadrant Grid Numbers refer to the A4CM-ZR-0011- Area IV Radiological Characterization Survey Final Report

Circled letters = approximate sample location designations

3-24-98

Figure 1. Map of the Building 064 Sideyard and 'G' Street Core - Drilling Sample Locations

Table 1. - Building 064 Sideyard and 'G' Street Core Samples Data Sheet

Sample Number	Sample Date	Location Designator	Depth Range Feet	Grid Number	Feet North	Feet East	Sampled By		Sample Description
064-98-0001	23-Mar-98	A	0 to 0.5	R24	28	91	E R	McGinnis	Soil
064-98-0002	23-Mar-98	E	0 to 1.5	R24	74	154	E R	McGinnis	Soil
064-98-0003	23-Mar-98	E	1.5 to 2.3	R24	74	154	E R	McGinnis	Soil
064-98-0004	23-Mar-98	F	0 to 1.5	R24	92	170	E R	McGinnis	Soil
064-98-0005	23-Mar-98	F	1.5 to 1.8	R24	92	170	E R	McGinnis	Soil
064-98-0006	23-Mar-98	G	0 to 1.1	R25	104	19	E R	McGinnis	Soil
064-98-0007	23-Mar-98	H	0 to 1.8	R24	33	197	E R	McGinnis	Soil
064-98-0008	23-Mar-98	H	1.8 to 3.1	R24	33	197	E R	McGinnis	Soil
064-98-0009	23-Mar-98	H	3.1 to 4.7	R24	33	197	E R	McGinnis	Soil
064-98-0010	23-Mar-98	H	4.7 to 6.4	R24	33	197	E R	McGinnis	Soil
064-98-0011	23-Mar-98	H	6.4 to 6.8	R24	33	197	E R	McGinnis	Soil
064-98-0012	23-Mar-98	M	0 to 1.4	R25	71	162	E R	McGinnis	Soil
064-98-0013	23-Mar-98	M	1.4 to 2.9	R25	71	162	E R	McGinnis	Soil
064-98-0014	23-Mar-98	M	2.9 to 4.5	R25	71	162	E R	McGinnis	Soil
064-98-0015	23-Mar-98	M	4.5 to 6	R25	71	162	E R	McGinnis	Soil
064-98-0016	23-Mar-98	M	6 to 8.3	R25	71	162	E R	McGinnis	Soil
064-98-0017	23-Mar-98	M	8.3 to 9.5	R25	71	162	E R	McGinnis	Soil
064-98-0018	23-Mar-98	M	9.5 to 10	R25	71	162	E R	McGinnis	Soil
064-98-0019	23-Mar-98	L	0 to 1.5	R25	77	139	E R	McGinnis	Soil
064-98-0020	23-Mar-98	L	1.5 to 3	R25	77	139	E R	McGinnis	Soil
064-98-0021	23-Mar-98	L	3 to 4.6	R25	77	139	E R	McGinnis	Soil
064-98-0022	23-Mar-98	L	4.6 to 6.3	R25	77	139	E R	McGinnis	Soil
064-98-0023	23-Mar-98	L	6.3 to 7.7	R25	77	139	E R	McGinnis	Soil
064-98-0024	23-Mar-98	L	7.7 to 8.5	R25	77	139	E R	McGinnis	Soil
064-98-0025	23-Mar-98	K	0 to 1.5	R25	93	126	E R	McGinnis	Soil
064-98-0026	23-Mar-98	K	1.5 to 3	R25	93	126	E R	McGinnis	Soil
064-98-0027	23-Mar-98	K	3 to 4.5	R25	93	126	E R	McGinnis	Soil
064-98-0028	23-Mar-98	K	4.5 to 6	R25	93	126	E R	McGinnis	Soil
064-98-0029	23-Mar-98	K	6 to 7.5	R25	93	126	E R	McGinnis	Soil
064-98-0030	23-Mar-98	K	7.5 to 9	R25	93	126	E R	McGinnis	Soil
064-98-0031	23-Mar-98	K	9 to 10.5	R25	93	126	E R	McGinnis	Soil
064-98-0032	23-Mar-98	K	10.5 to 12	R25	93	126	E R	McGinnis	Soil
064-98-0033	23-Mar-98	K	12 to 13.5	R25	93	126	E R	McGinnis	Soil
064-98-0034	23-Mar-98	K	13.5 to 15	R25	93	126	E R	McGinnis	Soil
064-98-0035	23-Mar-98	J	0 to 1.5	R25	82	102	E R	McGinnis	Soil
064-98-0036	23-Mar-98	J	1.5 to 3	R25	82	102	E R	McGinnis	Soil
064-98-0037	23-Mar-98	J	3 to 4.5	R25	82	102	E R	McGinnis	Soil
064-98-0038	23-Mar-98	J	4.5 to 6	R25	82	102	E R	McGinnis	Soil
064-98-0039	23-Mar-98	J	6 to 7.5	R25	82	102	E R	McGinnis	Soil
064-98-0040	23-Mar-98	J	7.5 to 9	R25	82	102	E R	McGinnis	Soil
064-98-0041	23-Mar-98	J	9 to 10.5	R25	82	102	E R	McGinnis	Soil
064-98-0042	23-Mar-98	I	0 to 1.5	R25	101	89	E R	McGinnis	Soil
064-98-0043	24-Mar-98	C	0 to 1.5	R24	2	142	E R	McGinnis	Soil
064-98-0044	24-Mar-98	C	1.5 to 2.2	R24	2	142	E R	McGinnis	Soil
064-98-0045	24-Mar-98	D	0 to 1.5	R24	49	164	E R	McGinnis	Soil
064-98-0046	24-Mar-98	D	3 to 4.5 *	R24	49	164	E R	McGinnis	Soil
064-98-0047	24-Mar-98	D	4.5 to 6	R24	49	164	E R	McGinnis	Soil
064-98-0048	24-Mar-98	D	6 to 7.5	R24	49	164	E R	McGinnis	Soil
064-98-0049	24-Mar-98	B	0 to 1.5	R24	59	127	E R	McGinnis	Soil
064-98-0050	24-Mar-98	B	1.5 to 3	R24	59	127	E R	McGinnis	Soil
064-98-0051	24-Mar-98	N	0 to 1.5	R25	76	194	E R	McGinnis	Soil
064-98-0052	24-Mar-98	N	1.5 to 3	R25	76	194	E R	McGinnis	Soil

** Location D, 1.5 to 3 feet, no sample retained.*

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TABLE 2 - BUILDING 064 SIDEYARD AND 'G' STREET SOIL DRILLING SAMPLES RESULTS

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	MAP LOC#	Sample wt.(grams)	K-40 pCi/g	Cs-137 pCi/g	Tl-208 pCi/g	Pb-212 pCi/g	Bi-212 pCi/g	Ra-224 pCi/g	Ac-228 pCi/g	Pb-210 pCi/g	Pb-214 pCi/g	Bi-214 pCi/g	Ra-226 pCi/g	Th-234 pCi/g	Pa-234m pCi/g	U-235 pCi/g
064-98-0001	3/23/98	A	713	18.22	0.02	0.36	0.56	< 0.14	1.03	0.93	0.95	0.67	0.89	1.63	0.68	< 2.67	0.10
064-98-0002	3/23/98	E	742	16.73	0.09	0.32	0.72	< 0.11	0.93	0.96	0.77	0.62	0.70	1.49	0.99	< 2.61	0.09
064-98-0003	3/23/98	E	741	18.26	0.05	0.36	0.67	1.08	1.30	0.98	0.83	0.89	0.87	1.63	0.92	< 2.74	0.10
064-98-0004	3/23/98	F	841	17.79	0.08	0.30	0.66	0.96	0.99	0.94	0.91	0.71	0.76	1.44	0.79	< 3.01	0.09
064-98-0005	3/23/98	F	861	17.84	< 0.03	0.36	0.52	< 0.14	1.34	1.02	< 0.74	0.60	0.84	1.39	0.61	< 2.60	0.08
064-98-0006	3/23/98	G	874	17.78	0.02	0.43	0.76	0.74	1.39	1.05	1.01	0.79	0.83	< 0.41	1.04	2.37	0.10
064-98-0007	3/23/98	H	716	16.76	0.04	0.36	0.92	1.00	1.05	1.05	0.76	0.75	0.77	2.08	1.14	< 2.79	0.13
064-98-0008	3/23/98	H	854	19.59	< 0.02	0.35	0.76	< 0.14	1.23	1.05	0.95	0.98	0.87	1.61	0.74	< 2.84	0.10
064-98-0009	3/23/98	H	879	17.62	< 0.02	0.34	0.56	0.99	1.40	1.01	0.96	0.81	0.77	1.86	0.72	< 2.73	0.11
064-98-0010	3/23/98	H	738	16.99	< 0.02	0.37	0.78	0.79	1.29	0.95	1.07	0.98	0.76	1.50	0.86	< 2.43	0.09
064-98-0011	3/23/98	H	662	16.10	< 0.02	0.36	0.61	1.85	1.40	0.97	< 0.76	0.77	0.82	1.74	0.73	< 2.68	0.11
064-98-0012	3/23/98	M	683	16.38	0.12	0.36	0.68	< 0.14	1.28	0.90	0.94	0.87	0.86	1.84	0.93	< 2.63	0.10
064-98-0013	3/23/98	M	720	16.75	< 0.02	0.37	0.73	< 0.13	1.10	0.99	< 0.73	0.84	0.84	1.92	0.82	< 2.71	0.12
064-98-0014	3/23/98	M	894	15.85	< 0.02	0.42	0.82	1.14	1.35	1.14	1.17	0.83	0.81	1.83	1.05	< 2.70	0.11
064-98-0015	3/23/98	M	708	14.56	< 0.02	0.34	0.76	0.78	1.18	0.99	1.27	0.89	0.76	1.49	0.97	< 2.58	0.09
064-98-0016	3/23/98	M	938	14.60	< 0.02	0.30	0.48	0.74	0.99	0.96	0.98	0.67	0.81	1.44	0.77	2.13	0.09
064-98-0017	3/23/98	M	1168	13.39	< 0.02	0.25	0.52	0.52	0.77	0.72	0.75	0.82	0.82	< 0.27	0.74	< 1.73	0.07
064-98-0018	3/23/98	M	1151	13.37	< 0.02	0.28	0.41	< 0.09	0.93	0.90	0.96	0.71	0.73	1.34	0.45	< 1.88	0.08
064-98-0019	3/23/98	L	773	16.80	0.03	0.37	0.71	1.02	1.19	1.02	0.70	0.72	0.94	1.61	0.86	< 2.41	0.10
064-98-0020	3/23/98	L	760	15.70	< 0.02	0.40	0.72	0.77	1.22	1.13	0.75	0.79	0.91	1.08	0.93	< 2.62	0.11
064-98-0021	3/23/98	L	843	15.98	< 0.02	0.37	0.52	2.08	1.29	1.09	< 0.68	0.71	0.82	1.84	0.63	< 2.43	0.11
064-98-0022	3/23/98	L	863	15.27	< 0.02	0.37	0.88	< 0.13	1.20	1.07	0.88	0.81	0.85	1.91	0.88	< 2.39	0.12
064-98-0023	3/23/98	L	793	14.42	< 0.02	0.37	0.51	< 0.11	1.19	1.03	0.75	0.66	0.71	1.42	0.61	1.88	0.09
064-98-0024	3/23/98	L	823	14.37	< 0.02	0.33	0.48	< 0.11	1.08	0.93	0.98	0.66	0.68	1.21	0.68	< 2.37	0.07
064-98-0025	3/23/98	K	1042	16.08	0.01	0.34	0.50	0.73	0.95	0.89	0.82	0.81	0.86	1.38	0.75	1.78	0.08
064-98-0026	3/23/98	K	898	16.28	< 0.02	0.33	0.80	0.90	1.17	0.87	0.61	0.59	0.91	1.58	0.71	< 2.23	0.10
064-98-0027	3/23/98	K	980	17.17	< 0.02	0.31	0.45	0.62	1.18	0.96	< 0.62	0.74	0.78	1.43	0.90	< 2.21	0.09
064-98-0028	3/23/98	K	861	17.31	< 0.02	0.34	0.55	< 0.12	0.97	0.91	0.91	0.86	0.86	1.48	0.73	< 2.27	0.09
064-98-0029	3/23/98	K	784	17.84	< 0.02	0.40	0.74	0.90	1.08	1.13	< 0.73	0.89	0.99	< 0.36	1.28	< 2.39	0.12
064-98-0030	3/23/98	K	752	17.52	< 0.02	0.39	0.82	0.76	1.44	1.13	1.41	0.82	0.91	1.81	1.18	<2.70	0.11
064-98-0031	3/23/98	K	781	16.85	< 0.02	0.40	0.70	< 0.13	1.38	1.13	0.92	0.67	0.91	1.71	0.83	2.22	0.10
064-98-0032	3/23/98	K	718	16.52	< 0.02	0.44	0.86	0.83	1.14	1.18	1.06	0.80	0.89	1.81	0.84	2.57	0.11
064-98-0033	3/23/98	K	611	15.32	< 0.02	0.38	0.79	1.05	1.15	1.12	0.99	0.72	0.80	1.79	1.08	< 2.67	0.11
064-98-0034	3/23/98	K	818	15.62	< 0.02	0.38	0.51	0.94	1.23	1.08	0.86	0.77	0.84	1.78	0.97	2.58	0.11
064-98-0035	3/23/98	J	816	16.89	< 0.02	0.42	0.53	0.98	1.37	1.08	< 0.72	0.75	0.83	1.53	0.91	< 2.47	0.09
064-98-0036	3/23/98	J	753	18.18	< 0.02	0.36	0.71	< 0.13	1.28	0.96	0.99	0.86	0.81	1.50	0.87	< 2.65	0.09
064-98-0037	3/23/98	J	737	18.37	< 0.02	0.40	0.74	< 0.13	1.29	1.02	1.15	0.90	0.97	1.69	1.08	< 2.70	0.10
064-98-0038	3/23/98	J	898	15.57	< 0.02	0.38	0.73	1.13	1.34	1.10	0.70	0.87	0.90	1.58	1.08	< 2.48	0.10
064-98-0039	3/23/98	J	765	16.68	< 0.02	0.42	0.74	< 0.13	1.24	1.19	< 0.75	0.81	0.86	1.72	0.82	< 2.64	0.10
064-98-0040	3/23/98	J	714	16.81	< 0.02	0.41	0.87	< 0.15	1.18	1.13	0.82	0.89	0.89	1.86	1.05	< 2.65	0.11
064-98-0041	3/23/98	J	797	16.11	< 0.02	0.44	0.47	1.14	1.15	1.13	0.84	0.80	0.87	1.62	1.06	< 2.49	0.10
064-98-0042	3/23/98	I	849	16.81	< 0.02	0.37	< 0.13	0.77	1.07	0.98	0.89	0.57	0.83	1.70	0.90	< 2.42	0.10
064-98-0043	3/24/98	C	858	16.88	0.13	0.35	0.44	< 0.12	1.20	1.01	< 0.64	0.56	0.67	1.28	0.80	< 2.16	0.08
064-98-0044	3/24/98	C	789	16.90	0.11	0.40	0.78	< 0.14	1.18	1.11	0.73	0.63	0.67	1.55	0.80	1.93	0.09
064-98-0045	3/24/98	D	854	17.88	< 0.02	0.33	0.67	1.00	1.18	0.87	1.01	0.77	0.86	1.51	1.14	< 2.92	0.09
064-98-0046	3/24/98	D	818	17.21	< 0.02	0.32	0.67	< 0.13	1.01	0.85	< 0.68	0.82	0.90	< 0.36	0.84	< 2.31	0.10
064-98-0047	3/24/98	D	784	19.02	< 0.02	0.33	0.67	0.86	1.13	1.01	0.87	0.81	0.85	1.47	0.94	< 2.80	0.09
064-98-0048	3/24/98	D	875	17.83	0.02	0.35	0.89	< 0.10	0.92	0.94	< 0.67	0.84	0.86	1.81	1.00	2.15	0.11
064-98-0049	3/24/98	B	843	17.38	0.02	0.31	0.42	< 0.11	1.01	0.83	0.73	0.73	0.71	1.44	0.58	< 2.31	0.09
064-98-0050	3/24/98	B	851	17.59	< 0.02	0.35	0.50	0.80	1.04	0.91	0.88	0.26	0.84	1.48	0.84	< 2.46	0.09
064-98-0051	3/24/98	N	828	16.58	0.02	0.35	0.84	0.72	1.10	0.91	0.70	0.83	0.87	1.82	1.20	< 2.43	0.11
064-98-0052	3/24/98	N	866	15.21	< 0.02	0.31	0.65	1.59	0.85	0.85	0.86	0.61	0.88	1.37	0.72	< 1.99	0.08
		Number of detects		52	14	52	51	31	52	52	41	52	52	48	52	9	52
		Detect[1]	Maximum	19.59	0.13	0.44	0.92	2.08	1.44	1.19	1.41	0.90	0.99	2.08	1.26	2.58	0.13
			Average	16.79	0.06	0.36	0.64	0.94	1.16	1.00	2.18	0.73	0.80	1.62	0.86	2.16	0.10
			Minimum	13.37	0.02	0.25	0.41	0.52	0.77	0.72	0.56	0.26	0.61	1.21	0.45	1.68	0.07

[1]Note: MDA's are not included in the summary calculations

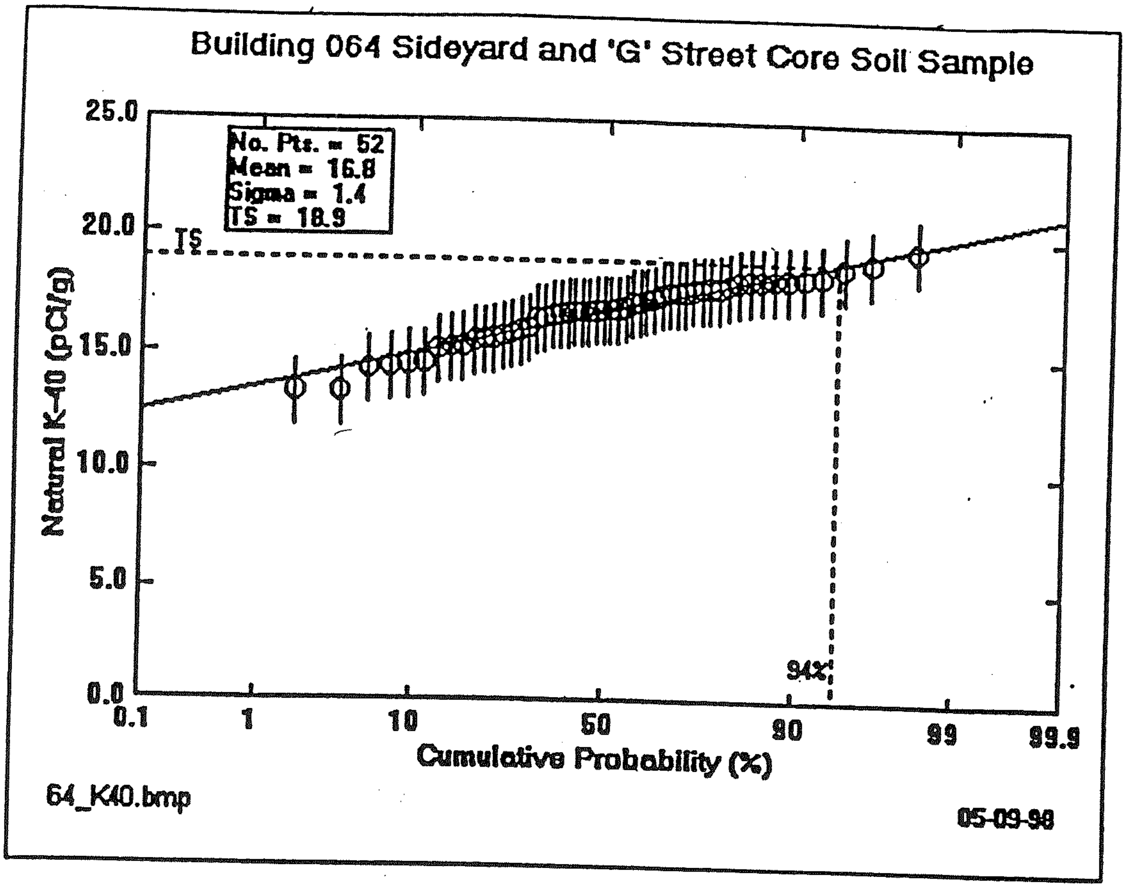

Figure 2. K-40 Cumulative Distribution Plot

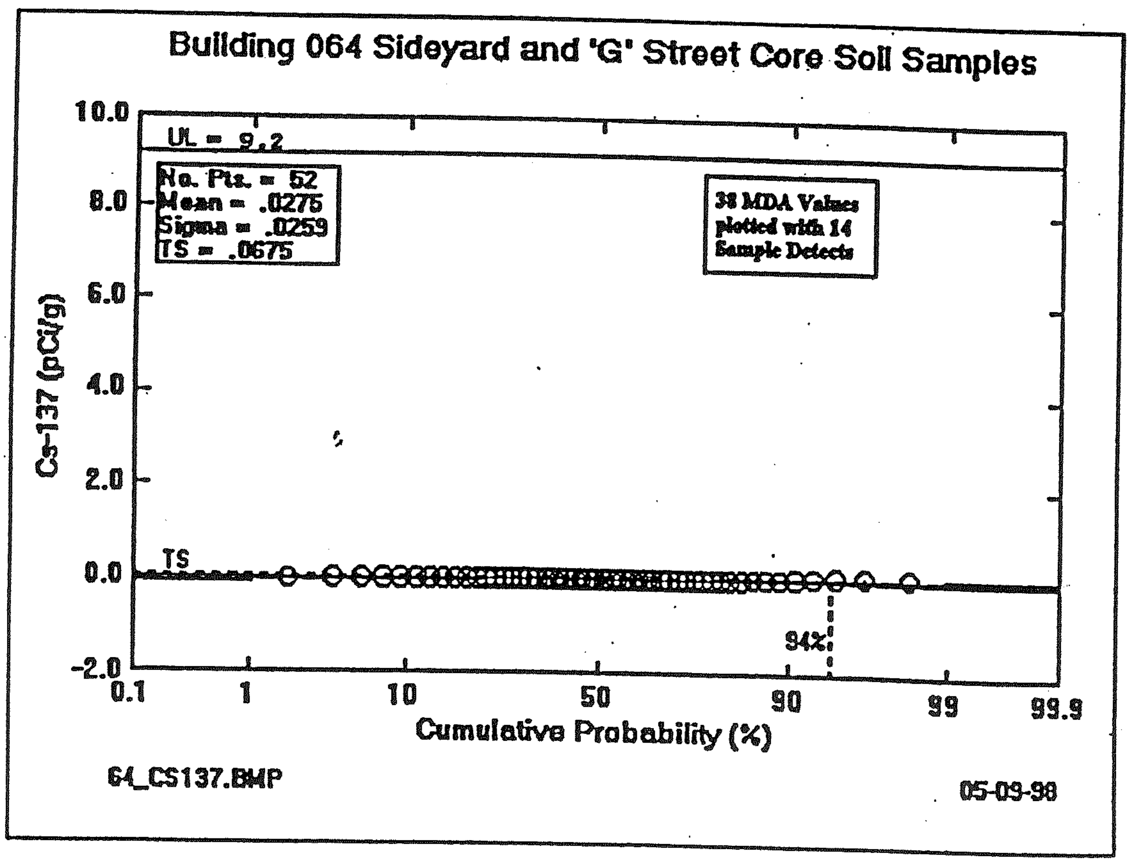

Figure 3. Cs-137 Cumulative Distribution Plot

TABLE 3
SITE-WIDE LIMITS FOR SOIL VERSUS OBSERVED CONCENTRATION (REFERENCE N001SRR140127) [a]

Radionuclide	Soil Guideline	Observed Concentration
Am-241	5.44	< 0.06
Co-60	1.94	< 0.02
Cs-134	3.33	< 0.02
Cs-137	9.20	0.02 – 0.13
Eu-152	4.51	< 0.04
Eu-154	4.11	< 0.03
K-40	27.6	13.4 – 19.6
Na-22	2.31	< 0.02
Ra-226	5[d], 15[d]	1.2 – 2.8
Th-228	5[d], 15[d]	< 3.7
Th-232	5[d], 15[d]	< 10.3
U-234	30[c]	< 16.5
U-235	30[c]	0.07 – 0.13
U-238	35[c]	1.68 – 3.01

[a] Reference taken from Boeing/Rocketdyne 96ETEC-DRF-0374, Enclosure A, June 28, 1996
[c] Generally more conservative NRC limits for uranium isotopes are proposed
[d] DOE Order 5400.5 limits are proposed (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)

ENERGY TECHNOLOGY ENGINEERING CENTER

OPERATED FOR THE U.S. DEPARTMENT OF ENERGY
ROCKETDYNE DIVISION, ROCKWELL INTERNATIONAL

No. SSWA-ZR-0001 Rev.
Page 1 of 72
Orig. Date 01/14/94
Rev. Date

SAFETY REVIEW REPORT (SRR)

TITLE: FINAL RADIOLOGICAL SURVEY REPORT OF BUILDING 064 INTERIOR

- APPROVALS -

Originator	F. C. Dahl/R. J. Tuttle	Fac Mgr	R. D. Meyer 2-10-94
Proj Mgr	G. G. Gaylord	RP&HPS	P. D. Rutherford 2/10/94
QA	T. D. Hunnicutt		

REV. LTR.	REVISION	APPROVAL/DATE

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ABSTRACT

A comprehensive radiological survey of Building 064 and its surrounding area at the SSFL was performed in 1988. In accordance with the recommendation made in that survey report, remedial efforts were undertaken to remove residual radioactively contaminated components from the Building 064 structure and grounds. After the decontamination efforts were completed, a comprehensive final survey of the building interior was performed to demonstrate regulatory compliance for release without radiological restrictions.

Results of surveys demonstrate that Building 064 meets the requirements of DOE, NRC, and State of California for releasing Building 064 for use without radiological controls.

REFERENCES

1. 154SRR000001, Radiological Survey Plan for SSFL, Rockwell International, dated September 25, 1985, F. H. Badger and R. J. Tuttle

2. GEN-ZR-0005, Radiological Survey of the Source and Special Nuclear Material Storage Vault - Building T064, dated August 19, 1988, J. A. Chapman

3. SSWA-AN-0001, D&D Work Plan for Building 064, Environmental Restoration

4. ER-AN-0002, ETEC Environmental Restoration Program Management Plan, dated October 25, 1991

5. N001OP000033, Methods and Procedures for Radiological Monitoring

6. N001OP000028, Quality Control and General Operating Procedure for Gamma Spectroscopy Using Canberra Multichannel Analyzers

7. DOE Order 5400.5, Radiation Protection of the Public and the Environment, dated February 8, 1990

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

9. NRC Dismantling Order for the L-85 Reactor Decommissioning, NRC to M. E. Remley, dated March 1, 1983

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

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

12. N704SRR990035, Radiological Assessment of the Building T064 Fenced-In Yard, January 12, 1994

13. N704SRR990031, Final Decontamination and Radiological Survey of the Building T064 Side Yard, Rev. A, September 10, 1993

14. SSWA-AR-0002, Building 064 D&D Operations Final Report

15. SSWA-SP-0001, Building 064 Interior Final Survey Procedure (completed "on-site work copy") dated February 25, 1993

1.0 INTRODUCTION

Decontamination and decommissioning (D&D) of a number of formerly used nuclear facilities and sites is underway at Rockwell International's Santa Susana Field Laboratory (SSFL). During D&D of these facilities, reasonable efforts are being made to eliminate or to reduce residual radioactive contamination to levels that are as low as reasonably achievable (ALARA). Upon completion of D&D, radiological surveys are performed under established protocols to determine that any remaining radioactivity does not exceed applicable regulatory limits. Findings from the surveys are also used to perform additional D&D or radiological investigations, as needed. The scope of the surveys includes both known and suspected areas of contamination in the Building 064 interior.

In accordance with a broad radiological survey plan for the SSFL (Ref. 1), a comprehensive radiological survey of Building 064 and its surrounding area was performed in 1988 (Ref. 2). Results of that survey showed that the soil of the Side Yard was radioactively contaminated (which was subsequently cleaned [Ref. 13]) and that some items within the building and the ventilation exhaust filter plenums were contaminated. This report presents the final status survey results following removal of the contaminated items and the filter plenums, and removal of the floor tiles.

This report is organized as follows: first, the summary of the results of the survey and the conclusions and recommendations; second, the background information concerning past radiological status, D&D efforts, and current radiological status; third, the survey results and the technical approach used in the data collection, analyses, and limit criteria; and fourth, the supporting documentation and calculations for historical records and report completeness.

2.0 SUMMARY AND CONCLUSIONS

Survey measurements were made for surface contamination (alpha and beta) on the interior walls, floors, and ceilings in Building 064, and for ambient gamma exposure rate at 1 meter above the interior floors. These measurements were tested statistically for compliance with acceptable contamination limits for enriched uranium, activation products, and mixed fission products, and for ambient exposure rate.

All tests for surface contamination showed that the facility is suitable for release without radiological restrictions. Interpretation of the gamma exposure rate measurements for the Building 064 interior is based on the average gamma exposure rate background value (15.76 μR/hr) for a building of similar construction (Building S445) that has never been used for any radiological purposes. The probability distributions of the comparisons between these measurements shows no local contamination, except for two measurements that were affected by the near proximity of smoke alarm units containing approximately 80 μCi Am-241. The results indicate a natural/normal background distribution for the building, with an average value of 14.7 μR/hr. Therefore, the Building 064 interior average gamma exposure rate is consistent with the average gamma exposure rate for Building S445.

3.0 BACKGROUND

3.1 Location

Building 064 is located within Rockwell International's 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, directly south of the City of Simi Valley. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 1. An enlarged map of neighboring SSFL communities is shown in Figure 2. Figure 3 is a plot plan of the western portion of SSFL known as Area IV, where Building 064 is located. Building 064 is located on government-optioned land, subject to the Health and Safety Clause of the operating contract with DOE, and is exempt from licensing.

3.2 Topography and Building Characteristics

Building T064 was designed and built as a special nuclear material and source radioactive material storage building. It was constructed in two phases. The first phase was constructed in 1958. This 2137 ft^2 portion, (room 110), is a reinforced concrete structure with 11-in thick walls on a concrete slab. The building eave height is 16 ft, and the structure is open bay except for a 12 ft x 13 ft material handling area in the southeast corner of the building. A fume hood was installed in this small southeast corner, (room 104).

In 1963, the building was enlarged by adding a bay to the north (room 114) bringing the total square footage of the building to 4418 ft^2. This addition used 12-in concrete block construction with cores filled with concrete. Total square footage includes a small 150 ft^2 office (room 100) and a 50 ft^2 rest room (room 102), both located on the dock on the east side of the building. On the northwest corner is a small supply and storage room, about 50 ft^2, (room 116).

Figure 1. Location of SSFL in relation to Los Angeles and Vicinity

Figure 2. Map of Neighboring SSFL Communities

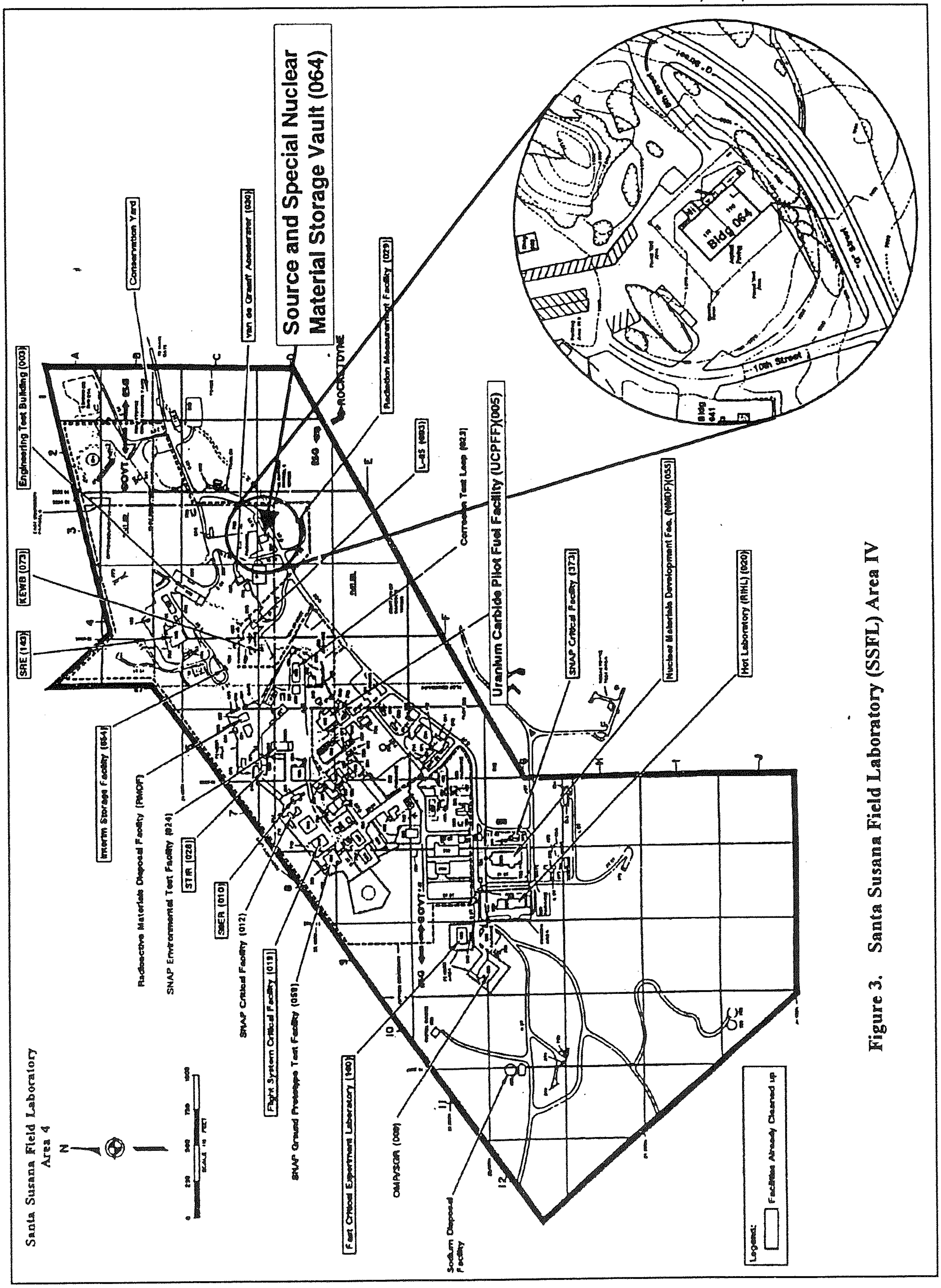

Figure 3. Santa Susana Field Laboratory (SSFL) Area IV

The concrete-slab floors were covered with 12-in square vinyl-asbestos tiles. The concrete-block walls are painted. In 1980, the entire facility was reroofed; interior wall surfaces were patched and painted; floor tile was removed and replaced; the rest room and office were restored; asphalt was patched; plumbing was repaired; heating and ventilation was repaired; and a window air-conditioner was installed in the office. Ten-ft-long fluorescent lights were suspended from the 16-ft high ceiling. Storage racks were constructed to accommodate fuel. Room 114 is accessible from the east through a 20 ft x 15 ft electrically driven rollup door and a conventional hinged door. Room 110 is accessible from the east through a heavy secured door. These two rooms are extremely secure. Ramps leading to each room allow easy transport of materials via forklift.

Since nuclear material was only stored here, there was no processing equipment within the building. No sinks were installed in the storage areas. The only water supply was to the rest room (room 102); this water was released to the sewer. The facility is not air conditioned. Each vault was ventilated by dedicated blowers through a plenum containing pre-filters and HEPA filters. Room 104 had a fume hood which exhausted through the south filter plenum.

Figure 4 is a plot plan of the building and immediate surrounding yard area. The facility sits atop a plateau about 25 ft above "G" Street and slightly above the 513 parking lot. Rock outcroppings exist upslope to the north-northeast and downslope in every other direction. Water runoff is primarily due east at the southern end of the facility. A sanitary leach field existed several years ago just north of the access road to "G" Street on the southeast section of the property. The building is surrounded by a chain link fence which is located from 20 to 30 ft from the exterior walls of the building. The area it encloses, including the building, is about 11,000 ft^2.

There are three points of access to the site location of Building T064. One access is directly from the north through the 513 parking area which is on the east side of 10th Street. A second point of access is directly off 10th Street at the NW corner of the facility, and the third is a short paved roadway connecting the SE corner of the facility with "G" Street to the east. There are two gates for accessing the fenced-in storage yard. One from the northeast corner, off of the 513 parking lot. The other from the southeast corner, off of "G" Street. Figure 5 is an aerial photo of Building T064 as viewed from the east side of the facility including the dock, office, crane, and main entrance.

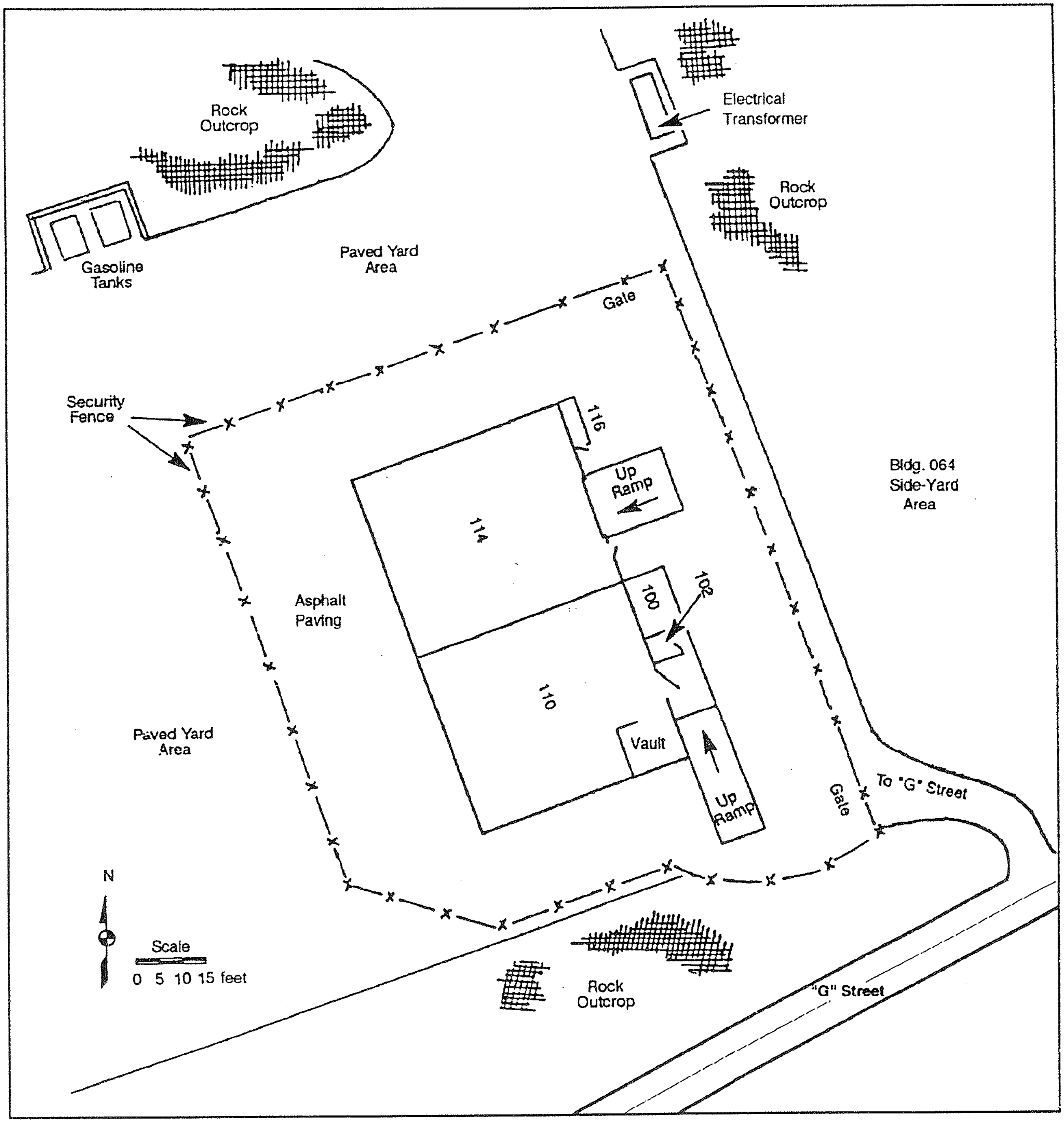

Figure 4. Building 064 Plan View

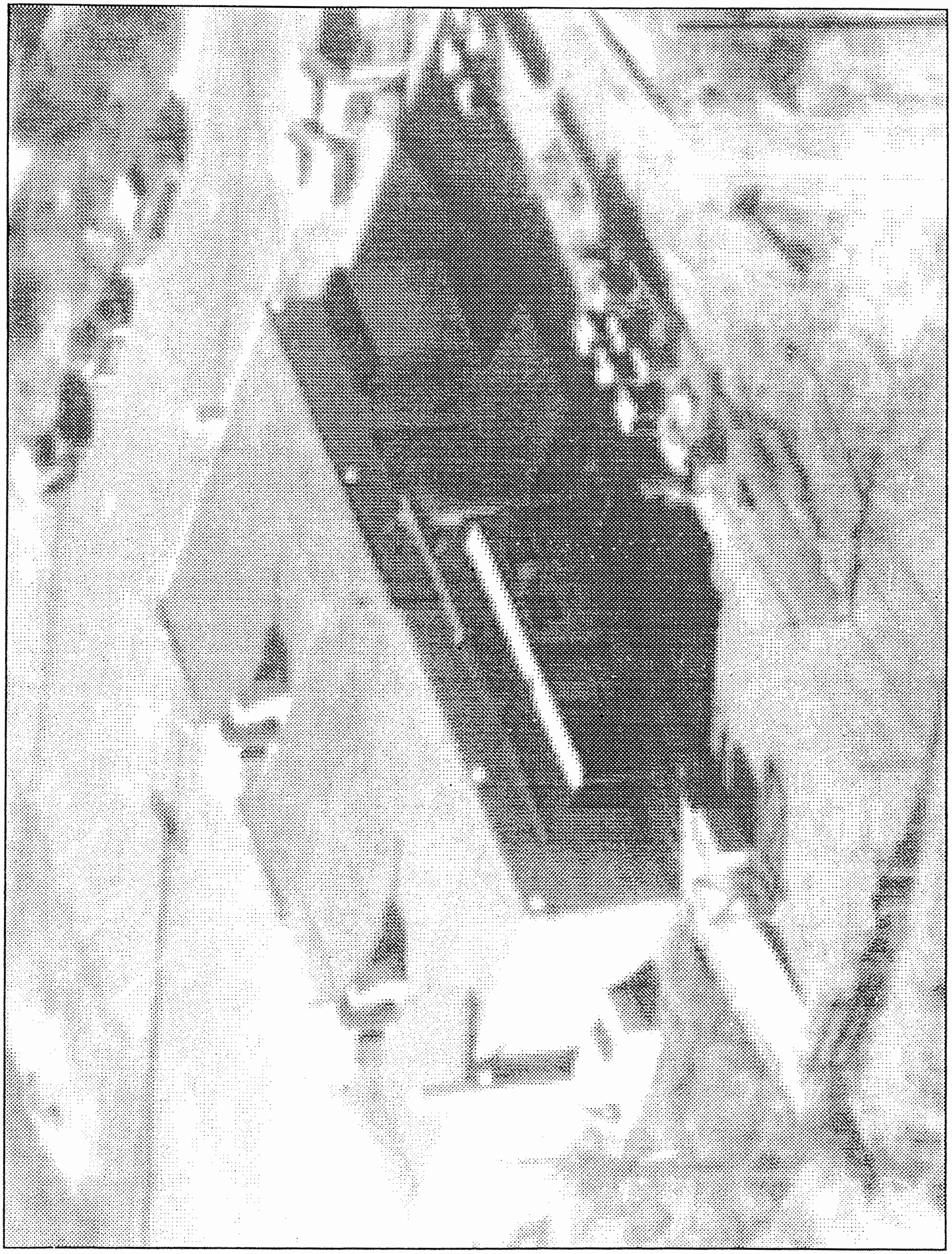

Figure 5: Aerial Photograph of Building 064, Viewing Eastside

3.3 Operating History

This building was used primarily for storage of packaged items of source material (normal uranium, depleted uranium, thorium) and special nuclear material (enriched uranium, plutonium, U-233) of various forms and configurations. Originally both the north (room 114) and the south (room 110) vaults contained steel racks for storing material. The south side was primarily used for storage of highly enriched uranium and plutonium bearing items; the north side was primarily used for source material and low enriched uranium storage.

Enriched uranium powders and source material powder packages were split into smaller units or combined into larger units in a glove box located in the small work area alcove (room 104) in the southeast corner of room 110. The glove box has since been removed from the building. Plutonium was handled only in packaged form; never in a loose form. No plutonium repackaging was done other than transferring sealed packages between containers. Transfers of solid metallic forms of material generally were handled in the glove box; however, on occasion, larger pieces were transferred and repackaged within the vault area. During shutdown and termination of the SNAP program, excess Zr-U (enriched U) alloy product line material was sectioned into lengths suitable for packaging for shipment in DOE (AEC) containers. This was done near the edge of the south side alcove in the vault. The floor was covered with plastic sheets before the Zr-U was sectioned using a common hack saw.

During the early 1960's, a changed storage configuration was required. The metal racks from the south half of room 110 was removed in order to store material in "birdcages" and drums. This storage included large quantities of special nuclear material recoverable scrap.

During this time, recoverable scrap space was at a premium. As a result, the entire yard area in front of the building (East), the side (North) and the back (West) was filled with 55 gallon drums of low enriched recoverable scrap. This material was shipped to various recovery sites in the mid-to late 1960's and early 1970's.

No plutonium or U-233 packages were ever opened in either vault. Any residual radioactive contamination is enriched uranium, normal uranium, depleted uranium, or thorium and generally could be expected to have come from "dust" from handling bare metallic pieces.

During the mid 1970's to early 1980's, most of the major DOE nuclear development and reactor contracts had ended.

No special nuclear material powders were handled or repackaged after 1980. Most of the material had been sent to other DOE sites for recovery and use. A new roof was installed on the facility in 1980 to correct leaks. Shortly afterward, the walls were repainted and other repairs were made. The racks from the north vault were removed and the area converted to storage of non-nuclear DOE components.

No reports of contamination incidents occurring within the building were recorded in the overall incident file.

3.4 Decommissioning and Demolition Efforts

To release the facility for use without radiological restrictions, all contaminated equipment and fixtures had to be removed in preparation for the final radiological survey. In addition, all hazardous materials and wastes in the facility had to be properly disposed. Where practical and cost effective, equipment was decontaminated and either disposed as non-RA waste or surplused. Some equipment required disassembly in order to remove hazardous materials such as oils, grease, and lead. Most of the items, however, could not be readily decontaminated and some equipment had areas that could not be surveyed with the confidence level necessary for release without radiological restrictions. Analysis of the floor tiles indicated that the tiles and mastic glue throughout the facility contained asbestos and would require removal and disposal.

The decommissioning work performed in room 114 consisted of the removal of miscellaneous packaged components and approximately 195 cubic yards of previously packaged containerized soil temporarily stored there. All of the items stored in room 114 were brought to the facility for storage after work with nuclear materials had ceased at B/064 and had been properly packaged to prevent release of contamination. During the removal of the equipment and boxes of soil, frequent area contamination surveys were performed by Radiation Protection and Health Physics Services (RP&HPS) representatives to assure that container integrity and contamination control were maintained. All contaminated equipment, components, and soil that had been stored in room 114 were transported to the RMDF for temporary storage awaiting eventual disposal at an approved DOE burial site.

Most of the items in room 110 had been used for operations at B/064 and were contaminated to varying degrees. When practical, size reduction and packaging were performed in the facility. However, some of the equipment required more aggressive techniques for size reduction and contamination control. These items included: a fume hood that had been used to package enriched uranium powders and source materials, two large balances, and several steel shipping drum inserts. All of these items were transferred to the RMDF for size reduction and packaging for disposal. The fluorescent light fixtures in this room were found to be contaminated and were taken down, disassembled, and the PCB containing ballasts were removed. The fixtures (less ballasts and bulbs) were packaged and disposed of as radioactive waste. The ballasts were surveyed and found to be radiologically clean and were disposed of as hazardous PCB waste. The fluorescent bulbs were decontaminated and disposed of as conventional waste. The storage racks contained fixed RA contamination and were disassembled, size reduced, and packaged, and transferred to the RMDF for eventual shipment to an approved disposal facility.

To maintain contamination control during the size reduction of the HEPA filter plenums, size reduction was done at the RMDF. The plenums were detached from the buildings and blowers as intact units and transported to the RMDF. Because of the large size of the exhaust plenums, this effort required the fabrication of custom boxes to assure contamination control during transport. Inlet and outlet openings were sealed, the units were disconnected from the building, placed in the boxes and transferred to the RMDF. The plenums were cut into manageable pieces using a plasma torch and packaged for disposal as radioactive waste.

Because the facility had been used for storage for a number of years, special attention was given to identifying hazardous or potentially hazardous materials requiring disposition. Two scales were found to contain oil and one also contained lead. A four-ounce quantity of oil from one of the scales was determined to contain radioactive contamination and was effectively treated during the Molten Salt Oxidation (MSO) Bench Scale Unit tests being performed at the RMDF. The other oil and the lead were certified as "Containing No DOE-Added Radioactivity," in accordance with ER-SP-0001 and were disposed of in accordance with the Rocketdyne Environmental Control Manual. The ballasts removed from the light fixtures in room 110 were hermetically sealed units and after a thorough radiological survey were also certified as "Containing No DOE-Added Radioactivity" and were disposed of in accordance with the Rocketdyne Environmental Control Manual.

Because the tiles throughout the facility had been determined to contain asbestos and were in a deteriorated state their removal was required. A sampling plan was developed and implemented in accordance with ER-SP-0001. Randomly selected tiles were removed and the tiles and subfloor were surveyed for total contamination. The results of this survey sampling concluded that the tiles and subfloor had no detectable activity (NDA) above background; therefore, all tiles were certified as "Containing No DOE-Added Radioactivity." An asbestos abatement contractor was employed to remove a total of 4,352 ft^2 of tile. The tile and abatement-related ACM wastes have been packaged and placed in an approved hazardous waste container and will be disposed at an approved disposal facility. Copies of certifications were forwarded to the DOE.

4.0 SURVEY RESULTS

4.1 Overview

Upon D&D of radioactive constituents, releasing a facility or area for unrestricted use requires a formal radiation survey to demonstrate that the applicable regulatory limits for such a release are met. The survey is performed under an established plan, and a statistical interpretation of the resulting data is made to determine if the regulatory release criteria have been met. This document provides information that demonstrates that Building 064 meets DOE, NRC, and State of California criteria for release of the facility for unrestricted use.

4.2 Scope of the Survey

For the final radiological survey of Building 064, the interior rooms and office were separated into sample lots. These sample lots are graphically shown in Figure 6. Sample lots were treated separately for the purposes of statistical data analyses. Distinguishable properties for selecting the sample lots were areas or rooms which contained contaminated components that were recently decontaminated. The chosen sample lots or areas are shown in Table 1 with the corresponding type of survey performed. (The Fenced-In Yard has been surveyed and reported [Ref. 12]. The Side Yard, to the east, has also been surveyed and reported [Ref. 13]).

Table 1. Sample Lots Surveyed

Sample Lot No.	Room or Area	Type of Survey Performed[1,3]				
		Total		Removable		Ambient Gamma[2]
		Alpha	Beta	Alpha	Beta	
1	Rooms 110 & 104	x	x	x	x	x
2	Room 114	x	x	x	x	x
3	Rooms 116, 120, & rest rooms	x	x	x	x	x

(1) The type of survey performed for each sample lot was dependent on the type of surface being measured (e.g., concrete floor, walls, asphalt, gravel roof, tile floors, etc.)

(2) Ambient gamma readings are performed only on the horizontal walking surfaces at 1 meter.

(3) 20% of all structural surfaces were surveyed in each sample lot for total alpha, total beta, removable alpha, and removable beta.

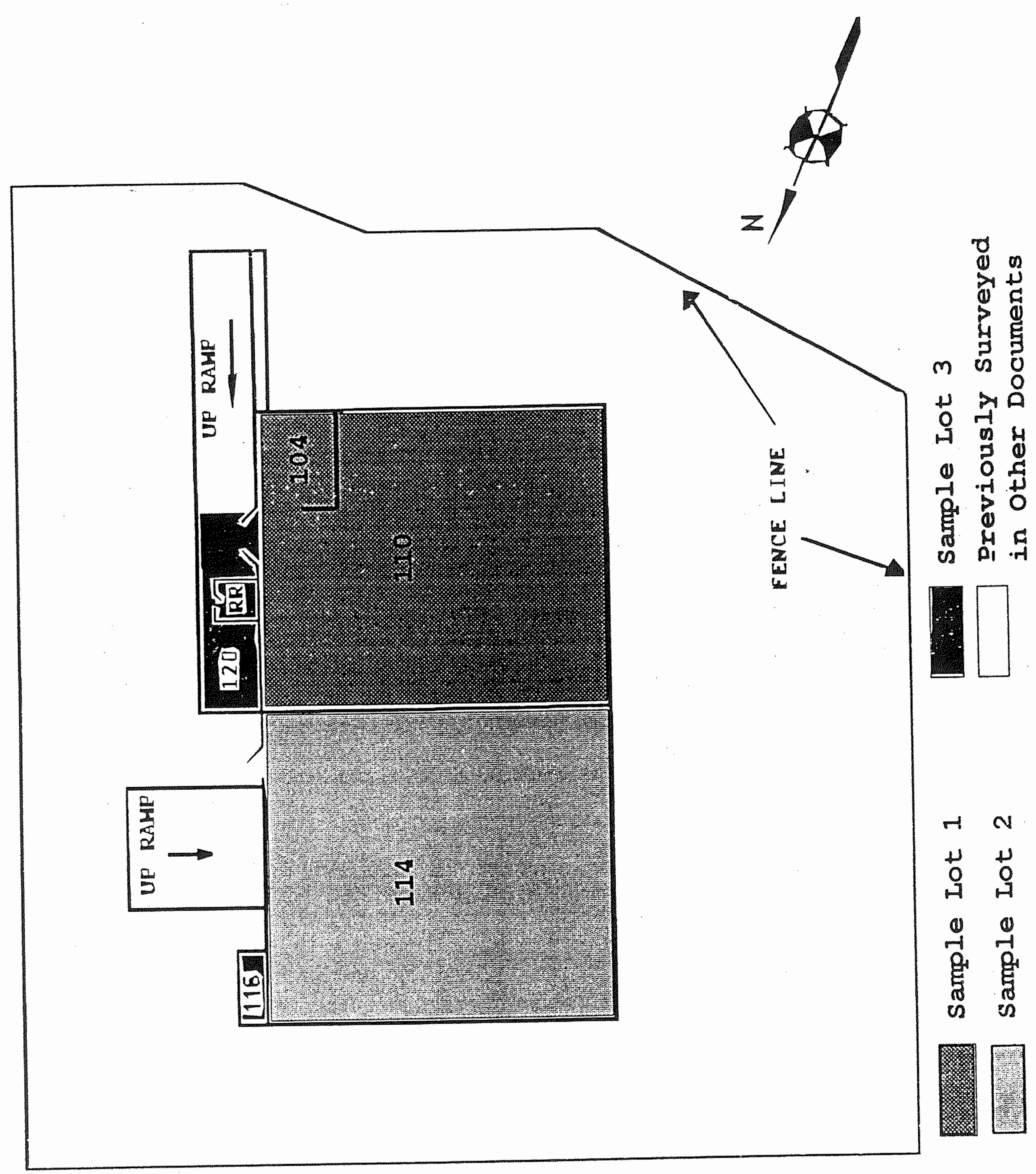

Figure 6: Building 064 Interior Sample Lot Identification

4.3 Survey Methods

The survey methods used for Building 064 interior are described in detail in Ref. 15. Maps, diagrams, and raw data for the final survey are also found in Ref. 15. Described below is a summary of those methods.

1. Sampling Method

   The method and type of survey measurements depended on the type of surfaces involved. For each sample lot, a 3-meter by 3-meter grid was superimposed on the floors, walls, ceilings, or ground of the entire sample lot area. A 100% direct frisk of each 3-m by 3-m grid was then performed using a G-M pancake probe. A 1-meter by 1-meter area was then selected from each 3-m by 3-m area based on previous D&D knowledge, randomly, or indications of elevated readings from the 100% direct frisk.

   Each selected 1-m by 1-m grid location was then surveyed for contamination based on the type of surface involved. This method satisfies the State of California guidelines in DECON-1 (Ref. 8) for a minimum of 10% of an area shall be surveyed, and is shown graphically in Figure 7. Walls, floors, and ceilings were surveyed for total alpha and beta activity, removable alpha and beta activity and maximum alpha and beta activity, if a "hot spot" was detected when the total alpha and beta measurements were made. Additionally, the floors were surveyed for ambient gamma exposure rate in μR/hr at 1 meter above the floor. Twenty percent of all structural surfaces (pipes, conduit, light fixtures, etc.) were surveyed for total and removable alpha and beta activity. Concrete slabs and pads were surveyed in the same manner as the interior floors. (Asphalt paving around the building was surveyed in another project and was reported in Ref. 12).

2. Instrument Calibrations and Checks

   Measurements of the total and maximum alpha surface activities were made with alpha scintillation detectors, sensitive only to alpha particles with energies exceeding about 1.5 MeV. The detectors were calibrated with a Th-230 alpha source standard, traceable to NIST. A 5-min integrated count time was used.

   Measurements of the total and maximum beta surface activities were made with a thin-window pancake Geiger-Mueller tube. The detectors were calibrated with a Tc-99 beta source standard, traceable to NIST. A 5-min integrated count time was used.

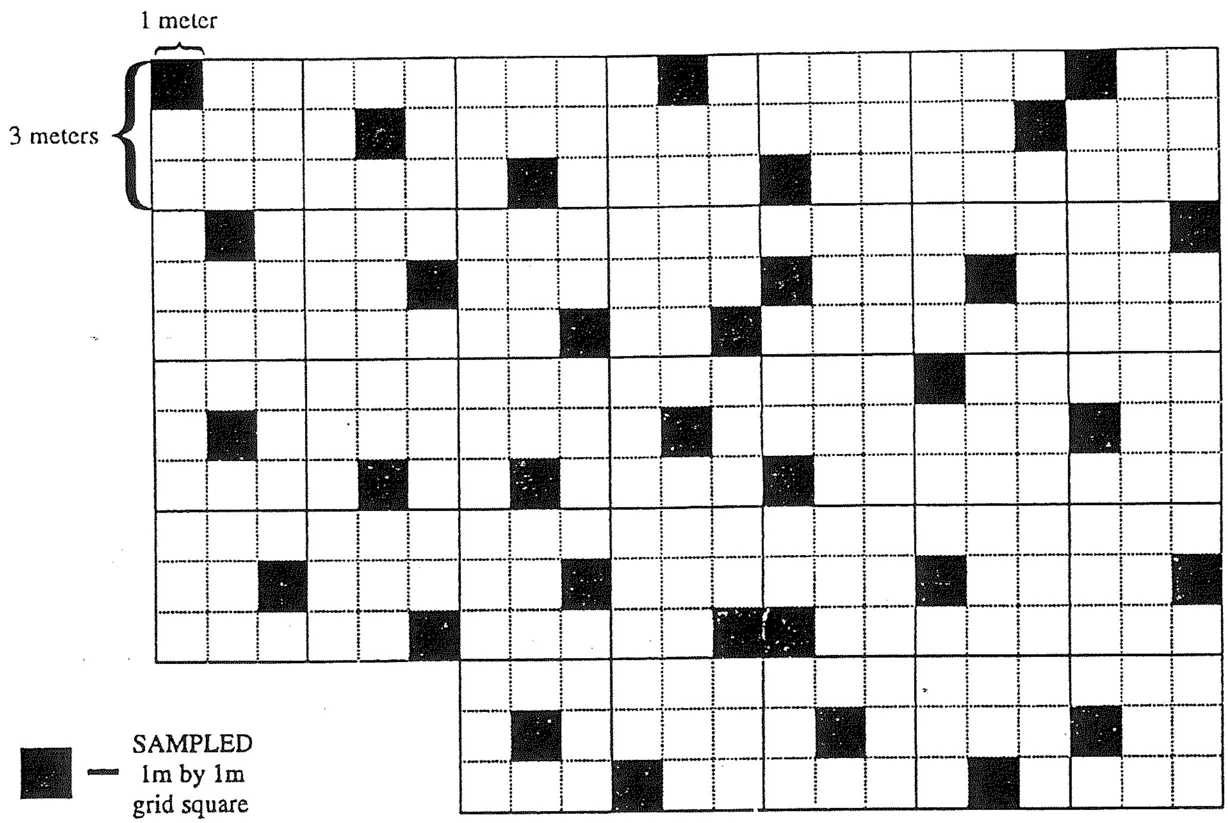

Figure 7: Typical Room or Area 3-Meter by 3-Meter Grid Markings

Measurements of removable surface activity (alpha and beta) were made by wiping approximately 100 cm^2 of surface area using standard smear disks. The activity on the disks were measured using a low-background gas-flow proportional counter. The counters were calibrated using Th-230 and Tc-99 standard sources, traceable to NIST. A 1-min integrated count time was used.

The ambient exposure rates at 1 m from surfaces were measured using a 1-in. NaI scintillation detector. These instruments were calibrated against a Reuter-Stokes high-pressure ionization chamber with natural background, and daily checks were made using a Ra-226 source, traceable to NIST, placed 1-m from the detector. A 1-min integrated count time was used.

All portable survey instruments were serviced and calibrated with NIST traceable standards on a quarterly basis. In addition, daily (when used) checks and calibrations were performed on all instrumentation to determine acceptable performance and establish a background value for the instrument on that day. Reference 5 provides further methods and procedures for environmental surveys.

Soil analyses were performed using a high purity Ge detector gamma-spectroscopy system calibrated with a NIST traceable standard. Reference 6 contains additional information concerning the entire method by which soil analyses are validated.

4.4 Technical Approach

1. Criteria and Their Implementation

   Acceptable contamination limits and gamma exposure rates for releasing a facility for unrestricted use are prescribed in DOE guidelines (Ref. 7). The lowest (most conservative) limits were chosen from these guidelines and incorporated into the final survey criteria for Building 064. Two distinguishable criteria were chosen from the guidelines.

   a) The surface contamination limits for alpha and beta were excerpted from DOE Order 5400.5 (Ref. 7 and State of California guidelines (Ref. 8);

b) The ambient gamma exposure rate limits at 1 m were excerpted from NRC Dismantling Order for the L-85 reactor decommissioning (Ref. 9) for conservatism and consistency with past decommissioning efforts. Although DOE Order 5400.5 (Ref. 7) recommends a value of 20 μR/hr above background, the value of 5 μR/hr from the NRC Dismantling Order (Ref. 9) was used for consistency, conservatism, and in keeping with ALARA principles.

Determination of an appropriate value for gamma exposure rate background has been a continuing problem, due to the variability of natural radiation on the site and differences between indoors and out. Reference values that have been used are 8.10 μR/hr inside a steel-walled and -roofed building with plasterboard office walls, and from 14.0 to 16.6 μR/hr in outside areas. This building does not correspond to either case, being an empty concrete structure.

To resolve this difficulty, a building with similar construction was sought for the purpose of determining a comparable radiation background. Building S445, near the entrance to SSFL and never used for nuclear or radioactive materials, was selected. This building was a concrete slab floor, cast-in-place concrete walls up to about 3 ft above grade with concrete blocks above, and a poured concrete roof. The ambient gamma exposure rate was measured, in the same manner as for a final survey, at 40 locations within Building 445, on an evenly spaced 1-m grid. A cumulative probability plot of these measurements is shown in Figure 8. This shows that the majority of values, with the exception of one anomalously low measurement, fit a Gaussian distribution very well. (The low value was measured adjacent to the steel double doors of the building, one open, the other closed.) The average of these values is 15.76 μR/hr, and the acceptance limit for gamma exposure rate in buildings of this sort is 20.76 μR/hr.

Table 2 provides a summary of the contamination limit criteria. Table 3 demonstrates that the detection limits (SSAs) for the instruments and method are well below the established limit criteria (from regulatory requirements) shown in Table 2.

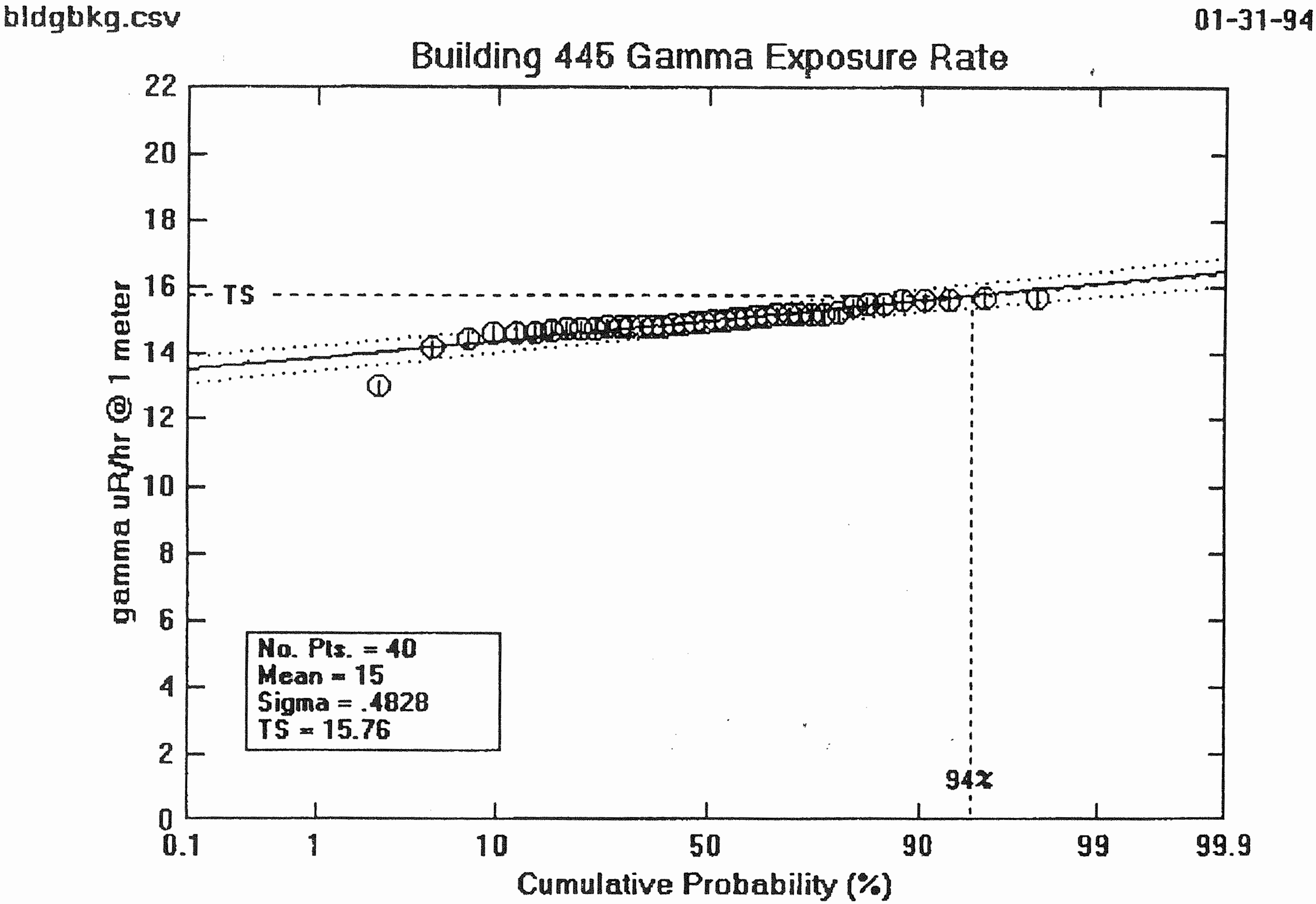

Figure 8: Gamma exposure rate measured in Bldg. 445. Concrete building (Bldg. 445) has construction similiar to that of T064 and no radiological history. Confidence bounds (95%) on least-squares fit of data are close to the derived Gaussian line. One value is anomalously low due to measurement near doorway. See Appendix B for data measurements.

Table 2. Building 064 Contamination Limit Criteria

Parameter	Limit				Reference
Allowable Total	Radionuclides[2]	Average[3,4]	Maximum[4,5]	Removable[4,6]	
Residual surface contamination for alpha and beta (dpm/100-cm^2)[1]	U-natural, U-235, U-238, & associated decay product, alpha emitters	≤5,000	≤15,000	≤1,000	8,9
Gamma exposure rate	≤5 µR/hr above background at 1 m interior				10

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

2 Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

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

4 The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

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

6 The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

Table 3. Observed Detection Limits versus Established Limit Criteria

	Total Alpha (dpm/100 cm^2)	Removable Alpa (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Ambient Gamma Exposure Rate (µR/hr)
Limit criteria	5000	1000	5000	1000	<5.0 above background
Average obs. detection limit (SSA*)	10	4	316	12	0.60
Obs. detection limit range	3-36	2-19	252-373	6-23	0.49-0.66
Ratio of ave-obs. detection limit to established limit criteria	0.20%	0.39%	6.32%	1.17%	12.02%

*SSA = 1.645 x SQRT (2 x counts) x area factor x efficiency factor/minutes = dpm/100 cm^2

2. Data Analyses and Statistical Criteria

A statistical procedure was used to validate the applicability of the raw survey data for selected sample lots or areas. The statistical method known as "sampling inspection by variables" (Ref. 11) was used. This method has been widely applied in industry and the military and is essential where the lot size is impractically large. In the case of determining residual contamination in Building 064, it would be unacceptably time consuming and not cost effective to measure and document 100% of the building. However, by applying sampling inspection by variables methods, acceptable confidence in the conclusion made about the level of contamination can be achieved.

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, $\overline{x}$, and its standard deviation, s, are then related to a "test statistic," TS, as follows:

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

where $\overline{x}$ = 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

UL = acceptance limit

TS and $\overline{x}$ are then compared with an acceptance limit, UL (such as those shown in Table 2), to determine acceptance or other plans of action, including rejection of the area as contaminated and requiring further remediation.

The sample mean, standard deviation, and acceptance limit 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 the LTPD. USNRC Regulatory Guide 6.6 ("Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing By-Product Material") 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 has stated that the consumer's risk of acceptance (β) at 10% defective (LTPD) must be 0.1. 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:

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

where k = tolerance factor

K_2 = the normal deviate exceeded with probability of β, 0.10 (from tables, K = 1.282)[1]

K_β = the normal deviate exceeded with probability equal to the LTPD, 10% (from tables, K = 1.282)[1]

n = number of samples

The statistical criteria for acceptance of the Building 064 interior final survey are presented below.

a) Acceptance: If the test statistic ($\bar{x}$ + ks) is less than or equal to the limit (UL), 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.) See Figure 9 for an example of the sample lot acceptance by the test.

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[1]The values chosen for these coefficients for the survey correspond to assuring, with 90% confidence, that 90% of the area has residual contamination below 100% of the applicable limit (a 90/90/100 test). The choice of values for the two coefficients is consistent with industrial sampling practices and State of California guidelines (Ref. 8).

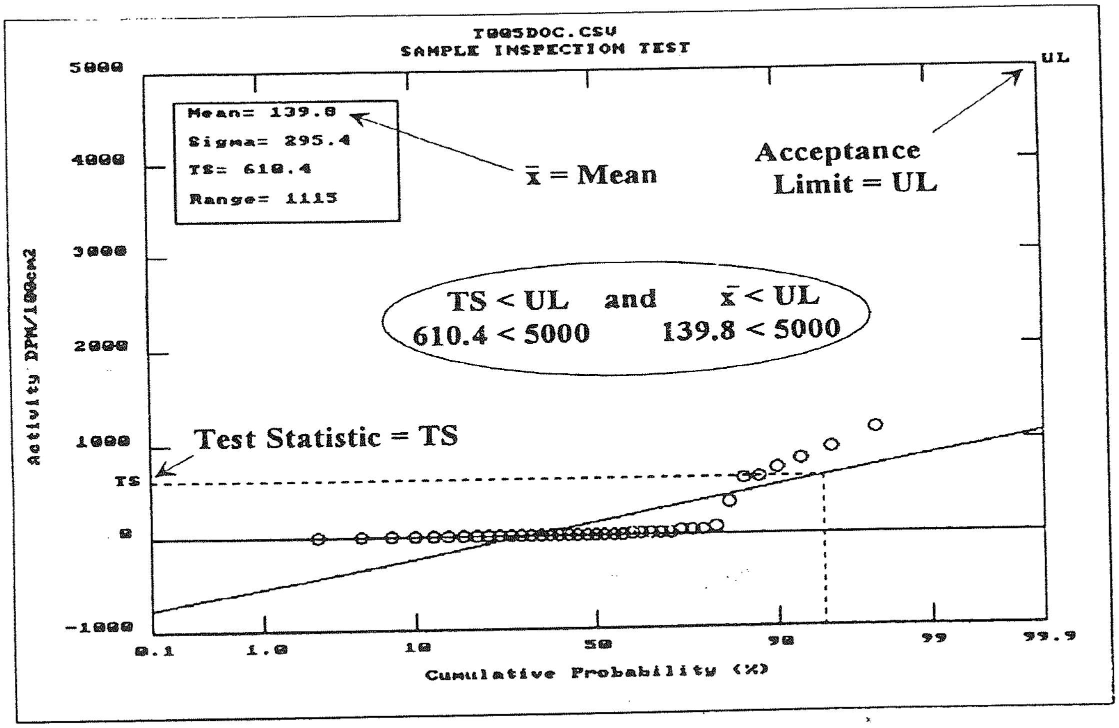


Figure 9. Example of Sample Lot Acceptance, where TS($=\bar{x}+ks$) $\leq$ UL and $\bar{x} \leq$ UL

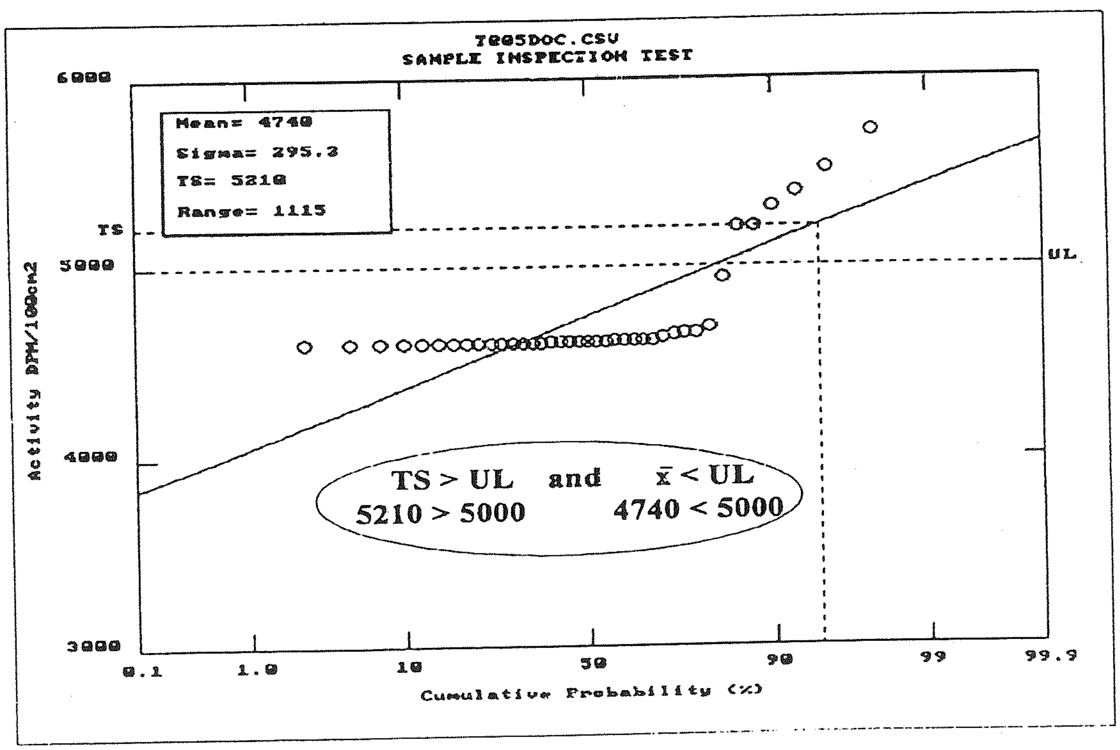


Figure 10. Example of Sample Lot Requiring Additional Measurements, where TS($=\bar{x}+ks$) > UL and $\bar{x}$ < UL

b) Collect additional measurements: If the test statistic ($\overline{x}$ + ks) is greater that the limit (UL), but $\overline{x}$ itself is less than UL, independently resample and combine all measured values to determine if $\overline{x}$ + ks ≤ = UL for the combined set; if so, accept the region as clean. If not, the region is contaminated and must be remediated. See Figure 10 for an example of additional measurements that must be taken in the sample lot to accept or reject it.

c) Rejection: If the test statistic ($\overline{x}$ + ks) is greater than the limit (UL) and $\overline{x}$ > = UL, the region is contaminated and must be remediated. See Figure 11 for an example of sample lot rejection by the test.

Thus, based on sampling inspection, we are willing to accept the hypothesis that the probability of accepting a lot as not being contaminated which is, in fact, 10% defective is 0.10. Or in other words, the Building 064 final survey corresponds to assuring with 90% confidence that 90% of the area has residual contamination below 100% (a 90/90/100 test) of the applicable limits described in Table 2.

4.5 Sample Lot Analyses and Results

1. Sample Lot 1

a) Description

Sample Lot 1 consists of room 110 and the southern section of the building, and room 114, where the fume hood had been installed.

b) Analyses of Sample Lot 1 Data

Raw data measurements for Sample Lot 1 were taken, subtracted for daily instrument background (except for ambient gamma exposure rates) and plotted on a cumulative probability graph as explained previously. For statistical comparisons (using the "sampling inspection by variables" method), similar areas within Sample Lot 1 were combined together and then analyzed for the specific type of radiation measurement made on the surface. Individual raw measurement data and instrument backgrounds are provided in Appendix A.

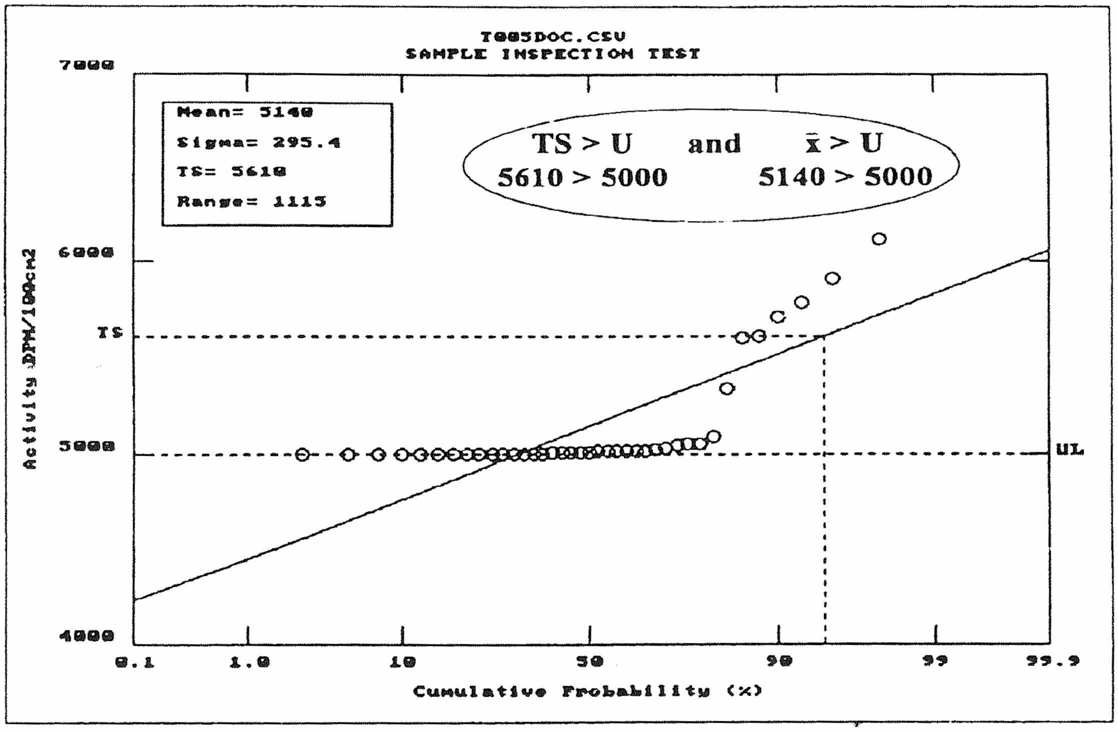


Figure 11. Example of Sample Lot Rejection, where TS(=$\overline{x}$+ks) > UL and $\overline{x}$ > UL

Table 4. Sample Lot 1 Results

	Calculated Test Statistic (TS = $\bar{x}$ + ks)				
	Total		Removable		Gamma Exposure Rate (μR/hr @ 1 m)
	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	
Acceptance Limit (UL)	5000	5000	1000	1000	20.76**
Floors only					16.25 (16)*
Entire area - floors, walls, ceiling, & structure	74.77 (12)*	863.5 (14)*	6.29 (13)*	12.98 (15)*	

* Numbers in parenthesis refer to figure numbers.

** The acceptance limit for ambient gamma exposure rate in μR/hr was determined by calculating the average ambient indoor background (15.76 μR/hr) from 40 locations inside a known uncontaminated building (Bldg. S445) and adding the acceptance criteria from Table 2 (<5 μR/hr above background) to achieve a final indoor ambient gamma exposure rate limit of 20.76 μR/hr. All values, excluding the ambient gamma exposure rate, in this table are subtracted for daily instrument background.

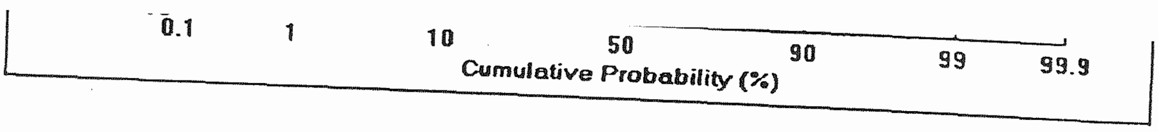
Sample lot results are summarized in Table 4 for comparing the test statistic ($TS = \bar{x} + ks$) with applicable, established contamination criteria or acceptance limit (UL) from Table 2. The corresponding figures for the graphs of each calculated cumulative probability plot are also provided. Individual sample results used as graph data for Sample Lot 1 are provided in Appendix B.

Initial review of the gamma exposure rate data, by use of the cumulative probability plot, showed an apparent discrepant value of 17.54 μR/hr at floor grid location 5,12. On investigation, it was found that a wall-mounted smoke alarm unit was approximately 1 meter away from the gamma detector during the measurement.

The radioactive source contained in this unit produces an estimated exposure rate of 2.79 μR/hr at the detector location. In the statistical interpretation of the Lot 1 data, this measurement has been reduced from 17.54 to 14.75 μR/hr to correct for this effect. The uncorrected value is listed in the appendix of survey results. (A similar smoke alarm unit is mounted on the wall of room 114 [Lot 2] but no adjacent measurements were made and so no corrections were required. An additional 6 units were mounted on each of the ceilings of rooms 110 and 114 and one unit in room 116, but increase the ambient exposure rate by only about 0.5 μR/hr.)

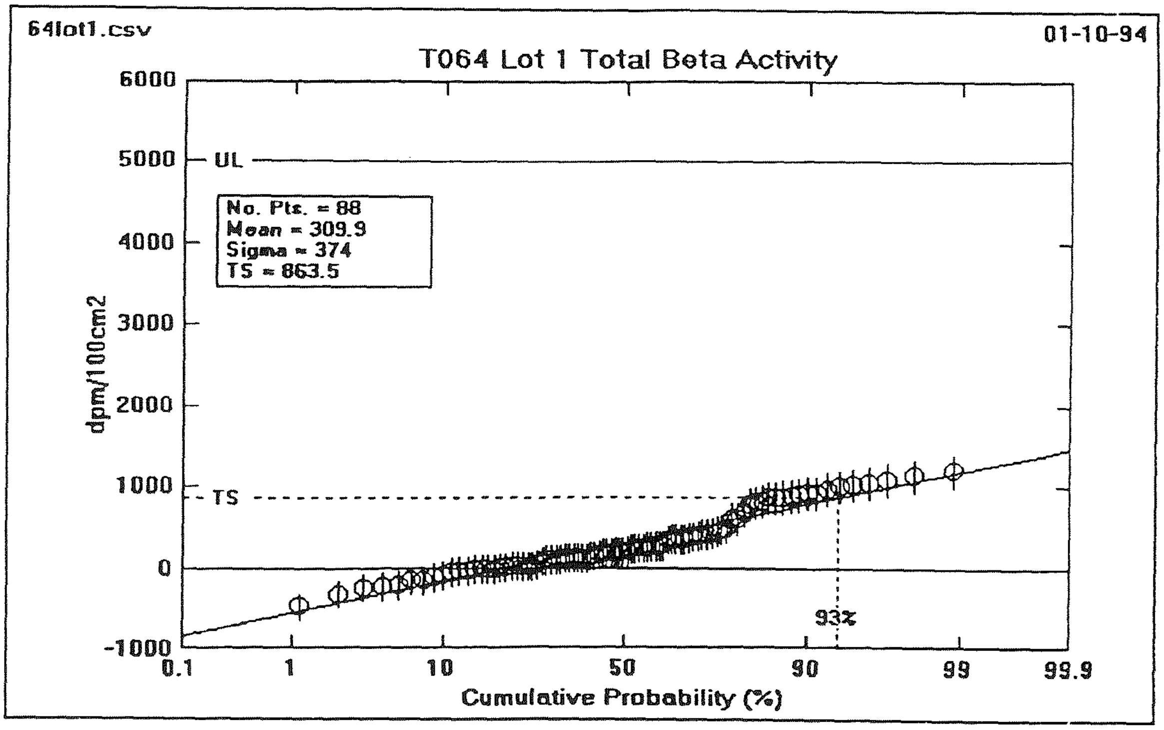
c) Interpretation of Results for Sample Lot 1

Figures 12 through 16 and Table 4 demonstrate that for each applicable acceptance limit (UL) from Table 2, the corresponding test statistic (TS) value is less than the UL or TS <UL. Therefore, the nine figures for Sample Lot 1 pass the "sampling inspection by variables" test and are "Accepted" as radiologically clean. Or in other words, the Building 064 Sample Lot 1 survey corresponds to assuring with a 90% confidence that 90% of Sample Lot 1 has residual contamination below 100% (a 90/90/100 test) of the applicable NRC, DOE, and State of California limits described in Table 2.

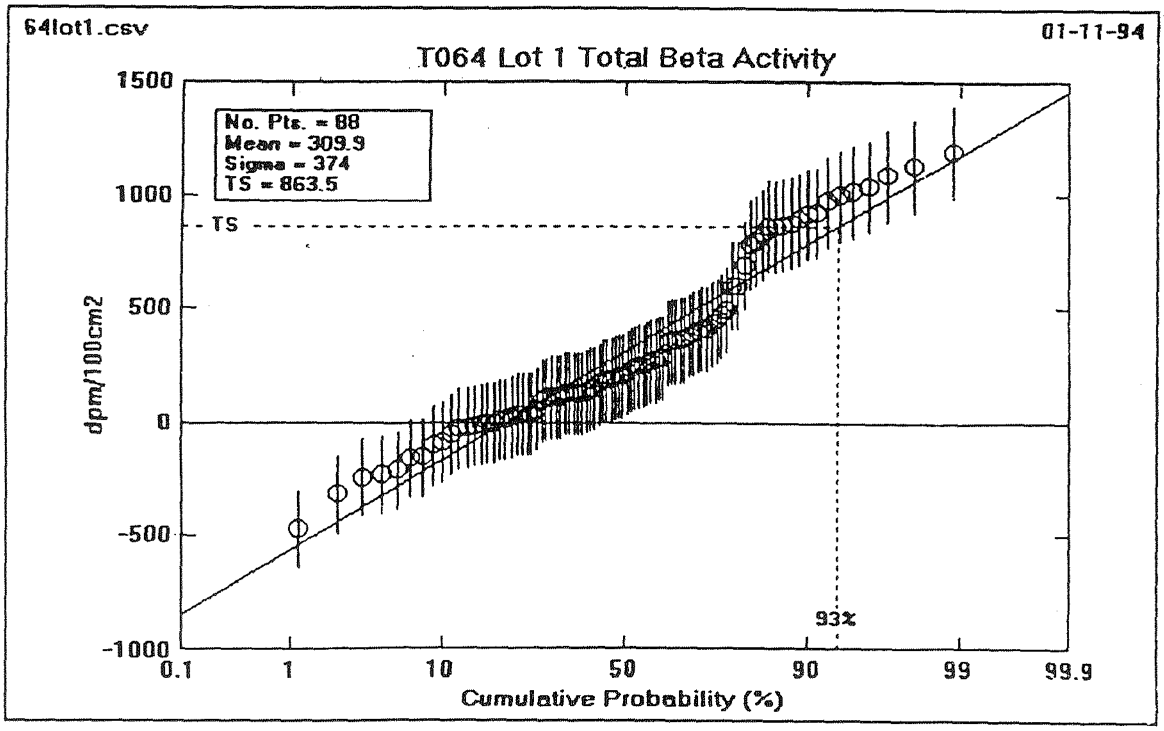


13b.) Expanded Scale

Figure 13: T064 - LOT 1 Removable Alpha Activity

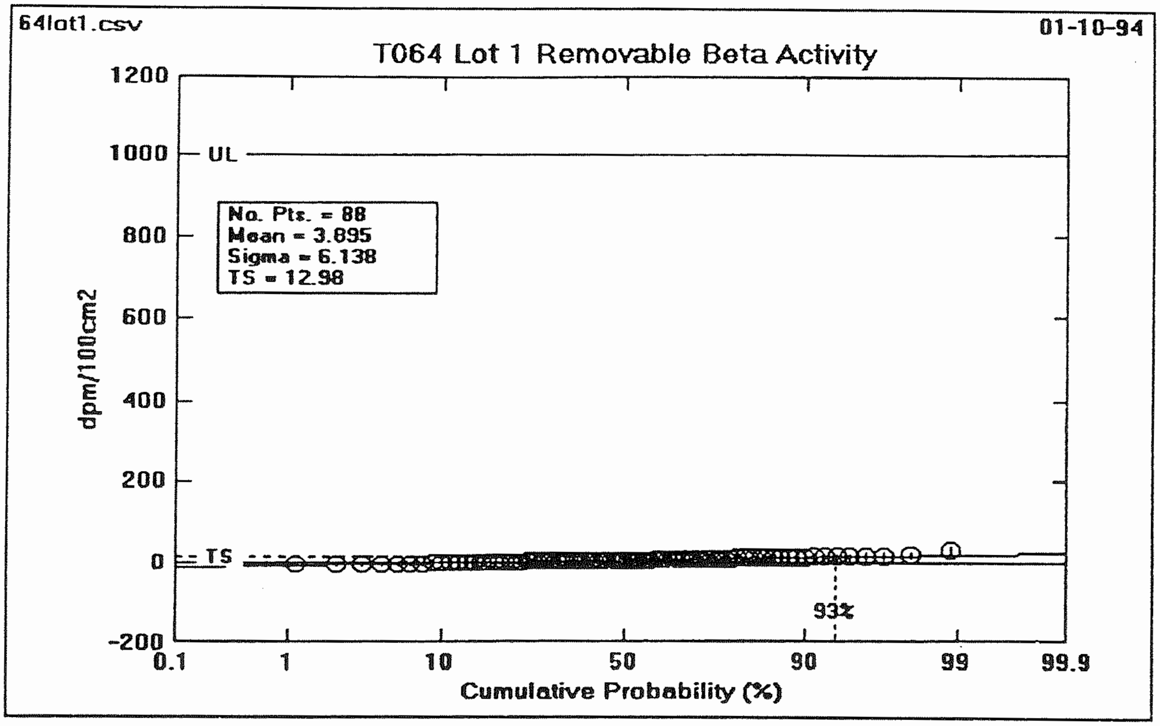


14a.) Scale including Acceptance Limit (UL)

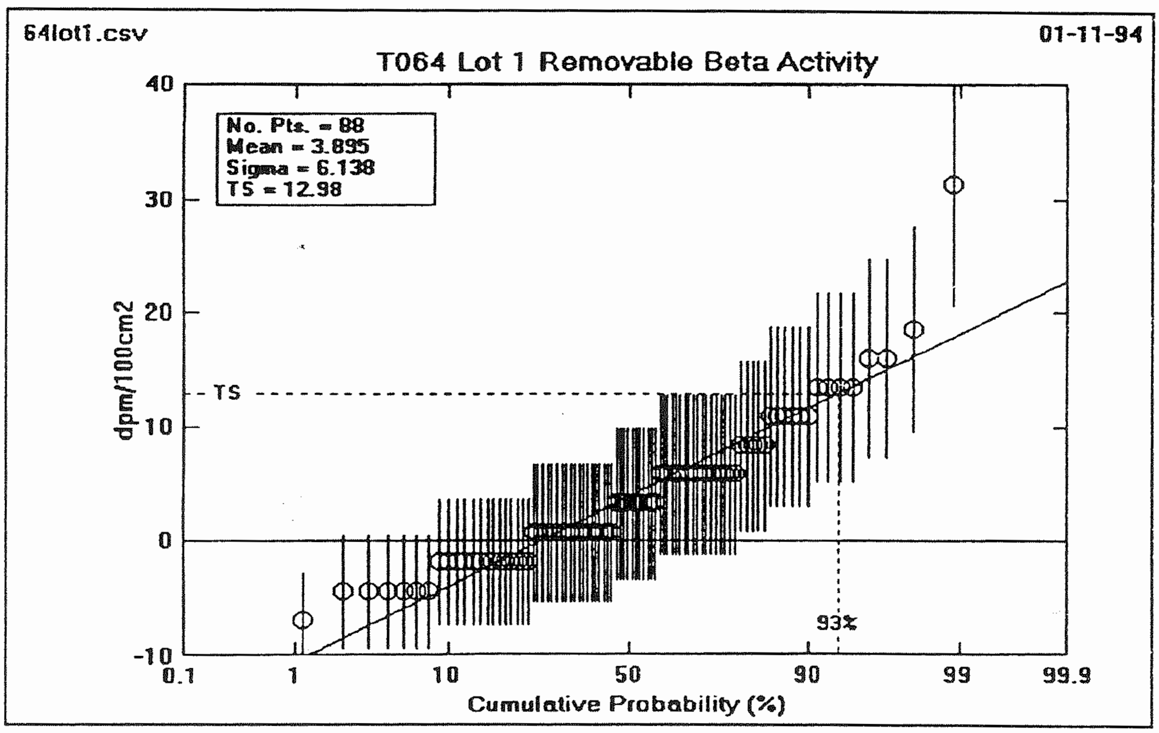


14b.) Expanded Scale

Figure 14: T064 - LOT 1 Total Beta Activity

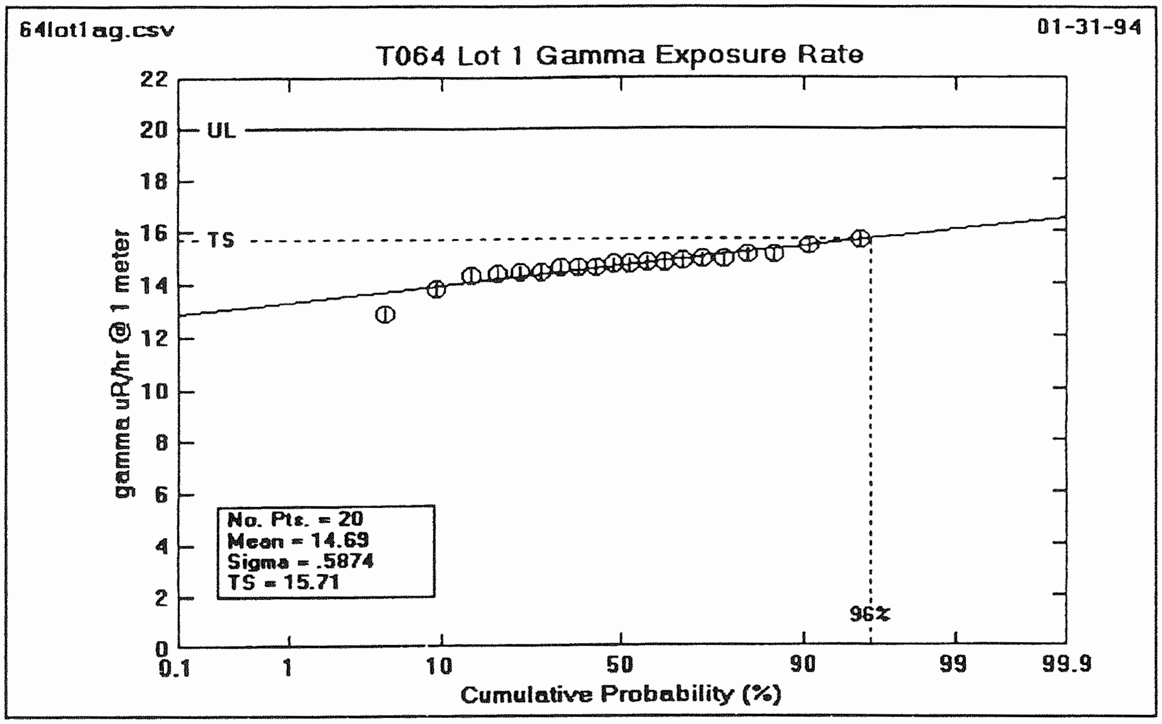


15a.) Scale including Acceptance Limit (UL)



15b.) Expanded Scale

Figure 15: T064 - LOT 1 Removable Beta Activity



16) Scale including Acceptance Limit (UL)

Figure 16: T064 - LOT 1 Floors Ambient Gamma Exposure Rate

2. Sample Lot 2

a) Description

Sample Lot 2 consists of room 114, the northern section of the building.

b) Analyses of Sample Lot 2 Data

Raw data measurements for Sample Lot 2 were taken, subtracted for daily instrument background (except for ambient gamma exposure rates) and plotted on a cumulative probability graph as explained previously. For statistical comparisons (using the "sampling inspection by variables" method), similar areas within Sample Lot 2 were combined together and then analyzed for the specific type of radiation measurement made on the surface. Individual raw measurement data and instrument backgrounds are provided in Appendix A. (The "total beta" measurements for two wall grid locations in room 110 were lost, and were replaced by measurements made in January 1994 to provide a complete set of data.)

Sample lot results are tabulated in Table 5 for comparing the test statistic ($TS = \overline{x} + ks$) with applicable, established contamination criteria or acceptance limit (UL) from Table 2. The corresponding figures for the graphs of each calculated cumulative probability plot are also provided. Individual sample results used as graph data for Sample Lot 2 are provided in Appendix B.

Table 5. Sample Lot 2 Results

	Calculated Test Statistic (TS = $\bar{x}$ + ks)				
	Total		Removable		Gamma Exposure Rate (μR/hr @ 1 m)
	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	
Acceptance Limit (UL)	5000	5000	1000	1000	20.76**
Floors only					16.0 (21)*
Entire area - floors, walls, ceiling, & structure	5.51 (17)*	938.7 (19)*	1.033 (18)*	9.067 (20)*	

* Numbers in parenthesis refer to figure numbers.

** The acceptance limit for ambient gamma exposure rate in μR/hr was determined by calculating the average ambient indoor background (15.76 μR/hr) from 40 locations inside a known uncontaminated building (Bldg. S445) and adding the acceptance criteria from Table 2 (<5 μR/hr above background) to achieve a final indoor ambient gamma exposure rate limit of 20.76 μR/hr. All values, excluding the ambient gamma exposure rate, in this table are subtracted for daily instrument background.

c) Interpretation of Results for Sample Lot 2

Figures 17 through 21 and Table 4 demonstrate that for each applicable acceptance limit (UL) from Table 2, the corresponding test statistic (TS) value is less than the UL or TS <UL. Therefore, the nine figures for Sample Lot 2 pass the "sampling inspection by variables" test and are "Accepted" as radiologically clean. Or in other words, the Building 064 Sample Lot 2 survey corresponds to assuring with a 90% confidence that 90% of Sample Lot 2 has residual contamination below 100% (a 90/90/100 test) of the applicable NRC, DOE, and State of California limits described in Table 2.

3. Sample Lot 3

a) Description

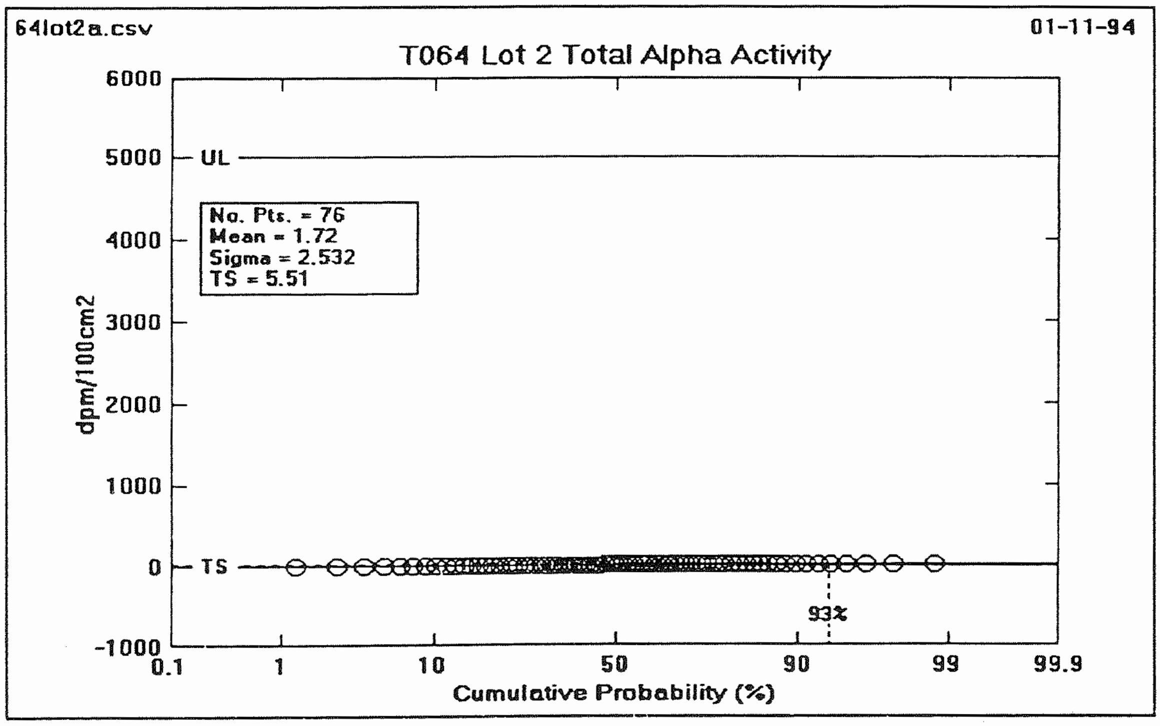
Sample Lot 3 consists of the office (room 120) and rest room, and the storage closet, room 116.

b) Analyses of Sample Lot 3 Data

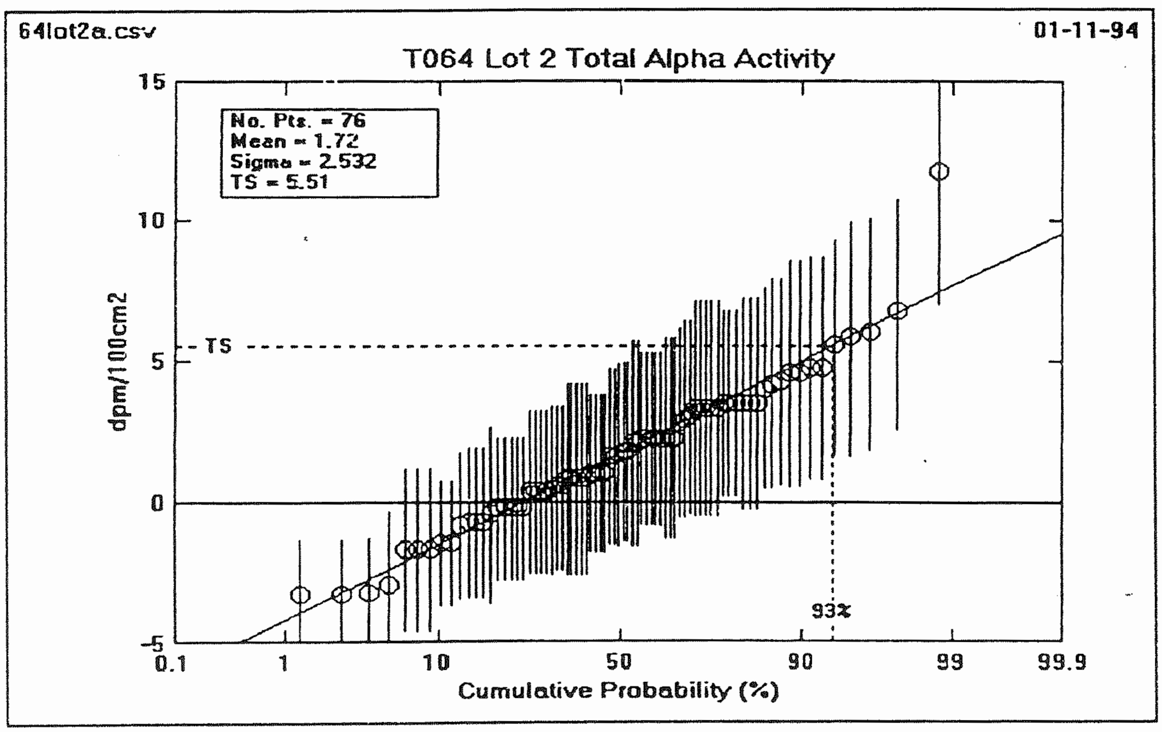
Raw data measurements for Sample Lot 3 were taken, subtracted for daily instrument background (except for ambient gamma exposure rates) and plotted on a cumulative probability graph as explained previously. For statistical comparisons (using the "sampling inspection by variables" method), similar areas within Sample Lot 3 were combined together and then analyzed for the specific type of radiation measurement made on the surface. Individual raw measurement data and instrument backgrounds are provided in Appendix A.

Sample lot results are tabulated in Table 6 for comparing the test statistic (TS = $\overline{x}$ + ks) with applicable, established contamination criteria or acceptance limit (UL) from Table 2. The corresponding figures for the graphs of each calculated cumulative probability plot are also provided. Individual sample results used as graph data for Sample Lot 3 are provided in Appendix B.

This lot also showed an outlier in the gamma exposure rate data. As in Lot 1, this elevated value was due to the close proximity of a smoke alarm unit. The measured value, 17.32 μR/hr, was reduced by 2.79 μR/hr to 14.53 μR/hr for statistical interpretation. The original measured value has been left in the tabulational results.

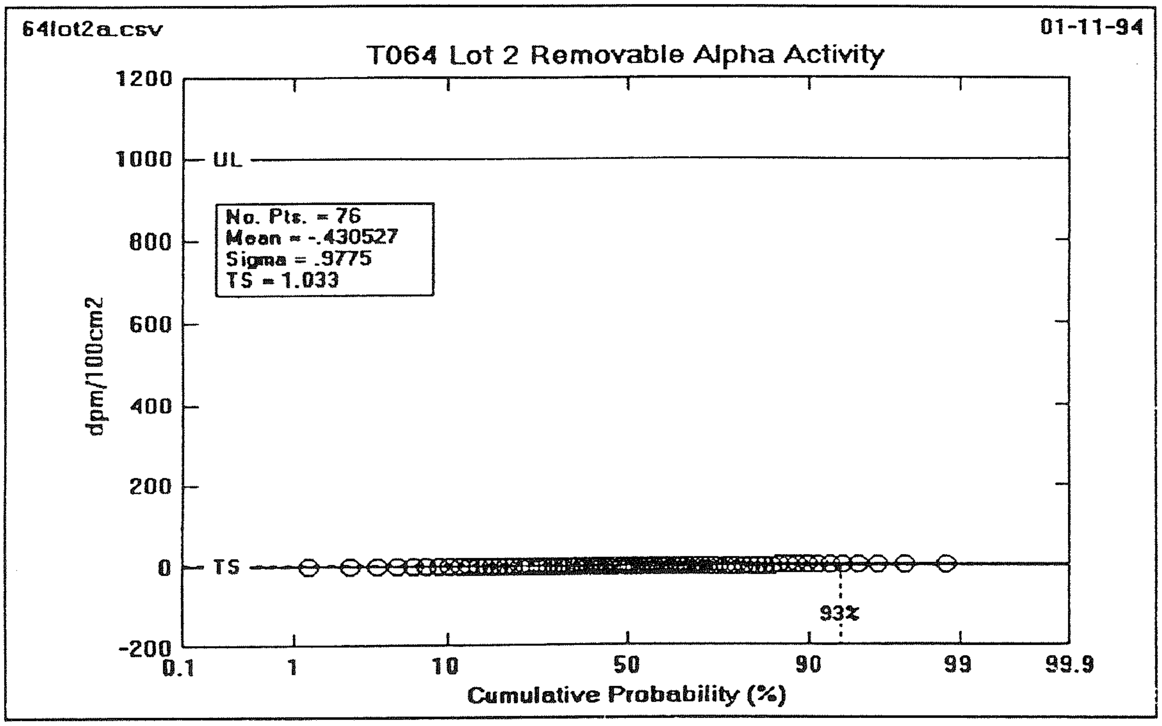


17a.) Scale including Acceptance Limit (UL)

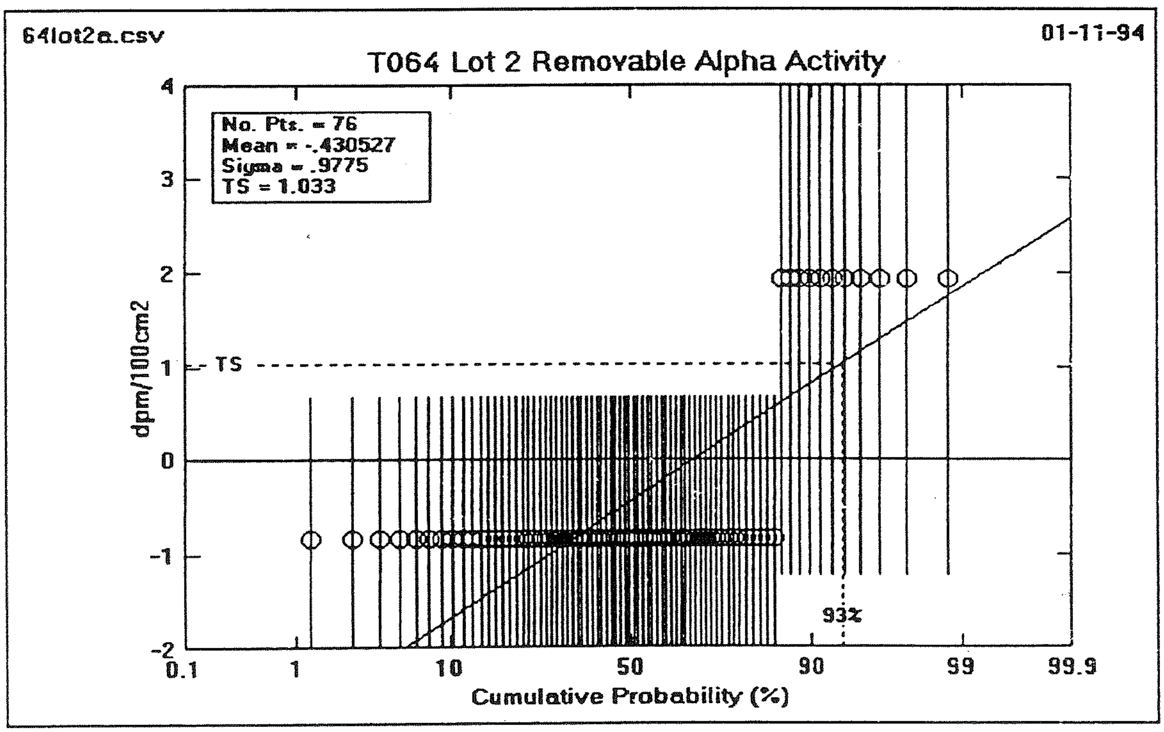


17b.) Expanded Scale

Figure 17: T064 - LOT 2 Total Alpha Activity

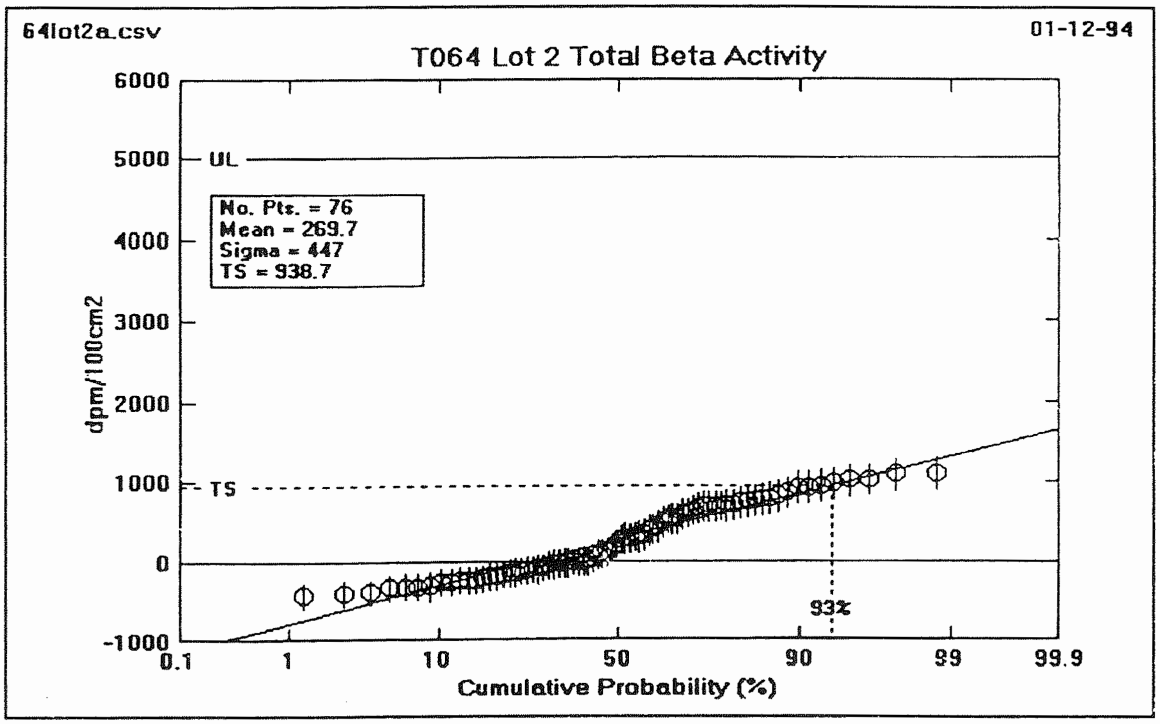


18a.) Scale including Acceptance Limit (UL)

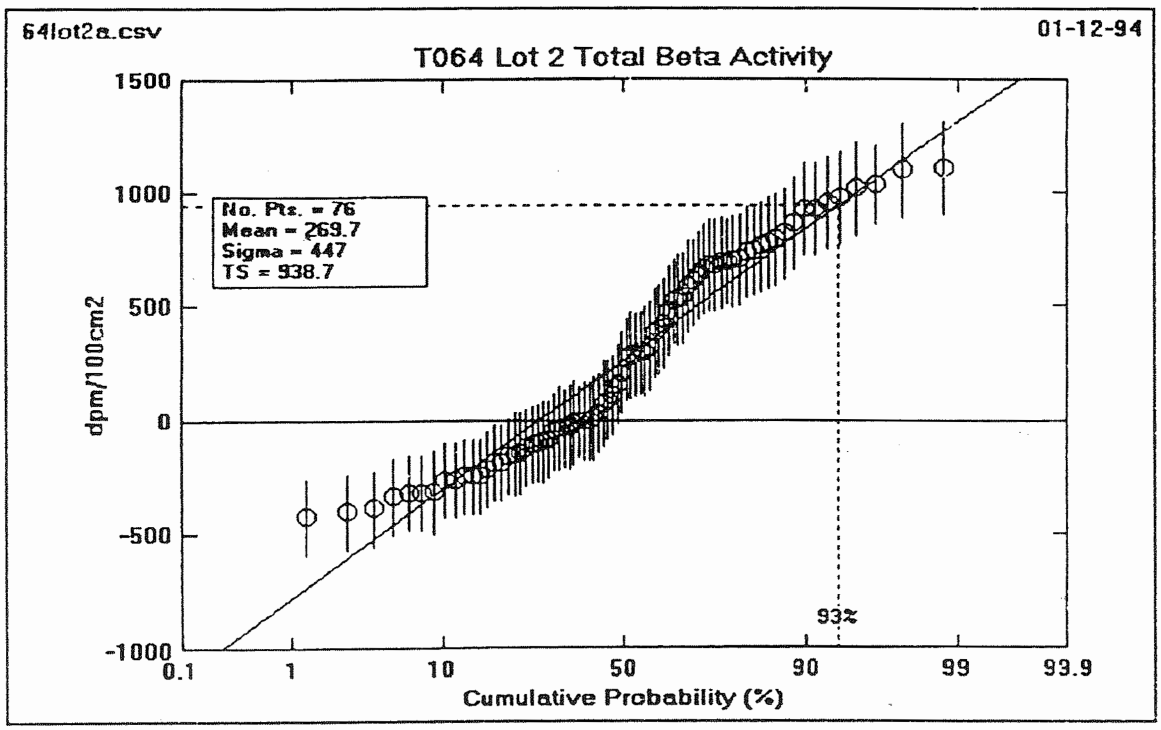


18b.) Expanded Scale

Figure 18: T064 - LOT 2 Removable Alpha Activity

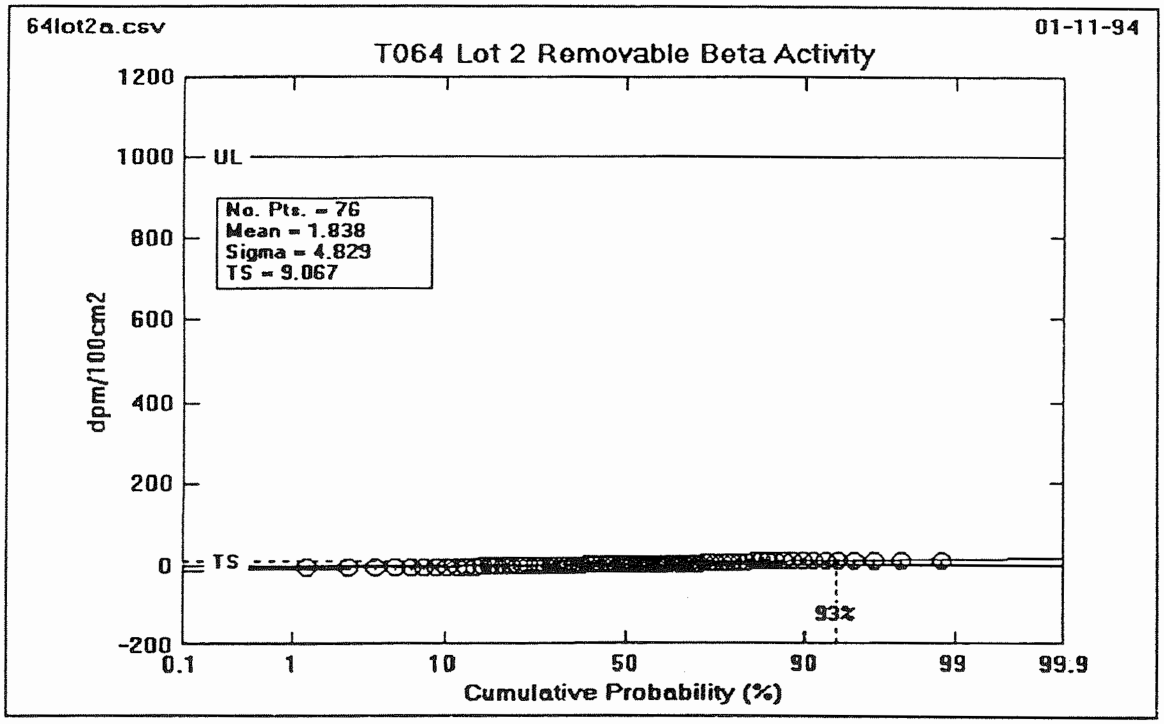


19a.) Scale including Acceptance Limit (UL)

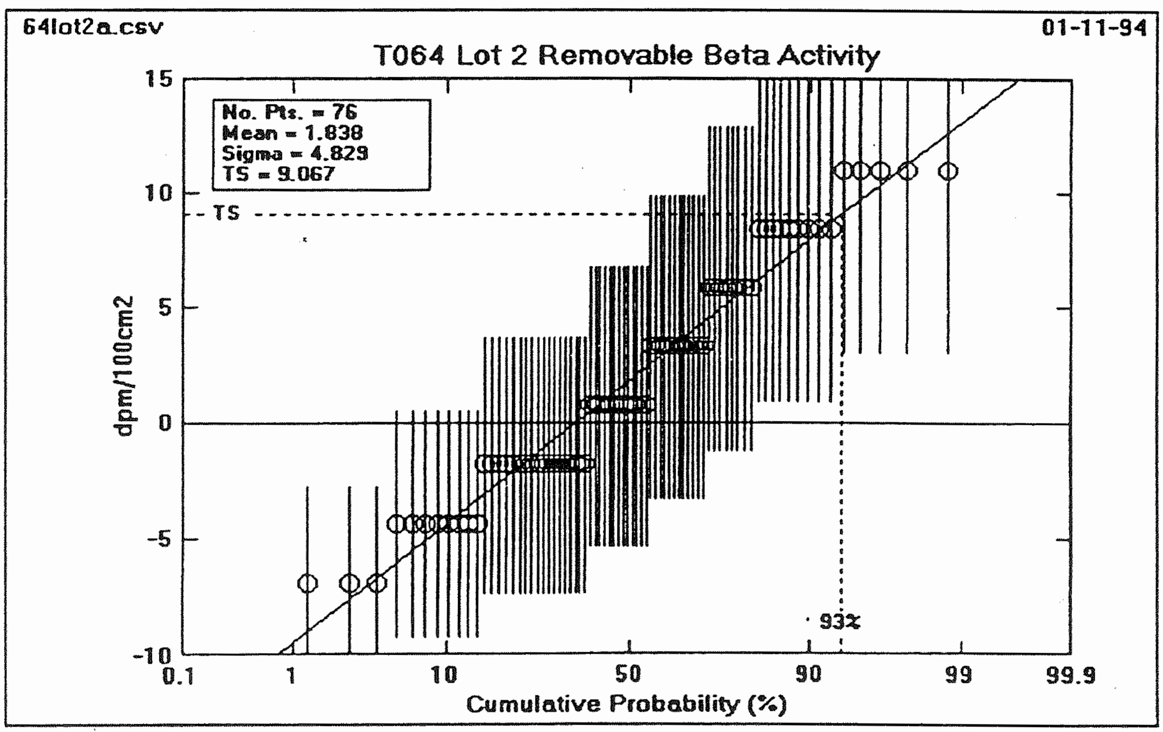


19b.) Expanded Scale

Figure 19: T064 - LOT 2 Total Beta Activity

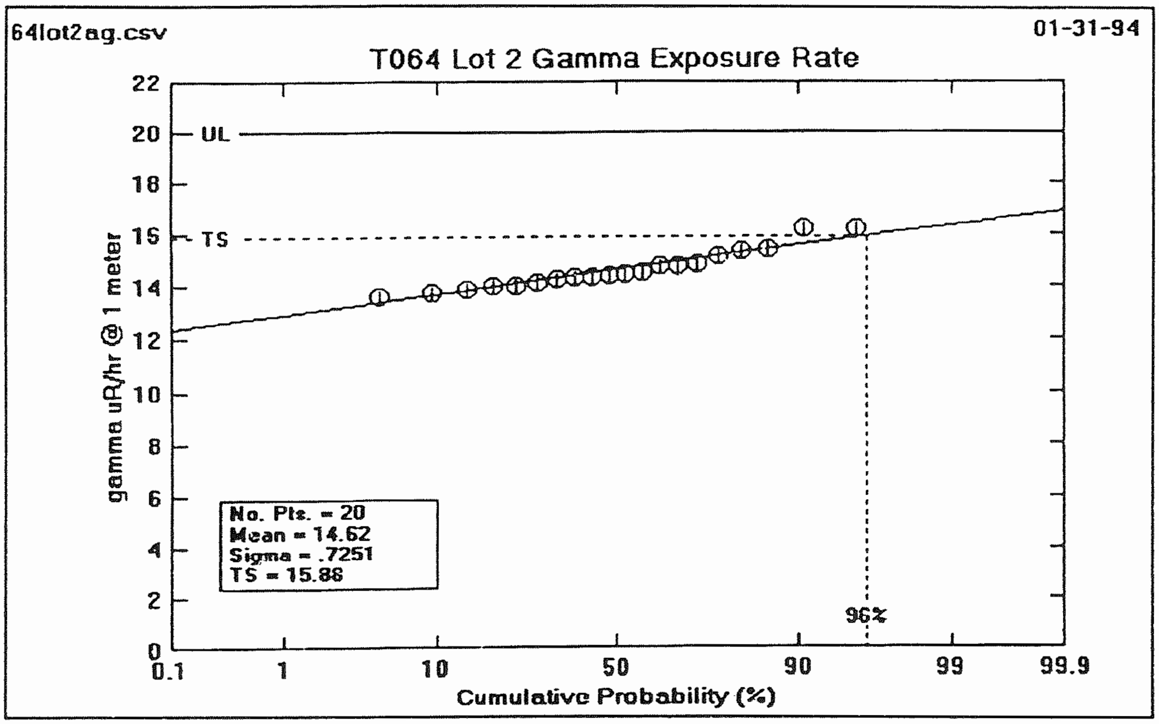


20a.) Scale including Acceptance Limit (UL)



20b.) Expanded Scale

Figure 20: T064 - LOT 2 Removable Beta Activity



21) Scale including Acceptance Limit (UL)

Figure 21: T064 - LOT 2 Floors Ambient Gamma Exposure Rate

Table 6. Sample Lot 3 Results

	Calculated Test Statistic (TS = $\bar{x}$ + ks)				
	Total		Removable		Gamma Exposure Rate (μR/hr @ 1 m)
	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)	
Acceptance Limit (UL)	5000	5000	1000	1000	20.76**
Floors only					18.2 (26)*
Entire area - floors, walls, ceiling, & structure	36.3 (22)*	1246 (24)*	1.959 (23)*	15.27 (25)*	

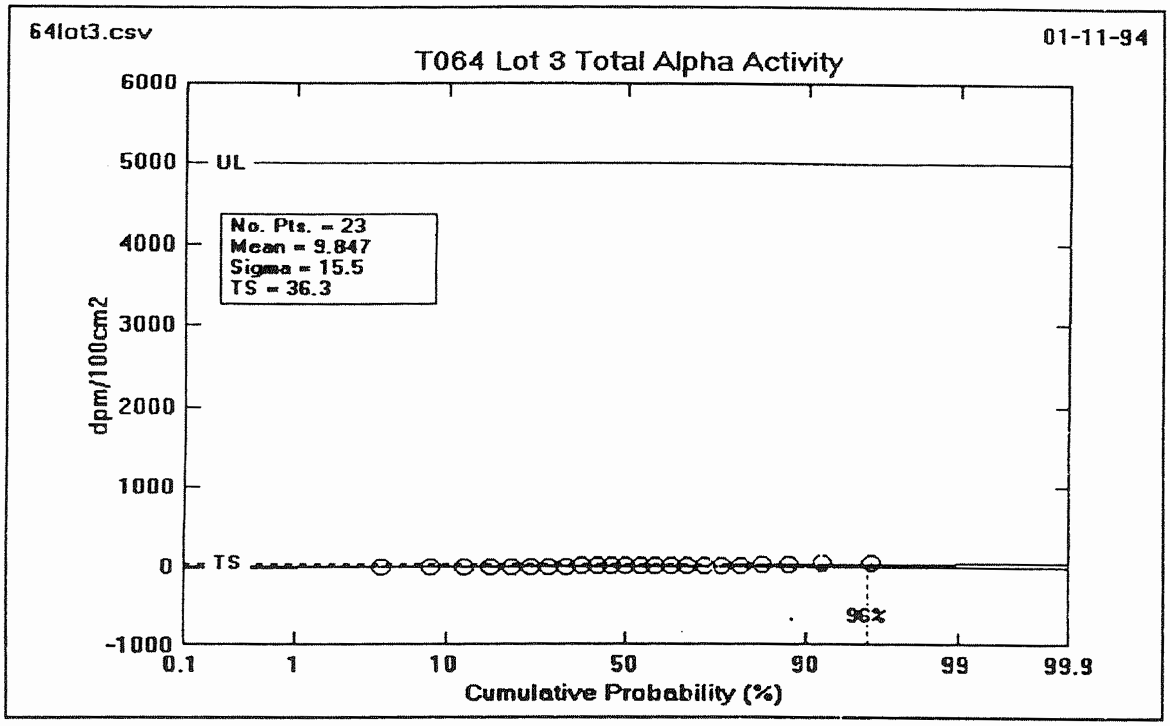
* Numbers in parenthesis refer to figure numbers.

** The acceptance limit for ambient gamma exposure rate in μR/hr was determined by calculating the average ambient indoor background (15.76 μR/hr) from 40 locations inside a known uncontaminated building (Bldg. S445) and adding the acceptance criteria from Table 2 (<5 μR/hr above background) to achieve a final indoor ambient gamma exposure rate limit of 20.76 μR/hr. All values, excluding the ambient gamma exposure rate, in this table are subtracted for daily instrument background.

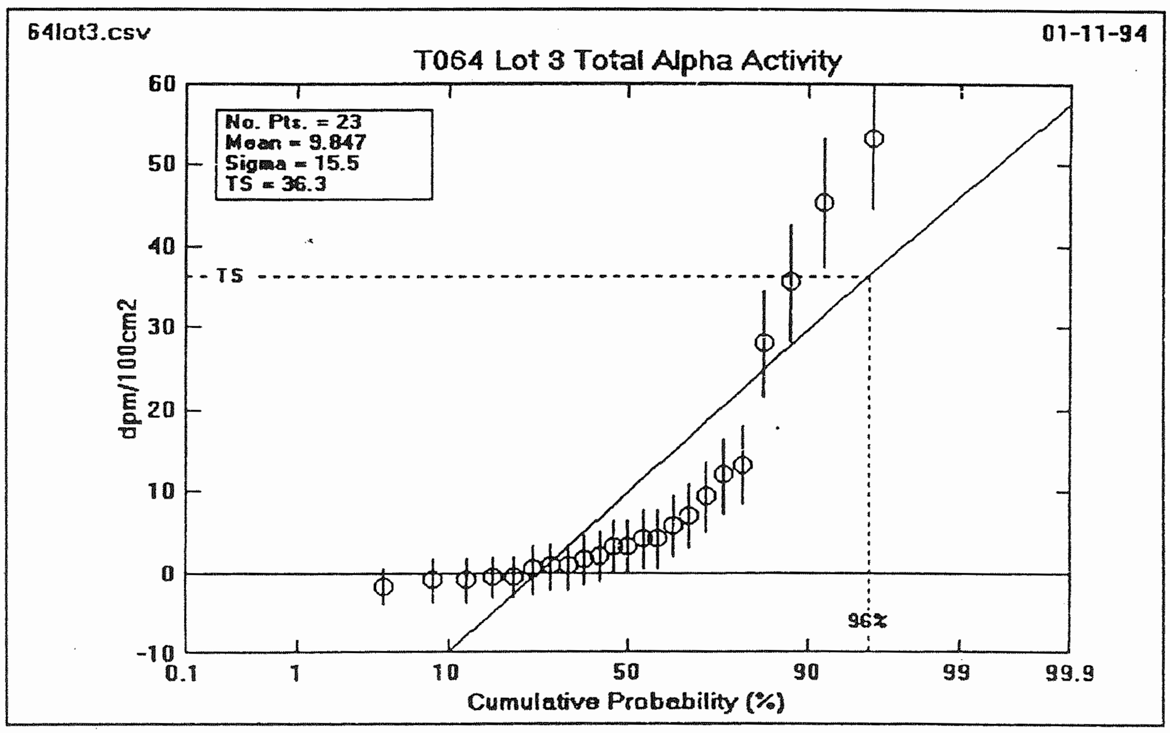
c) Interpretation of Results for Sample Lot 3

Figures 22 through 26 and Table 6 demonstrate that for each applicable acceptance limit (UL) from Table 2, the corresponding test statistic (TS) value is less than the UL or TS <UL. Therefore, the nine figures for Sample Lot 3 pass the "sampling inspection by variables" test and are "Accepted" as radiologically clean. Or in other words, the Building 064 Sample Lot 3 survey corresponds to assuring with a 90% confidence that 90% of Sample Lot 3 has residual contamination below 100% (a 90/90/100 test) of the applicable NRC, DOE, and State of California limits described in Table 2.

SSWA-0001.ZR/bjb

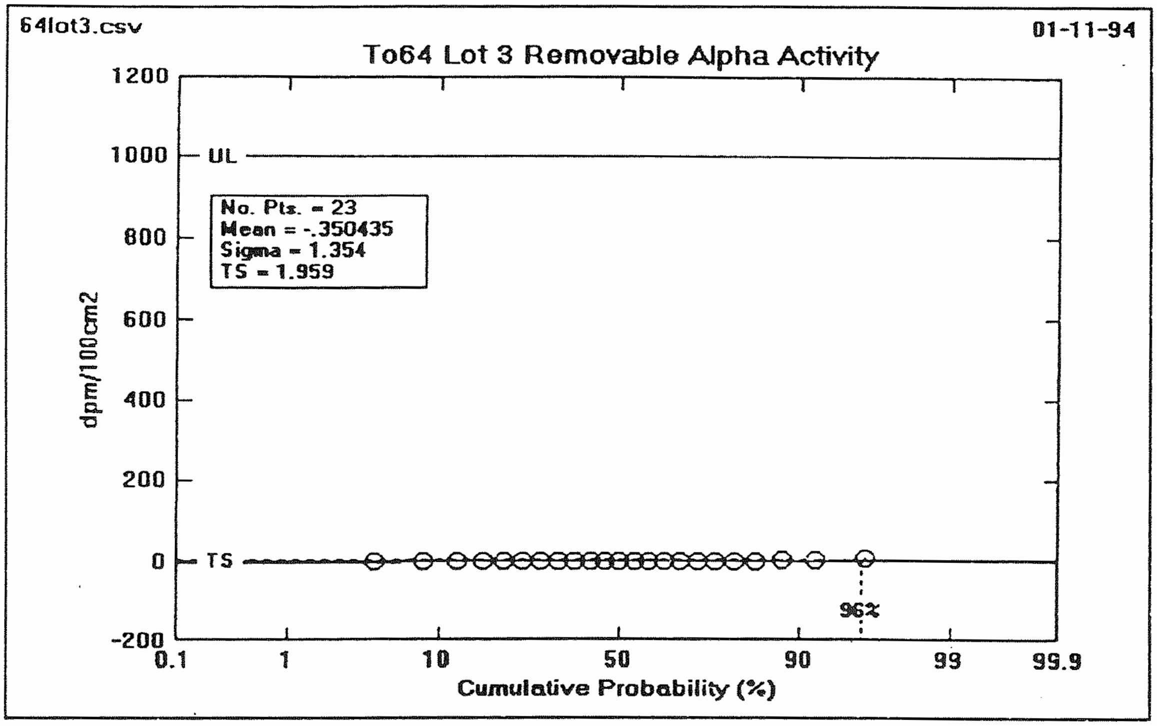


22a.) Scale including Acceptance Limit (UL)

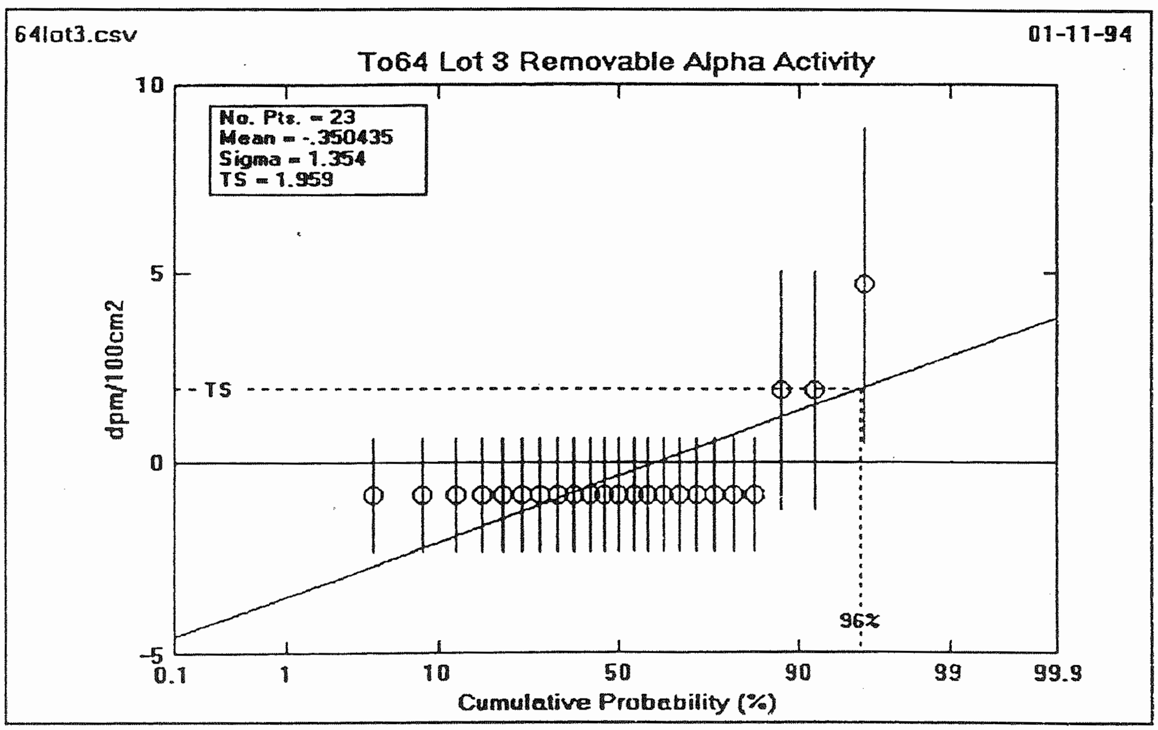


22b.) Expanded Scale

Figure 22: T064 - LOT 3 Total Alpha Activity

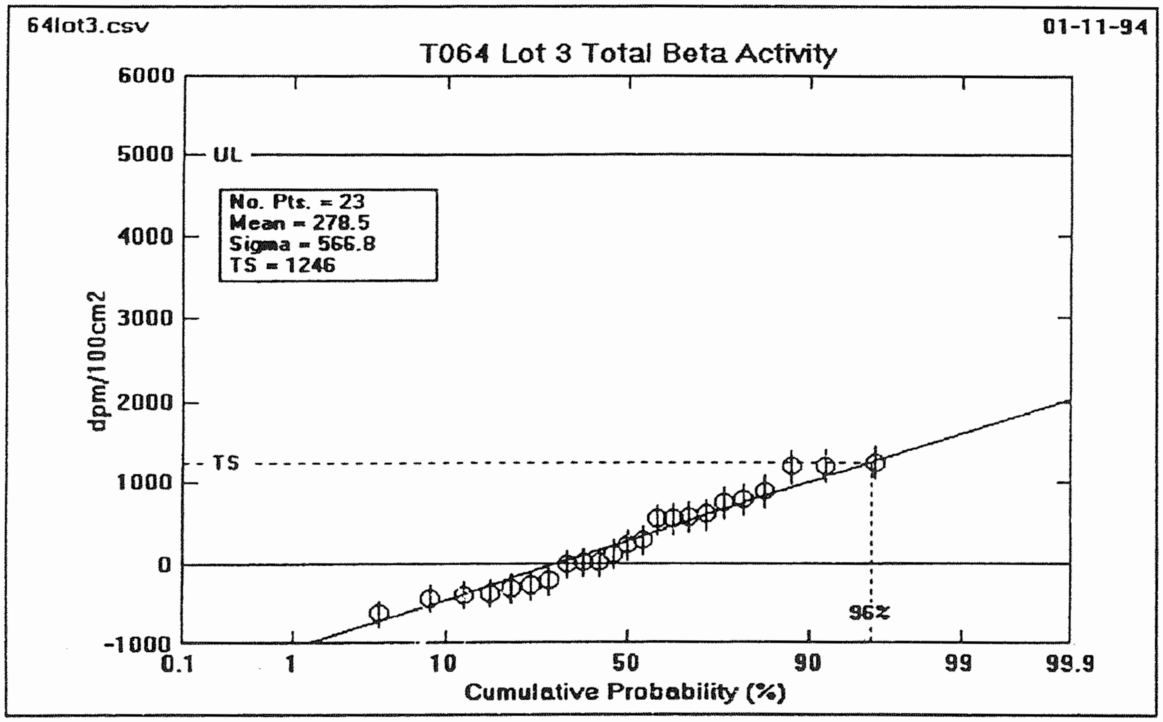


23a.) Scale including Acceptance Limit (UL)

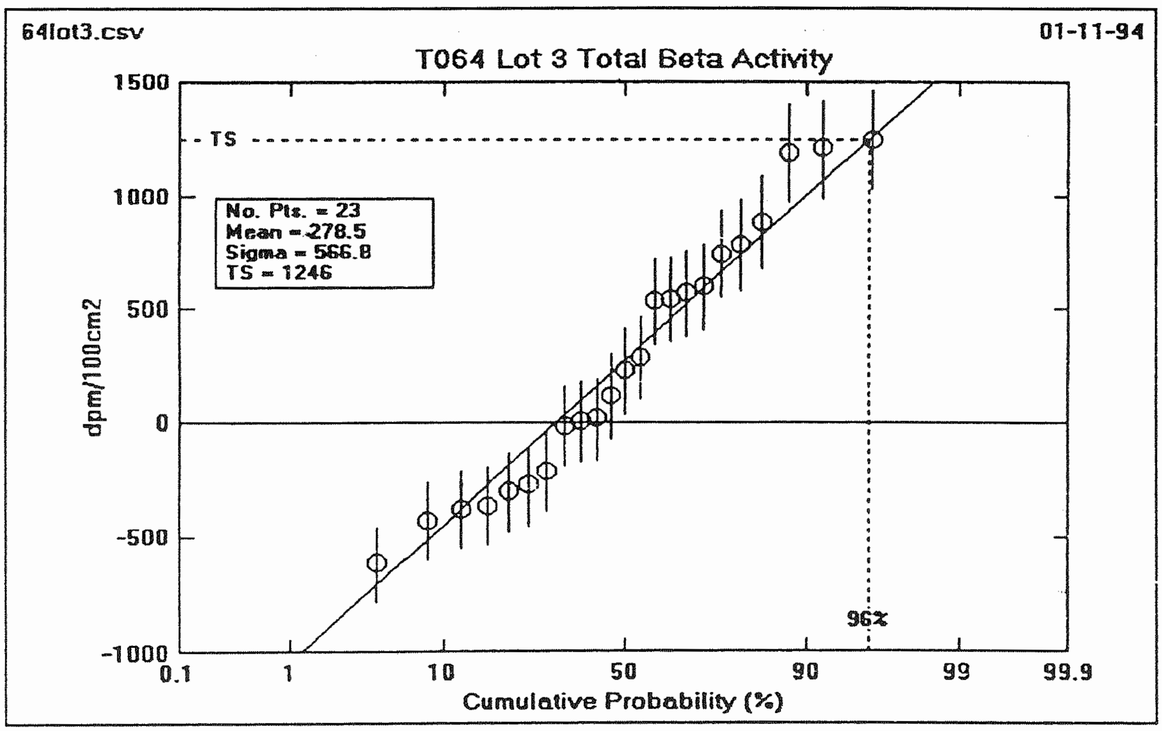


23b.) Expanded Scale

Figure 23: T064 - LOT 3 Removable Alpha Activity

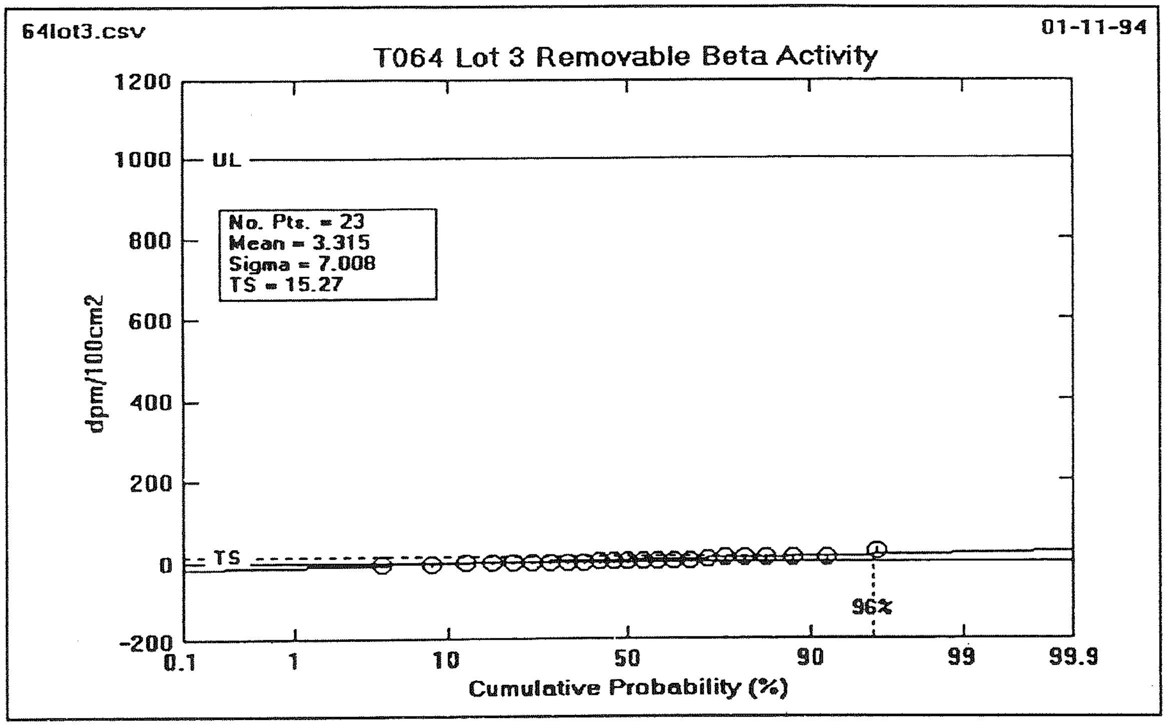


24a.) Scale including Acceptance Limit (UL)

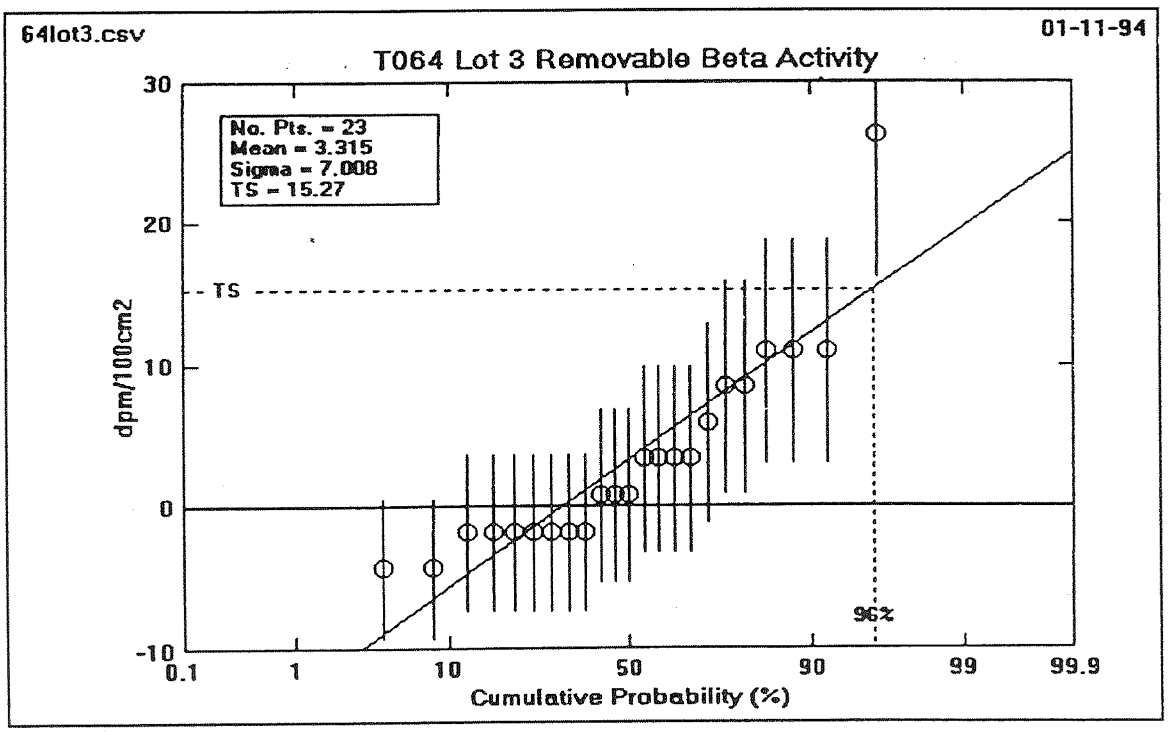


24b.) Expanded Scale

Figure 24: T064 - LOT 3 Total Beta Activity

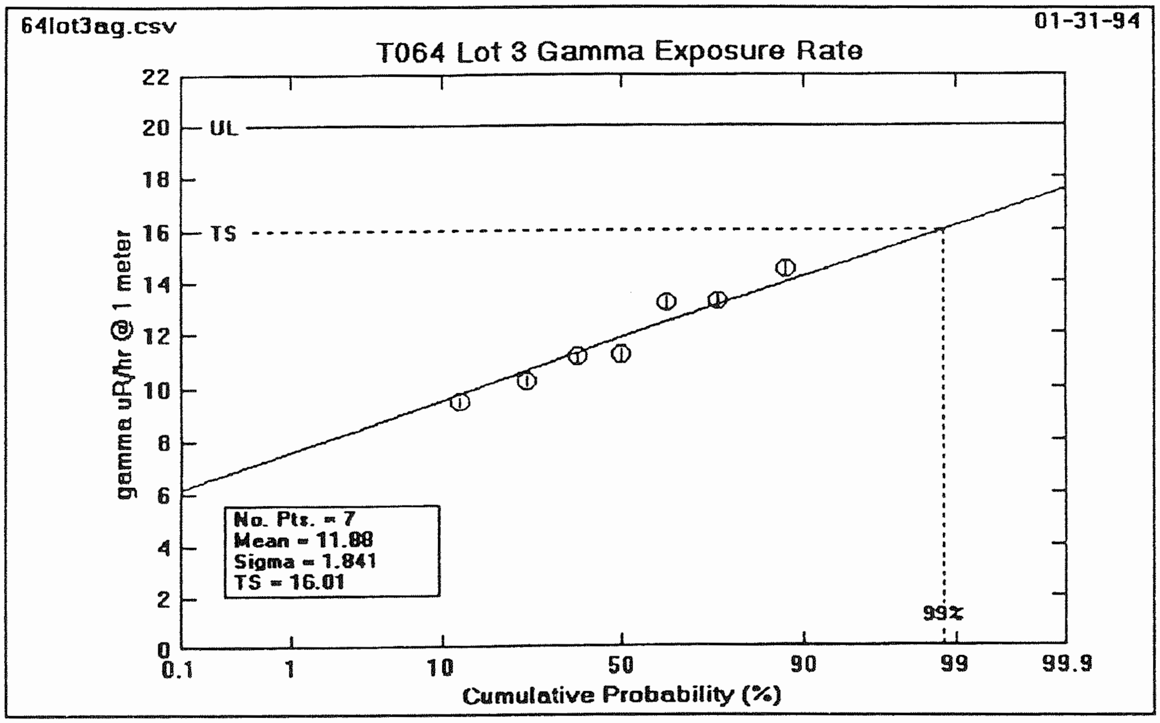


25a.) Scale including Acceptance Limit (UL)



25b.) Expanded Scale

Figure 25: T064 - LOT 3 Removable Beta Activity



26) Scale including Acceptance Limit (UL)

Figure 26: T064 - LOT 3 Floors Ambient Gamma Exposure Rate

4. Supplemental Measurements

In addition to the standard survey measurements, several supplemental measurements were made to provide additional assurance of the quality of the decontamination effort. Special samples of paint from the walls were analyzed in gamma spectrometry. The detected activities are shown below:

	Cs-137	U-234	U-235
Paint (Lot 1)	0.1 dpm/100cm^2	1.6 dpm/100cm^2	0.3 dpm/100cm^2
Paint (Lot 2)	2.0 dpm/100cm^2	1.6 dpm/100cm^2	0.3 dpm/100cm^2
Paint (Lot 3)	0.4 dpm/100cm^2	1.5 dpm/100cm^2	0.1 dpm/100cm^2

All values are below the applicable limits and in agreement with the measurements for removable alpha and beta measurements results from the smears.

APPENDIX A

Building 064 Interior

Lots 1 through 3

Final Survey Data

SAMPLE	GRID	GROSS COUNTS IN 5 MINUTES						In 1 MIN	ALPHA					BETA					GAMMA
		ALPHA			BETA			GAMMA		INSTRUMENT		SMEAR			INSTRUMENT		SMEAR		
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	EFACT
Floors - Rms 104 & 110	1,1	7		0	358		0	3148	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	1,11	8		0	394		6	3207	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	2,6	4		0	427		9	3258	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	3,9	7		0	370		3	3217	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	4,7	5		0	400		2	3103	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	5,4	9		0	435		5	3116	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	5,12	10		1	412		2	3773	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	6,5	5		0	406		5	3087	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	7,2	2		0	410		2	3319	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	7,12	8		0	383		3	3094	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	8,8	5		0	393		2	3171	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	9,3	7		0	396		3	3171	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	10,6	3		0	392		7	3196	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	11,4	4		1	421		2	3219	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	12,7	3		0	382		5	3144	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	12,10	4		0	399		5	2973	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	13,5	4		0	387		3	3154	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	14,11	9		0	415		1	3186	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	14,2	7		0	358		6	3259	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Floors - Rms 104 & 110	15,5	5		0	392		4	2769	2.563	4.407	1.41	0.3	2.75	279.759	7.705	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	1,5	4		0	272		2		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	2,8	2		0	289		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	3,12	6		0	334		8		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	3,2	3		0	289		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	4,6	2		1	287		8		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	5,9	4		0	287		6		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	6,4	5		0	274		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	6,11	4		0	289		2		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	7,1	9		0	320		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	8,3	5		0	272		7		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	9,7	4		0	299		2		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	9,12	8		1	304		1		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	10,5	4		0	305		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	11,2	5		0	319		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	11,11	3		0	299		2		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	12,9	4		1	287		7		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	13,2	6		6	322		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	14,3	4		1	326		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Ceiling - Rms 104 & 110	15,1	7		1	318		8		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465

SAMPLE NAME	GRID NAME	GROSS COUNTS IN 5 MINUTES ALPHA TOTAL	ALPHA MAX	ALPHA REM	BETA TOTAL	BETA MAX	BETA REM	In 1 MIN GAMMA TOTAL	ALPHA INSTRUMENT BACKG	ALPHA INSTRUMENT EFACT	ALPHA INSTRUMENT AFACT	ALPHA SMEAR BACKG	ALPHA SMEAR EFACT	BETA INSTRUMENT BACKG	BETA INSTRUMENT EFACT	BETA INSTRUMENT AFACT	BETA SMEAR BACKG	BETA SMEAR EFACT	GAMMA EFACT
Ceiling - Rms 104 & 110	14,10	6		0	301		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	1,3	9		3	252		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	3,2	12		1	297		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	6,1	13		1	270		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	8,3	11		0	245		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	10,4	9		0	241		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	11,1	14		0	274		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	13,2	10		0	266		1		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 110	15,3	11		0	269		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	18,4	14		0	290		7		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	19,1	16		1	285		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	21,2	22		0	296		1		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	23,2	11		1	211		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	25,2	11		2	296		7		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 110	27,3	9		1	277		7		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 110	2,3	12		0	309		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 110	4,2	12		1	309		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 110	6,1	10		0	319		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 110	7-8,5	9		0	289		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 110	10,3	16		0	292		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	12,2	17		1	289		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	14,3	7		0	277		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	16,2	12		1	277		4		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	18,3	9		1	306		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	20,1	12		0	294		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	22,4	11		0	325		6		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 110	23,3	13		0	271		2		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall East - Rm 104(deconned)	2,2	52	376	4	333	311	10		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Wall East - Rm 104	4,2	12		1	307		5		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall South - Rm 104(deconned)	5,1	13	227	1	301	284	1		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Wall West - Rm 104	8,3	9		0	261		6		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall West - Rm 104	10,1	35		9	280		15		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 104	12,3	12		0	298		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Wall North - Rm 104	14,2-3	10		1	277		3		2.167	4.445	1.41	0.3	2.75	272.333	7.648	5	2.7	2.55	0.00465
Structure - Trusses Rm 104	St-1	156		1	327		5		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Trusses Rm 104	St-2	133		0	322		9		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Trusses Exit Rm 110	St-3	48		3	228		2		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Trusses NE corner Rm 110	St-4	80		0	325		1		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Trusses near C(4,10)	St-5	48		1	319		3		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465

T64L1DAT.WB1

			GROSS COUNTS IN 5 MINUTES					In 1 MIN			ALPHA					BETA			GAMMA
SAMPLE	GRID		ALPHA			BETA		GAMMA		INSTRUMENT		SMEAR			INSTRUMENT		SMEAR		
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	EFACT
Structure - Trusses near Center	St-6	37		0	304		2		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Trusses C(6,4) near HTR	St-7	23		1	316		8		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Beam Ledges - West	Sb-1	77		2	256		3		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Beam Ledges - Center Wes	Sb-2	37		1	249		3		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Beam Ledges - Center	Sb-3	59		2	282		5		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Beam Ledges - Center Eas	Sb-4	111		0	288		4		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Beam Ledges - East	Sb-5	126		0	299		2		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Heater Outside Wall	Sh-1	6		0	266		2		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Heater Inside Grating	Sh-2	4		1	272		3		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465
Structure - Heater Inside Wall	Sh-3	2		0	239		5		2.000	4.459	1.41	0.3	2.75	268.833	7.742	5	2.7	2.55	0.00465

					GROSS COUNTS IN 5 MINUTES						ALPHA					BETA			GAMMA	
SAMPLE	GRID		ALPHA			BETA		GAMMA		INSTRUMENT		SMEAR			INSTRUMENT		SMEAR			
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT
Floors - Rm 114	1,4	3		1	397		5	3294	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	2,1	2		0	402		4	3314	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	3,7	6		0	360		2	3172	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	2,10	0		0	391		4	3487	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	5,12	4		0	412		1	3373	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	4,5	7		0	383		7	2966	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	5,2	4		0	377		2	3110	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	6,6	3		0	394		6	3102	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	7,3	5		0	367		5	3120	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	8,8	2		0	413		3	3083	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	7,11	2		0	391		2	3192	2.563	4.407	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Floors - Rm 114	9,4	6		0	393		6	3079	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	10,1	5		0	355		6	2932	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	11,7	7		0	382		6	2983	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	12,6	6		0	395		2	3017	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	12,10	6		1	335		4	3252	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	13,1	8		0	362		3	3047	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	14,5	7		0	369		2	3065	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	15,2	5		0	348		3	3010	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Floors - Rm 114	15,11	5		1	384		4	3481	3.167	4.394	1.41	0.3	2.75	293.167	7.775	5	2.7	2.55		0.00465
Ceiling - Rm 114	1,1	4		0	268		5		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	2,4	6		1	256		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	3,6	4		0	229		7		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	4,3	5		0	252		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	5,2	6		0	275		5		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	6,6	1		1	236		4		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	7,7	8		0	224		1		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	8,9	3		0	238		5		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	9,4	6		1	256		4		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	10,5	7		0	248		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	11,9	4		0	246		4		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	12,2	6		0	246		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	13,4	4		1	227		4		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	14,7	5		0	277		7		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	15,6	2		1	248		3		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	13,12	7		0	265		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	10,10	6		0	238		4		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	8,12	4		0	267		3		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Ceiling - Rm 114	4,11	2		0	270		0		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465

		GROSS COUNTS IN 5 MINUTES							ALPHA					BETA					GAMMA	
SAMPLE	GRID		ALPHA			BETA		GAMMA	INSTRUMENT			SMEAR		INSTRUMENT			SMEAR			
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT
Ceiling - Rm 114	1,10	2		1	248		2		3.333	4.434	1.41	0.3	2.75	281.333	7.358	5	2.7	2.55		0.00465
Wall - South Rm 114	3,1	5		0	311		5		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - South Rm 114	4,4	5		0	278		2		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - South Rm 114	5,2	3		0	276		7		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - South Rm 114	8,3	2		0	257		1		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - South Rm 114	8,5	2		0	257		3		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - South Rm 114	10,1	4		0	263		2		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - South Rm 114	11,4	4		0	283		1		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - South Rm 114	13,3	2		0	278		1		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - South Rm 114	15,5	3		0	293		3		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - West Rm 114	17,2	4		0	362		5		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - West Rm 114	20,2	4		0	370		2		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - West Rm 114	23,1	3		0	341		2		2.667	4.290	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - West Rm 114	26,3	3		0	339		6		2.667	4.290	1.41	0.3	2.75	287.833	7.808	5	2.7	2.55		0.00465
Wall - West Rm 114	21,4	2		0	300		4		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - West Rm 114	25,4	3		0	349		3		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	2,2	5		0	368		6		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - North Rm 114	4,3	3		1	307		6		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	7,1	1		0	360		3		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - North Rm 114	10,3	2		0	318		3		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	13,1	1		1	358		2		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - North Rm 114	3,4	5		0	372		2		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	9,5	4		0	291		6		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	11,4	3		0	364		0		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - North Rm 114	15,4	6		0	319		2		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - East Rm 114	17,2	4		0	313		6		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - East Rm 114	20,2	2		0	323		1		2.167	4.379	1.41	0.3	2.75	274.833	7.995	5	2.7	2.55		0.00465
Wall - East Rm 114	23,1	5		0	234		4		2.200	3.082	1.41	0.3	2.75	233.5	7.051	5	2.7	2.55		0.00465
Wall - East Rm 114	26,1	3		0	315		3		2.167	4.379	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Wall - East Rm 114	19,1	8		0	376		5		2.200	3.082	1.41	0.3	2.75	233.5	7.051	5	2.7	2.55		0.00465
Wall - East Rm 114	27,4	4		0	360		0		2.667	4.290	1.41	0.3	2.75	278.333	7.421	5	2.7	2.55		0.00465
Structure - Trusses Rm 114 NW	St-1	4		0	242		3		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Structure - Trusses Rm114 Cente	St-2	3		0	278		7		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Structure - Trusses Rm114 SE	St-3	5		0	280		4		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Structure - Beams Rm 114 North	Sb-1	8		0	263		3		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Structure - Beams Rm 114 Center	Sb-2	6		0	277		1		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Structure - Beams Rm 114 South	Sb-3	12		0	291		1		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465

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		GROSS COUNTS IN 5 MINUTES						1 MIN		ALPHA					BETA				GAMMA	
SAMPLE	GRID		ALPHA			BETA		GAMMA		INSTRUMENT		SMEAR			INSTRUMENT		SMEAR			
NAME	NAME	TOTAL	MAX	REM	TOTAL	MAX	REM	TOTAL	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT	AFACT	BACKG	EFACT	BACKG	EFACT
Floors - Rm 116	F-1	6		0	437		7	3725	2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Floors - Rm 116	F-2	45		0	432		7	2861	2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Ceiling - Rm 116	C-1	2		1	296		2		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Wall - West Rm 116	2,2	2		2	392		5		2.667	4.467	1.41	0.3	2.75	261.333	8.015	5	2.7	2.55		0.00465
Wall - North Rm 116	5,1	3		0	430		1		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Wall - East Rm 116	7,3	4		0	379		4		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Wall - South Rm 116	10,2	6		0	310		3		2.667	4.467	1.41	0.3	2.75	281.333	8.015	5	2.7	2.55		0.00465
Floors - Rm 120	3,1	8		0	378		2	2848	2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Floors - Rm 120	4,3	10		0	351		2	2414	2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Floors - Rm 120	7,3	25		0	352		3	2395	2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Floors - Rm 120	8,1	39		0	359		4	2038	2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Ceiling - Rm 120	1,4	5		0	244		3		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Ceiling - Rm 120	3,1	5		0	278		2		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - West Rm 120	1,2	4		0	224		6		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - West Rm 120	4,3	7		1	240		4		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - East Rm 120	9,1	3		0	282		2		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - East Rm 120	12,2	3		0	232		13		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - South Rm 120	14,1	1		0	199		2		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Floors - Restroom	F-1	13		0	355		7	2200	2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Ceiling - Restroom	C-1	2		0	230		4		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - West Restroom	3,2	12		0	252		1		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - North Restroom	5,2	31		0	318		2		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465
Wall - East Restroom	7,1	2		0	281		6		2.333	4.393	1.41	0.3	2.75	279.833	7.579	5	2.7	2.55		0.00465

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APPENDIX B

Building 064 Interior

Lots 1 through 3

Final Survey Results

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/hr) TOTAL	STD DEV
Floors - Rms 104 & 110	1,1	5.52	3.84			-0.83	1.51	602.81	194.57			-6.89	4.19	14.64	0.26
Floors - Rms 104 & 110	1,11	6.76	4.04			-0.83	1.51	880.18	199.99			8.42	7.52	14.91	0.26
Floors - Rms 104 & 110	2,6	1.79	3.18			-0.83	1.51	1134.43	204.83			16.07	8.72	15.15	0.27
Floors - Rms 104 & 110	3,9	5.52	3.84			-0.83	1.51	695.27	196.39			0.76	6.09	14.96	0.26
Floors - Rms 104 & 110	4,7	3.03	3.42			-0.83	1.51	926.40	200.87			-1.79	5.53	14.43	0.26
Floors - Rms 104 & 110	5,4	8.00	4.23			-0.83	1.51	1196.06	205.98			5.87	7.08	14.49	0.26
Floors - Rms 104 & 110	5,12	9.24	4.41			1.93	3.14	1018.86	202.64			-1.79	5.53	17.54	0.29
Floors - Rms 104 & 110	6,5	3.03	3.42			-0.83	1.51	972.63	201.76			5.87	7.08	14.35	0.26
Floors - Rms 104 & 110	7,2	-0.70	2.65			-0.83	1.51	1003.45	202.35			-1.79	5.53	15.43	0.27
Floors - Rms 104 & 110	7,12	6.76	4.04			-0.83	1.51	795.43	198.35			0.76	6.09	14.39	0.26
Floors - Rms 104 & 110	8,8	3.03	3.42			-0.83	1.51	872.47	199.84			-1.79	5.53	14.75	0.26
Floors - Rms 104 & 110	9,3	5.52	3.84			-0.83	1.51	895.58	200.28			0.76	6.09	14.75	0.26
Floors - Rms 104 & 110	10,6	0.54	2.93			-0.83	1.51	864.77	199.69			10.96	7.94	14.86	0.26
Floors - Rms 104 & 110	11,4	1.79	3.18			1.93	3.14	1038.20	203.95			-1.79	5.53	14.97	0.26
Floors - Rms 104 & 110	12,7	0.54	2.93			-0.83	1.51	787.72	198.20			5.87	7.08	14.62	0.26
Floors - Rms 104 & 110	12,10	1.79	3.18			-0.83	1.51	918.70	200.73			5.87	7.08	13.82	0.25
Floors - Rms 104 & 110	13,5	1.79	3.18			-0.83	1.51	826.24	198.94			0.76	6.09	14.67	0.26
Floors - Rms 104 & 110	14,11	8.00	4.23			-0.83	1.51	1041.97	203.08			-4.34	4.91	14.81	0.26
Floors - Rms 104 & 110	14,2	5.52	3.84			-0.83	1.51	602.81	194.57			8.42	7.52	15.15	0.27
Floors - Rms 104 & 110	15,5	3.03	3.42			-0.83	1.51	864.77	199.69			3.31	6.60	12.88	0.24
Ceiling - Rms 104 & 110	1,5	2.30	3.11			-0.83	1.51	-2.55	178.44			-1.79	5.53		
Ceiling - Rms 104 & 110	2,8	-0.21	2.56			-0.83	1.51	127.47	181.21			3.31	6.60		
Ceiling - Rms 104 & 110	3,12	4.80	3.58			-0.83	1.51	471.64	188.33			13.52	8.34		
Ceiling - Rms 104 & 110	3,2	1.04	2.85			-0.83	1.51	127.47	181.21			3.31	6.60		
Ceiling - Rms 104 & 110	4,6	-0.21	2.56			1.93	3.14	112.17	180.88			13.52	8.34		
Ceiling - Rms 104 & 110	5,9	2.30	3.11			-0.83	1.51	112.17	180.88			8.42	7.52		
Ceiling - Rms 104 & 110	6,4	3.55	3.36			-0.83	1.51	12.75	178.77			0.76	6.09		
Ceiling - Rms 104 & 110	6,11	2.30	3.11			-0.83	1.51	127.47	181.21			-1.79	5.53		
Ceiling - Rms 104 & 110	7,1	8.57	4.19			-0.83	1.51	364.57	186.14			5.87	7.08		
Ceiling - Rms 104 & 110	8,3	3.55	3.36			-0.83	1.51	-2.55	178.44			10.96	7.94		
Ceiling - Rms 104 & 110	9,7	2.30	3.11			-0.83	1.51	203.95	182.81			-1.79	5.53		
Ceiling - Rms 104 & 110	9,12	7.31	4.00			1.93	3.14	242.19	183.61			-4.34	4.91		
Ceiling - Rms 104 & 110	10,5	2.30	3.11			-0.83	1.51	249.84	183.77			3.31	6.60		
Ceiling - Rms 104 & 110	11,2	3.55	3.36			-0.83	1.51	356.92	185.99			5.87	7.08		

BUILDING 064 - FINAL SURVEY CALCULATED RESULTS FOR LOT 1

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/hr) TOTAL	STD DEV
Ceiling - Rms 104 & 110	11,11	1.04	2.85			-0.83	1.51	203.95	182.81			-1.79	5.53		
Ceiling - Rms 104 & 110	12,9	2.30	3.11			1.93	3.14	112.17	180.88			10.96	7.94		
Ceiling - Rms 104 & 110	13,2	4.80	3.58			15.68	6.90	379.86	186.46			5.87	7.08		
Ceiling - Rms 104 & 110	14,3	2.30	3.11			1.93	3.14	410.46	187.08			3.31	6.60		
Ceiling - Rms 104 & 110	15,1	6.06	3.79			1.93	3.14	349.27	185.83			13.52	8.34		
Ceiling - Rms 104 & 110	14,10	4.80	3.58			-0.83	1.51	219.25	183.13			3.31	6.60		
Wall North - Rm 110	1,3	8.57	4.19			7.43	5.00	-155.51	175.13			0.76	6.09		
Wall North - Rm 110	3,2	12.33	4.72			1.93	3.14	188.66	182.49			3.31	6.60		
Wall North - Rm 110	6,1	13.58	4.88			1.93	3.14	-17.85	178.11			0.76	6.09		
Wall North - Rm 110	8,3	11.07	4.55			-0.83	1.51	-209.05	173.96			0.76	6.09		
Wall North - Rm 110	10,4	8.57	4.19			-0.83	1.51	-239.65	173.29			0.76	6.09		
Wall North - Rm 110	11,1	14.83	5.04			-0.83	1.51	12.75	178.77			5.87	7.08		
Wall North - Rm 110	13,2	9.82	4.37			-0.83	1.51	-48.44	177.45			-4.34	4.91		
Wall North - Rm 110	15,3	11.07	4.55			-0.83	1.51	-25.49	177.95			0.76	6.09		
Wall East - Rm 110	18,4	14.83	5.04			-0.83	1.51	135.12	181.37			10.96	7.94		
Wall East - Rm 110	19,1	17.34	5.34			1.93	3.14	96.88	180.56			5.87	7.08		
Wall East - Rm 110	21,2	24.86	6.16			-0.83	1.51	181.01	182.33			-4.34	4.91		
Wall East - Rm 110	23,2	11.07	4.55			1.93	3.14	-469.09	168.15			5.87	7.08		
Wall East - Rm 110	25,2	11.07	4.55			4.68	4.17	181.01	182.33			10.96	7.94		
Wall East - Rm 110	27,3	8.57	4.19			1.93	3.14	35.69	179.26			10.96	7.94		
Wall South - Rm 110	2,3	12.33	4.72			-0.83	1.51	280.44	184.41			5.87	7.08		
Wall South - Rm 110	4,2	12.33	4.72			1.93	3.14	280.44	184.41			5.87	7.08		
Wall South - Rm 110	6,1	9.82	4.37			-0.83	1.51	356.92	185.99			0.76	6.09		
Wall South - Rm 110	7-8,5	8.57	4.19			-0.83	1.51	127.47	181.21			0.76	6.09		
Wall South - Rm 110	10,3	17.34	5.34			-0.83	1.51	150.42	181.69			3.31	6.60		
Wall West - Rm 110	12,2	18.59	5.49			1.93	3.14	127.47	181.21			3.31	6.60		
Wall West - Rm 110	14,3	6.06	3.79			-0.83	1.51	35.69	179.26			5.87	7.08		
Wall West - Rm 110	16,2	12.33	4.72			1.93	3.14	35.69	179.26			3.31	6.60		
Wall West - Rm 110	18,3	8.57	4.19			1.93	3.14	257.49	183.93			5.87	7.08		
Wall West - Rm 110	20,1	12.33	4.72			-0.83	1.51	165.71	182.01			0.76	6.09		
Wall West - Rm 110	22,4	11.07	4.55			-0.83	1.51	402.81	186.93			8.42	7.52		
Wall West - Rm 110	23,3	13.58	4.88			-0.83	1.51	-10.20	178.28			-1.79	5.53		
Wall East - Rm 104(deconned)	2,2	62.87	9.24	470.27	24.45	10.18	5.70	496.77	189.93	326	186	18.62	9.09		
Wall East - Rm 104	4,2	12.33	4.72			1.93	3.14	265.14	184.09			5.87	7.08		

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/hr) TOTAL	STD DEV
Wall South - Rm 104(deconned)	5,1	13.83	4.87	282.91	19.03	1.93	3.14	249.03	184.81	117	182	-4.34	4.91		
Wall West - Rm 104	8,3	8.57	4.19			-0.83	1.51	-86.68	176.63			8.42	7.52		
Wall West - Rm 104	10,1	41.15	7.64			23.93	8.39	58.64	179.75			31.37	10.73		
Wall North - Rm 104	12,3	12.33	4.72			-0.83	1.51	196.30	182.65			0.76	6.09		
Wall North - Rm 104	14,2-3	9.82	4.37			1.93	3.14	35.69	179.26			0.76	6.09		
Structure - Trusses Rm 104	St-1	193.64	15.81			1.93	3.14	450.32	188.98			5.87	7.08		
Structure - Trusses Rm 104	St-2	164.72	14.61			-0.83	1.51	411.61	188.18			16.07	8.72		
Structure - Trusses Exit Rm 110	St-3	57.84	8.89			7.43	5.00	-316.13	172.57			-1.79	5.53		
Structure - Trusses NE corner Rm 110	St-4	98.08	11.39			-0.83	1.51	434.84	188.66			-4.34	4.91		
Structure - Trusses near C(4,10)	St-5	57.84	8.89			1.93	3.14	388.39	187.70			0.76	6.09		
Structure - Trusses near Center	St-6	44.01	7.85			-0.83	1.51	272.26	185.29			-1.79	5.53		
Structure - Trusses C(6,4) near HTR	St-7	26.41	6.29			1.93	3.14	365.16	187.23			13.52	8.34		
Structure - Beam Ledges - West	Sb-1	94.30	11.18			4.68	4.17	-99.35	177.36			0.76	6.09		
Structure - Beam Ledges - Center West	Sb-2	44.01	7.85			1.93	3.14	-153.55	176.17			0.76	6.09		
Structure - Beam Ledges - Center	Sb-3	71.67	9.82			4.68	4.17	101.94	181.70			5.87	7.08		
Structure - Beam Ledges - Center East	Sb-4	137.06	13.37			-0.83	1.51	148.39	182.69			3.31	6.60		
Structure - Beam Ledges - East	Sb-5	155.92	14.23			-0.83	1.51	233.55	184.48			-1.79	5.53		
Structure - Heater Outside Wall	Sh-1	5.03	3.56			-0.83	1.51	-21.94	179.04			-1.79	5.53		
Structure - Heater Inside Grating	Sh-2	2.51	3.08			1.93	3.14	24.52	180.04			0.76	6.09		
Structure - Heater Inside Wall	Sh-3	0.00	2.51			-0.83	1.51	-230.97	174.47			5.87	7.08		

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/h) TOTAL	STD DEV
Floors - Rm 114	1,4	0.54	2.93			1.93	3.14	976.67	207.22			5.87	7.08	15.32	0.27
Floors - Rm 114	2,1	-0.70	2.65			-0.83	1.51	1016.64	207.99			3.31	6.60	15.41	0.27
Floors - Rm 114	3,7	4.27	3.64			-0.83	1.51	680.87	201.43			-1.79	5.53	14.75	0.26
Floors - Rm 114	2,10	-3.18	1.99			-0.83	1.51	928.70	206.29			3.31	6.60	16.21	0.27
Floors - Rm 114	5,12	1.79	3.18			-0.83	1.51	1096.58	209.52			-4.34	4.91	15.68	0.27
Floors - Rm 114	4,5	5.52	3.84			-0.83	1.51	864.74	205.05			10.96	7.94	13.79	0.25
Floors - Rm 114	5,2	1.79	3.18			-0.83	1.51	816.78	204.11			-1.79	5.53	14.46	0.26
Floors - Rm 114	6,6	0.54	2.93			-0.83	1.51	952.68	206.75			8.42	7.52	14.42	0.26
Floors - Rm 114	7,3	3.03	3.42			-0.83	1.51	736.83	202.54			5.87	7.08	14.51	0.26
Floors - Rm 114	8,8	-0.70	2.65			-0.83	1.51	1104.58	209.67			0.76	6.09	14.34	0.26
Floors - Rm 114	7,11	-0.70	2.65			-0.83	1.51	928.70	206.29			-1.79	5.53	14.84	0.26
Floors - Rm 114	9,4	3.51	3.75			-0.83	1.51	776.23	203.67			8.42	7.52	14.32	0.26
Floors - Rm 114	10,1	2.27	3.54			-0.83	1.51	480.77	197.95			8.42	7.52	13.63	0.25
Floors - Rm 114	11,7	4.75	3.95			-0.83	1.51	690.70	202.03			8.42	7.52	13.87	0.25
Floors - Rm 114	12,6	3.51	3.75			-0.83	1.51	791.78	203.97			-1.79	5.53	14.03	0.26
Floors - Rm 114	12,10	3.51	3.75			1.93	3.14	325.26	194.87			3.31	6.60	15.12	0.27
Floors - Rm 114	13,1	5.99	4.14			-0.83	1.51	535.19	199.02			0.76	6.09	14.17	0.26
Floors - Rm 114	14,5	4.75	3.95			-0.83	1.51	589.62	200.08			-1.79	5.53	14.25	0.26
Floors - Rm 114	15,2	2.27	3.54			-0.83	1.51	426.34	196.38			0.76	6.09	14.00	0.26
Floors - Rm 114	15,11	2.27	3.54			1.93	3.14	706.25	202.33			3.31	6.60	16.19	0.27
Ceiling - Rm 114	1,1	0.83	3.39			-0.83	1.51	-98.11	172.46			5.87	7.08		
Ceiling - Rm 114	2,4	3.33	3.82			1.93	3.14	-186.41	170.56			-1.79	5.53		
Ceiling - Rm 114	3,6	0.83	3.39			-0.83	1.51	-385.07	166.22			10.96	7.94		
Ceiling - Rm 114	4,3	2.08	3.61			-0.83	1.51	-215.84	169.93			-1.79	5.53		
Ceiling - Rm 114	5,2	3.33	3.82			-0.83	1.51	-46.60	173.55			5.87	7.08		
Ceiling - Rm 114	6,6	-2.92	2.60			1.93	3.14	-333.57	167.36			3.31	6.60		
Ceiling - Rm 114	7,7	5.83	4.21			-0.83	1.51	-421.86	165.41			-4.34	4.91		
Ceiling - Rm 114	8,9	-0.42	3.15			-0.83	1.51	-318.85	167.68			5.87	7.08		
Ceiling - Rm 114	9,4	3.33	3.82			1.93	3.14	-186.41	170.56			3.31	6.60		
Ceiling - Rm 114	10,5	4.58	4.02			-0.83	1.51	-245.27	169.29			-1.79	5.53		
Ceiling - Rm 114	11,9	0.83	3.39			-0.83	1.51	-259.99	168.97			3.31	6.60		
Ceiling - Rm 114	12,2	3.33	3.82			-0.83	1.51	-259.99	168.97			-1.79	5.53		
Ceiling - Rm 114	13,4	0.83	3.39			1.93	3.14	-399.79	165.90			3.31	6.60		

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/h) TOTAL	STD DEV
Ceiling - Rm 114	14,7	2.08	3.61			-0.83	1.51	-31.89	173.87			10.96	7.94		
Ceiling - Rm 114	15,6	-1.67	2.89			1.93	3.14	-245.27	169.29			0.76	6.09		
Ceiling - Rm 114	13,12	4.58	4.02			-0.83	1.51	-120.18	171.99			-1.79	5.53		
Ceiling - Rm 114	10,10	3.33	3.82			-0.83	1.51	-318.85	167.68			3.31	6.60		
Ceiling - Rm 114	8,12	0.83	3.39			-0.83	1.51	-105.47	172.30			0.76	6.09		
Ceiling - Rm 114	4,11	-1.67	2.89			-0.83	1.51	-83.39	172.77			-6.89	4.19		
Ceiling - Rm 114	1,10	-1.67	2.89			1.93	3.14	-245.27	169.29			-1.79	5.53		
Wall - South Rm 114	3,1	3.50	3.31			-0.83	1.51	289.14	193.50			5.87	7.08		
Wall - South Rm 114	4,4	3.50	3.31			-0.83	1.51	-2.47	175.03			-1.79	5.53		
Wall - South Rm 114	5,2	1.03	2.81			-0.83	1.51	9.33	187.63			10.96	7.94		
Wall - South Rm 114	8,3	-0.21	2.52			-0.83	1.51	-142.57	184.37			-4.34	4.91		
Wall - South Rm 114	8,5	-0.21	2.52			-0.83	1.51	-158.31	171.69			0.76	6.09		
Wall - South Rm 114	10,1	2.26	3.07			-0.83	1.51	-94.60	185.40			-1.79	5.53		
Wall - South Rm 114	11,4	2.26	3.07			-0.83	1.51	34.63	175.81			-4.34	4.91		
Wall - South Rm 114	13,3	-0.21	2.52			-0.83	1.51	-2.47	175.03			-4.34	4.91		
Wall - South Rm 114	15,5	1.03	2.81			-0.83	1.51	108.84	177.37			0.76	6.09		
Wall - West Rm 114	17,2	2.26	3.07			-0.83	1.51	696.86	201.75			5.87	7.08		
Wall - West Rm 114	20,2	2.26	3.07			-0.83	1.51	760.81	203.01			-1.79	5.53		
Wall - West Rm 114	23,1	0.40	2.88			-0.83	1.51	528.97	198.39			-1.79	5.53		
Wall - West Rm 114	26,3	0.40	2.88			-0.63	1.51	399.53	195.50			8.42	7.52		
Wall - West Rm 114	21,4	-0.21	2.52			-0.83	1.51	160.78	178.46			3.31	6.60		
Wall - West Rm 114	25,4	0.40	2.86			-0.83	1.51	524.39	185.86			0.76	6.09		
Wall - North Rm 114	2,2	3.50	3.31			-0.83	1.51	744.82	202.69			8.42	7.52		
Wall - North Rm 114	4,3	0.40	2.88			1.93	3.14	212.73	179.53			8.42	7.52		
Wall - North Rm 114	7,1	-1.44	2.20			-0.83	1.51	680.87	201.43			0.76	6.09		
Wall - North Rm 114	10,3	-0.81	2.61			-0.83	1.51	294.35	181.21			0.76	6.09		
Wall - North Rm 114	13,1	-1.44	2.20			1.93	3.14	664.88	201.11			-1.79	5.53		
Wall - North Rm 114	3,4	2.82	3.35			-0.83	1.51	695.07	189.24			-1.79	5.53		
Wall - North Rm 114	9,5	1.61	3.12			-0.83	1.51	93.99	177.06			8.42	7.52		
Wall - North Rm 114	11,4	1.03	2.81			-0.83	1.51	635.70	188.07			-6.89	4.19		
Wall - North Rm 114	15,4	4.03	3.56			-0.83	1.51	301.77	181.36			-1.79	5.53		
Wall - East Rm 114	17,2	2.26	3.07			-0.83	1.51	305.12	193.83			8.42	7.52		
Wall - East Rm 114	20,2	-0.21	2.52			-0.83	1.51	385.07	195.47			-4.34	4.91		

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				ALPHA						BETA				GAMMA	
SAMPLE	GRID			(DPM/100CM2)						(DPM/100CM2)				(uR/h)	
NAME	NAME	TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	TOTAL	STD DEV
Wall - East Rm 114	23,1	2.43	2.33			-0.83	1.51	3.53	152.45			3.31	6.60		
Wall - East Rm 114	26,1	1.03	2.81			-0.83	1.51	272.09	180.76			0.76	6.09		
Wall - East Rm 114	19,1	5.04	2.78			-0.83	1.51	1004.76	174.07			5.87	7.08		
Wall - East Rm 114	27,4	1.61	3.12			-0.83	1.51	606.02	187.48			-6.89	4.19		
Structure - Trusses Rm 114 NW	St-1	1.68	3.25			-0.83	1.51	-315.27	183.36			0.76	6.09		
Structure - Trusses Rm114 Center	St-2	0.42	3.00			-0.83	1.51	-26.72	189.57			10.96	7.94		
Structure - Trusses Rm114 SE	St-3	2.94	3.49			-0.83	1.51	-10.69	189.90			3.31	6.60		
Structure - Beams Rm 114 North	Sb-1	6.72	4.11			-0.83	1.51	-146.95	187.01			0.76	6.09		
Structure - Beams Rm 114 Center	Sb-2	4.20	3.71			-0.83	1.51	-34.73	189.40			-4.34	4.91		
Structure - Beams Rm 114 South	Sb-3	11.76	4.82			-0.83	1.51	77.48	191.76			-4.34	4.91		
Maximum:		11.76	4.82			1.93	3.14	1104.58	209.67			10.96	7.94	16.21	0.27
Minimum:		-3.18	1.99			-0.83	1.51	-421.86	152.45			-6.89	4.19	13.63	0.25
Average:		1.91	3.23			-0.43	1.74	269.40	186.41			1.84	6.23	14.67	0.26

SAMPLE NAME	GRID NAME	ALPHA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	BETA (DPM/100CM2) TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	GAMMA (uR/h) TOTAL	STD DEV
Floors - Rm 116	F-1	4.20	3.71			-0.83	1.51	1247.73	214.83			10.96	7.94	17.32	0.28
Floors - Rm 116	F-2	53.33	8.70			-0.83	1.51	1207.65	214.08			10.96	7.94	13.30	0.25
Ceiling - Rm 116	C-1	-0.84	2.72			1.93	3.14	117.56	192.59			-1.79	5.53		
Wall - West Rm 116	2,2	-0.84	2.72			4.68	4.17	887.04	207.99			5.87	7.08		
Wall - North Rm 116	5,1	0.42	3.00			-0.83	1.51	1191.62	213.78			-4.34	4.91		
Wall - East Rm 116	7,3	1.68	3.25			-0.83	1.51	782.84	205.97			3.31	6.60		
Wall - South Rm 116	10,2	4.20	3.71			-0.83	1.51	229.77	194.91			0.76	6.09		
Floors - Rm 120	3,1	7.02	3.98			-0.83	1.51	743.97	194.38			-1.79	5.53	13.24	0.25
Floors - Rm 120	4,3	9.50	4.35			-0.83	1.51	539.35	190.35			-1.79	5.53	11.23	0.23
Floors - Rm 120	7,3	28.08	6.48			-0.83	1.51	546.92	190.50			0.76	6.09	11.14	0.23
Floors - Rm 120	8,1	45.42	7.96			-0.83	1.51	599.97	191.55			3.31	6.60	9.48	0.21
Ceiling - Rm 120	1,4	3.30	3.35			-0.83	1.51	-271.57	173.46			0.76	6.09		
Ceiling - Rm 120	3,1	3.30	3.35			-0.83	1.51	-13.89	179.00			-1.79	5.53		
Wall - West Rm 120	1,2	2.06	3.12			-0.83	1.51	-423.14	170.11			8.42	7.52		
Wall - West Rm 120	4,3	5.78	3.78			1.93	3.14	-301.88	172.79			3.31	6.60		
Wall - East Rm 120	9,1	0.83	2.86			-0.83	1.51	16.42	179.64			-1.79	5.53		
Wall - East Rm 120	12,2	0.83	2.86			-0.83	1.51	-362.51	171.46			26.27	10.10		
Wall - South Rm 120	14,1	-1.65	2.26			-0.83	1.51	-612.61	165.84			-1.79	5.53		
Floors - Restroom	F-1	13.21	4.85			-0.83	1.51	569.66	190.95			10.96	7.94	10.23	0.22
Ceiling - Restroom	C-1	-0.41	2.58			-0.83	1.51	-377.67	171.12			3.31	6.60		
Wall - West Restroom	3,2	11.97	4.69			-0.83	1.51	-210.94	174.77			-4.34	4.91		
Wall - North Restroom	5,2	35.51	7.15			-0.83	1.51	289.25	185.30			-1.79	5.53		
Wall - East Restroom	7,1	-0.41	2.58			-0.83	1.51	8.84	179.48			8.42	7.52		
Maximum:		53.33	8.70			4.68	4.17	1247.73	214.83			26.27	10.10	17.32	0.28
Minimum:		-1.65	2.26			-0.83	1.51	-612.61	165.84			-4.34	4.91	9.48	0.21
Average:		9.85	4.09			-0.35	1.76	278.45	188.04			3.31	6.49	12.28	0.24

T64L3DAT.WB1

Gamma exposure rate in Bldg. 445

counts/1 min	uR/hr	uncertainty
3205	14.91	0.26
3189	14.83	0.26
3362	15.64	0.27
3366	15.66	0.27
3149	14.65	0.26
3194	14.86	0.26
3187	14.82	0.26
3109	14.46	0.26
3261	15.17	0.27
3365	15.65	0.27
3150	14.65	0.26
3181	14.80	0.26
3183	14.80	0.26
3237	15.06	0.26
3252	15.13	0.27
3380	15.72	0.27
3179	14.79	0.26
3231	15.03	0.26
3264	15.18	0.27
3242	15.08	0.26
3322	15.45	0.27
3274	15.23	0.27
3263	15.18	0.27
3191	14.84	0.26
3336	15.52	0.27
3228	15.01	0.26
3275	15.23	0.27
3174	14.76	0.26
3209	14.93	0.26
3212	14.94	0.26
3162	14.71	0.26
3264	15.18	0.27
3144	14.62	0.26
2794	13.00	0.25
3332	15.50	0.27
3277	15.24	0.27
3219	14.97	0.26
3376	15.70	0.27
3191	14.84	0.26
3049	14.18	0.26

BUILDING 064 - FINAL SURVEY CALCULATED DAILY INSTRUMENT BACKGROUNDS

	Instrument Background Qualification Data				
DATE	BKGD-A	EFACT-A	BKGD-B	EFACT-B	
	AVE for 5 min		AVE for 5 min		
07-Sep-93	2.563	4.407	279.759	7.705	ave plex
08-Sep-93	2.563	4.407	279.759	7.705	ave plex
09-Sep-93	2.563	4.407	279.759	7.705	ave plex
10-Sep-93	2.563	4.407	279.759	7.705	ave plex
14-Sep-93	2.167	4.445	272.333	7.648	
15-Sep-93	2.000	4.459	268.833	7.742	
16-Sep-93	2.563	4.407	274.833	7.995	
17-Sep-93	3.167	4.394	293.167	7.775	
20-Sep-93	2.167	4.379	278.333	7.421	
21-Sep-93	2.667	4.290	287.833	7.808	
22-Sep-93	3.333	4.434	281.333	7.358	
23-Sep-93	2.667	4.467	281.333	8.015	
24-Sep-93	2.333	4.393	279.833	7.579	
ave plex	0.513	4.407	55.952	7.705	

Rockwell International
Rocketdyne Division

SUPPORTING DOCUMENT

GO NO.	S/A NO.	PAGE 1 OF	TOTAL PAGES	REV LTR/CHG NO. SEE SUMMARY OF CHG	NUMBER
96110		80	81	A	N704SRR990031

PROGRAM TITLE

Decontamination of the Building T064 Side Yard

DOCUMENT TITLE

Final Decontamination and Radiological Survey of the Building T064 Side Yard

DOCUMENT TYPE

Safety Review Report

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H. Farrar IV 10/30/90

R. J. Tuttle 10/30/90

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ABSTRACT

A comprehensive radiological survey of Building T064, its fenced-in yard, and a surrounding 2-acre area at the SSFL was performed in 1988. In accordance with that survey report's recommendation, remedial efforts were undertaken in a localized 4,500 ft^2 area, designated the Building T064 Side Yard, to reduce the cesium-137 (^{137}Cs) radionuclide contamination found in that area. Follow-up surveys were performed and analyzed using methods similar to the 1988 survey. Current U.S. Department of Energy (DOE) guidelines for residual soil activity for man-made nuclides were applied using an associated DOE computer code, RESRAD. Results show that the remaining ^{137}Cs activity and radiation levels at the Side Yard are well below the applicable limits, and that the residual activity poses no hazard to potential current or future users of the site.

Results of the surveys demonstrate that the Side Yard and other surveyed areas surrounding Building T064 meet the requirements of DOE Order 5400.5, "Radiation Protection of the Public and Environment" (February 1990), for release without radiological restrictions.

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* COMPLETE DOCUMENT

NO ASTERISK, TITLE PAGE/SUMMARY OF CHANGE PAGE ONLY

REV	SUMMARY OF CHANGE	APPROVALS AND DATE
A	1. Appendix F has been added. The appendix discusses additional excavating, sampling and sample results following the ORISE survey (reported in their draft report of December 1992) and following the DOE decision that a retroactive limit of 10 mrem/y will apply to this project. 2. Editorial changes were made on pages 3 and 7 to incorporate references to the new appendix. 3. Distribution was updated. REL. DATE 9-10-93	Phil Rutherford 8/2/93 P. D. Rutherford for A. Okuda

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SUMMARY

PURPOSE. This Safety Review Report provides an assessment of residual radioactivity present at the Building T064 Side Yard, located in Rockwell International's Santa Susana Field Laboratories (SSFL), following its decontamination. Near– and long–term consequences due to the presence of the residual activities to current and future occupants of the Yard were evaluated to determine if this location is acceptably clean of radioactive materials.

BACKGROUND. Since the late 1950s, Building T064 and its fenced–in yard were utilized by Rockwell and its predecessor firms in support of a number of the US government's nuclear programs. In the early 1960s, a contamination incident involving radioactive mixed fission products from a reactor fuel–element shipping cask occurred in an area near the eastern portion of the fenced–in yard. The area was cleaned up in 1963 to then–existing requirements for radiological cleanliness. Subsequently, a comprehensive 1988 radiological survey report on the building and surroundings recommended remedial actions to further reduce residual activities in a 4,000 ft^2 area of the Side Yard near the eastern fence to current requirements. The remaining portions of the fenced–in yard were found to be free of contamination.

WORK PERFORMED. To further reduce contamination to levels that are as low as reasonably achievable (ALARA), top layer materials from the Side Yard were removed to depths varying from several inches to several feet. The residual activity in the soil, following decontamination, was analyzed and compared with previous measurements. An analysis was performed, in accordance with the U.S. Department of Energy (DOE) guidelines, to determine the consequences resulting from the presence of this residual radioactivity.

STATUS. The Side Yard remains vacant and no radioactive materials or equipment are planned to be brought to the yard. Building T064 itself is being used as a storage facility for the soil excavated from the Side Yard and from other SSFL locations. The slightly contaminated soil is contained in tight steel boxes. Further determination of the radiological status of the building will be done after the planned disposal of the soil.

CONCLUSION. Based on results of the 1988 survey and the subsequent work described here, radiation and contamination levels in the Side Yard and other surveyed areas surrounding Building T064 are well below acceptable regulatory limits, and pose no hazard to the safety and health of potential current or future occupants. Therefore, the Side Yard and other surveyed areas can be released for use without radiological restrictions.

1. INTRODUCTION

Decontamination and decommissioning (D&D) of a number of formerly used nuclear facilities and sites is underway at Rockwell International's Santa Susana Field Laboratories (SSFL). During D&D of these facilities, reasonable efforts are being made to eliminate or reduce residual radioactive contamination to levels that are as low as reasonably achievable (ALARA). Upon completion of D&D, radiological surveys are performed, under established protocols to determine that any remaining radioactivity does not exceed applicable regulatory limits. Findings from the surveys are also used to perform additional D&D or radiological investigations, as needed. The scope of the surveys includes both known and suspected areas of contamination.

In accordance with a broad radiological survey plan for the SSFL (Ref. 1), a comprehensive radiological survey of Building T064, its fenced–in storage yard, and a surrounding 2–acre area was performed in 1988 (Ref. 2). With respect to the area surrounding T064, results of the survey showed elevated radiation levels due to ^{137}Cs radionuclide contamination in an approximately 4,000 ft^2 area, in the vicinity of the fenced–in yard. As recommended in the survey report, top soil was removed from portions of a larger 4,500 ft^2 area; follow–up investigations were carried out by performing additional surveys and analyses, which are the subject of this present safety review report (SRR). The radiological status of Building T064 per se is not addressed in this SRR because the building continues to be under radiological control, pending authorized disposal of slightly contaminated items stored there.

The findings presented in this SRR include a statistical treatment of the measured external gamma dose rates and soil activity data from the Side Yard. While gamma exposure rates can be compared with a generic regulatory acceptance limit, corresponding generic limits for allowable concentrations of artificial radionuclides in soil, such as ^{137}Cs, have not been set. Recently, however, the U.S. DOE has established dose and interpretation guidelines and developed an associated computer code called RESRAD, by means of which a limit for residual activities in soil may be derived on a site–specific basis (Ref. 3). The code was used and results of analyses of the soil activity data from the T064 Side Yard using this code are also presented in this report.

This report is organized as follows: A background on the Building T064 Side Yard that includes its location and operating history is provided in the next section (Section 2). A summary of the comprehensive radiological survey performed in 1988 and its findings with respect to the Side Yard are highlighted in section 3. Section 4 describes the technical approach used to implement the recommendation of the 1988 survey and to analyze the resulting data using statistical techniques and the RESRAD code. Results are provided and discussed in section 5, and section 6 states the conclusions drawn from the review.

Additional data and information pertaining to the Side Yard are provided in the following appendices. Appendix A is a document describing a T064 Side Yard contamination incident in the early 1960s that led to the 1988 survey of this area. Appendices B and C provide a variety of related data obtained from the present investigation. Input data used to perform the RESRAD code calculations are included in Appendix D. Appendix E provides a list of items of record obtained during the D&D and surveys, which are archived at Rockwell. Appendix F describes additional soil removal accomplished to meet the DOE's retroactive limit of 10 mrem/y. Summary outputs of the RESRAD calculations are maintained in the archives.

2. BACKGROUND

2.1 LOCATION

Building T064 is located within Rockwell International's Santa Susana Field Laboratories (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. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 1. An enlarged map of neighboring SSFL communities is shown in Figure 2. Figure 3 is a plot plan of the western portion of SSFL, known as area IV, where Building T064 is located.

A drawing (plan view) of Building T064 and its adjoining areas is shown in Figure 4. As shown, T064 is totally fenced in with a chain–link fence. Two photographs of the north and east sides of T064 are shown in Figures 5 and 6, respectively. Of these, the eastern fence, shown in Fig. 6, runs through an approximately 4,500 ft^2 trapezoidal area, which is shown in Figure 7. This 4,500 ft^2 area is referred to as the "Building T064 Side Yard" and was designated for D&D after a smaller ~4,000 ft^2 area to the east of the fence was identified for remedial action following a 1988 radiological survey of the building and surrounding areas (Ref. 2). Thus, the Side Yard, although never identified as such in previous documents including the 1988 survey, is a part of the fenced–in yard and the adjoining area surrounding the fenced–in yard. Additional figures and dimensions of the affected area are provided in subsequent sections of this report.

Figure 8 shows relevant portions of a 1967 edition of the U.S. Geological Survey (USGS) topographic map of the Calabasas Quadrangle where the SSFL is located. The map in Figure 8 includes the authors' markup of the location of the Building T064 Side Yard. Using USGS terminology, the USGS description for the Building T064 Side Yard is: Township T2N; Range R17W; and Section 30, Calabasas Quadrangle.

2.2 AREA CHARACTERISTICS AND TOPOGRAPHY

Figure 9 is a photograph of Building T064 taken from the south end of the complex. The facility sits atop a plateau about 25 ft above "G" Street (Figure 3). As shown in Figure 9, the terrain throughout most of the SSFL areas is uneven due to rock outcroppings. Rock outcroppings exist upslope to the north–northeast and downslope in every other direction. Water run–off is primarily due east at the southern end of the facility. The fenced–in yard surrounding the building was paved with asphalt. Except for the portion of

Figure 1. Map of Los Angeles Area

6239-2

Figure 2. Map of Neighboring SSFL Communities

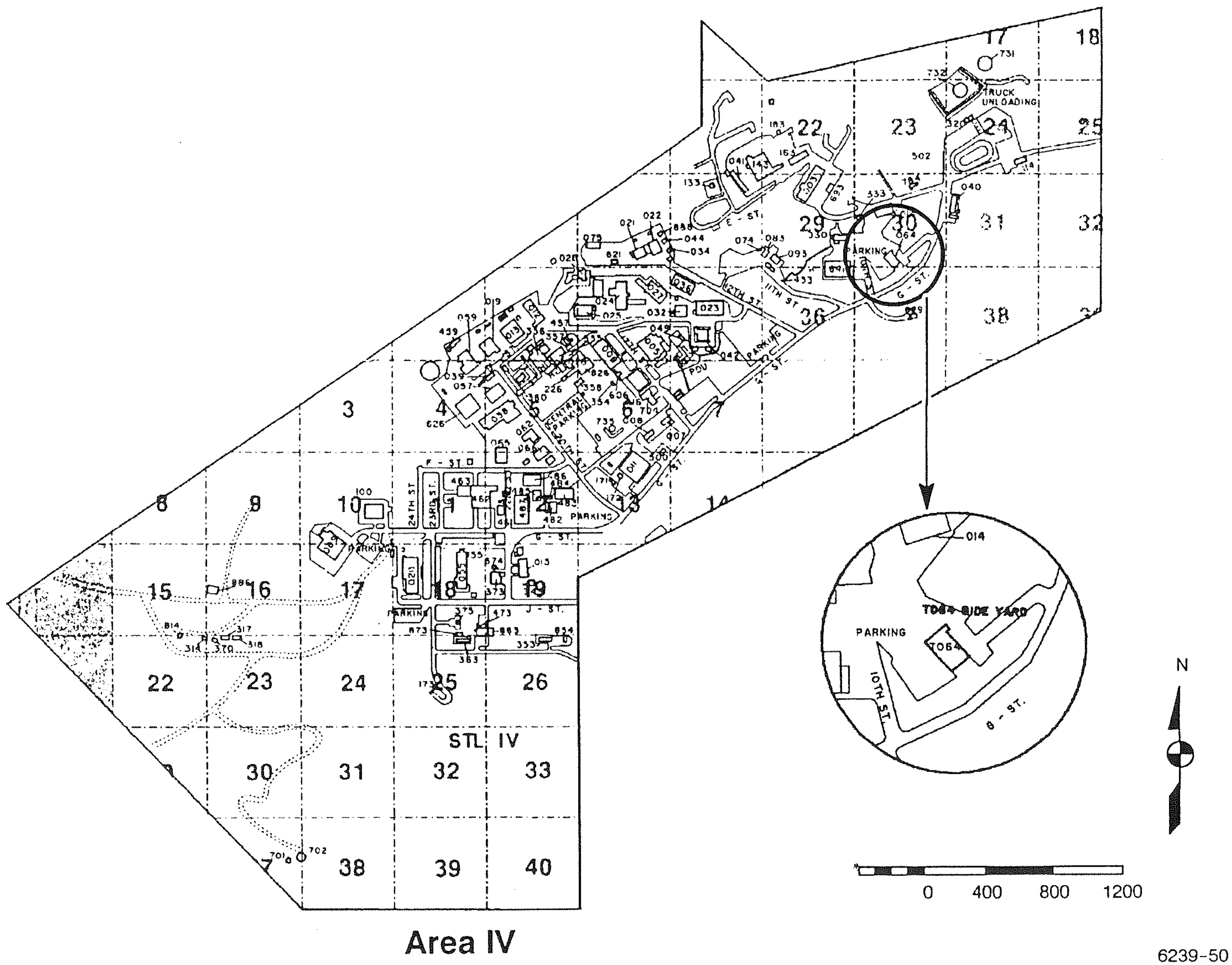


Figure 3. SSFL Layout Showing Location of the Building T064 Side Yard

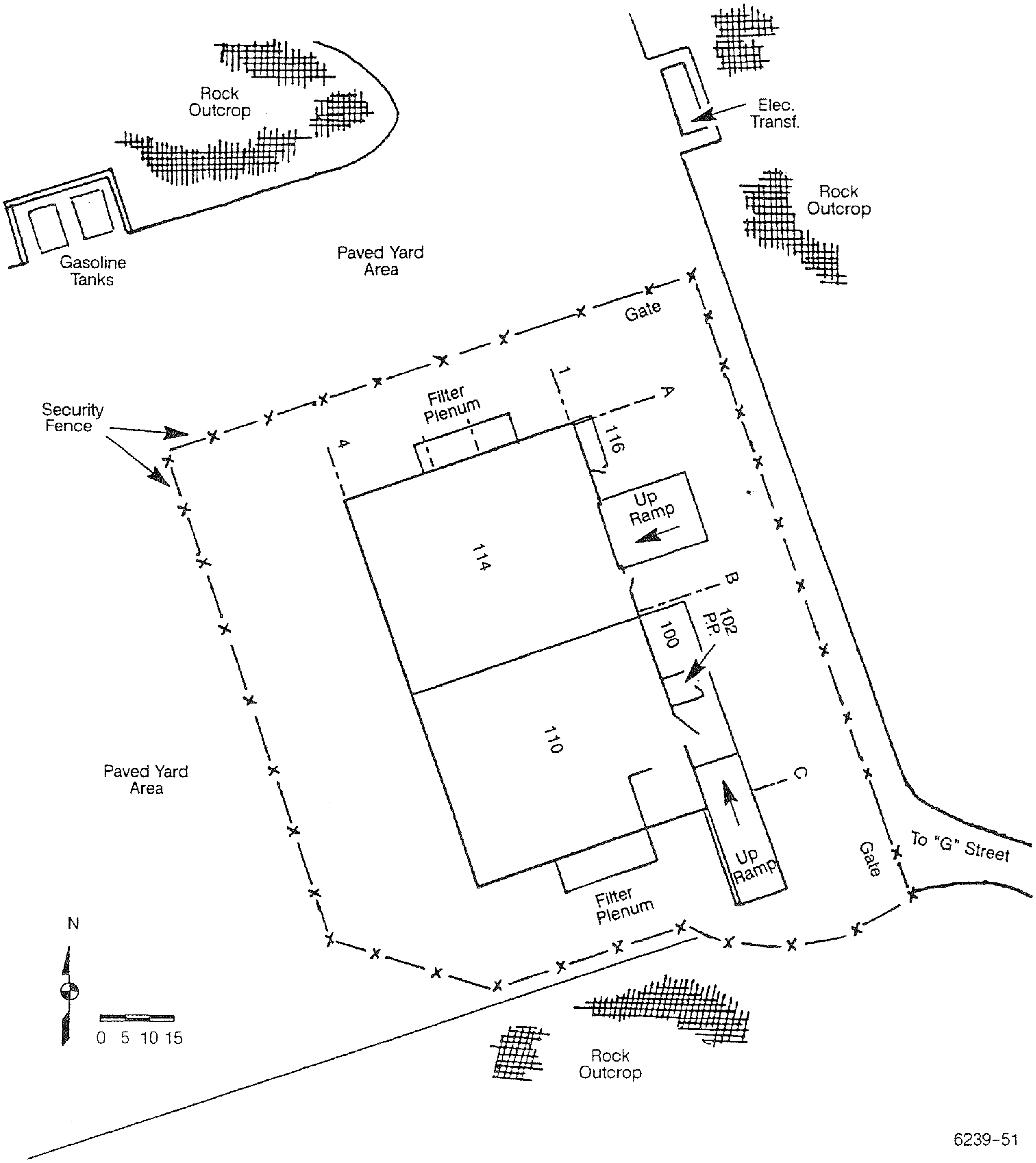


Figure 4. Source and Special Nuclear Material Storage Building, T064

Figure 5. View from North of Building T064 (1987)

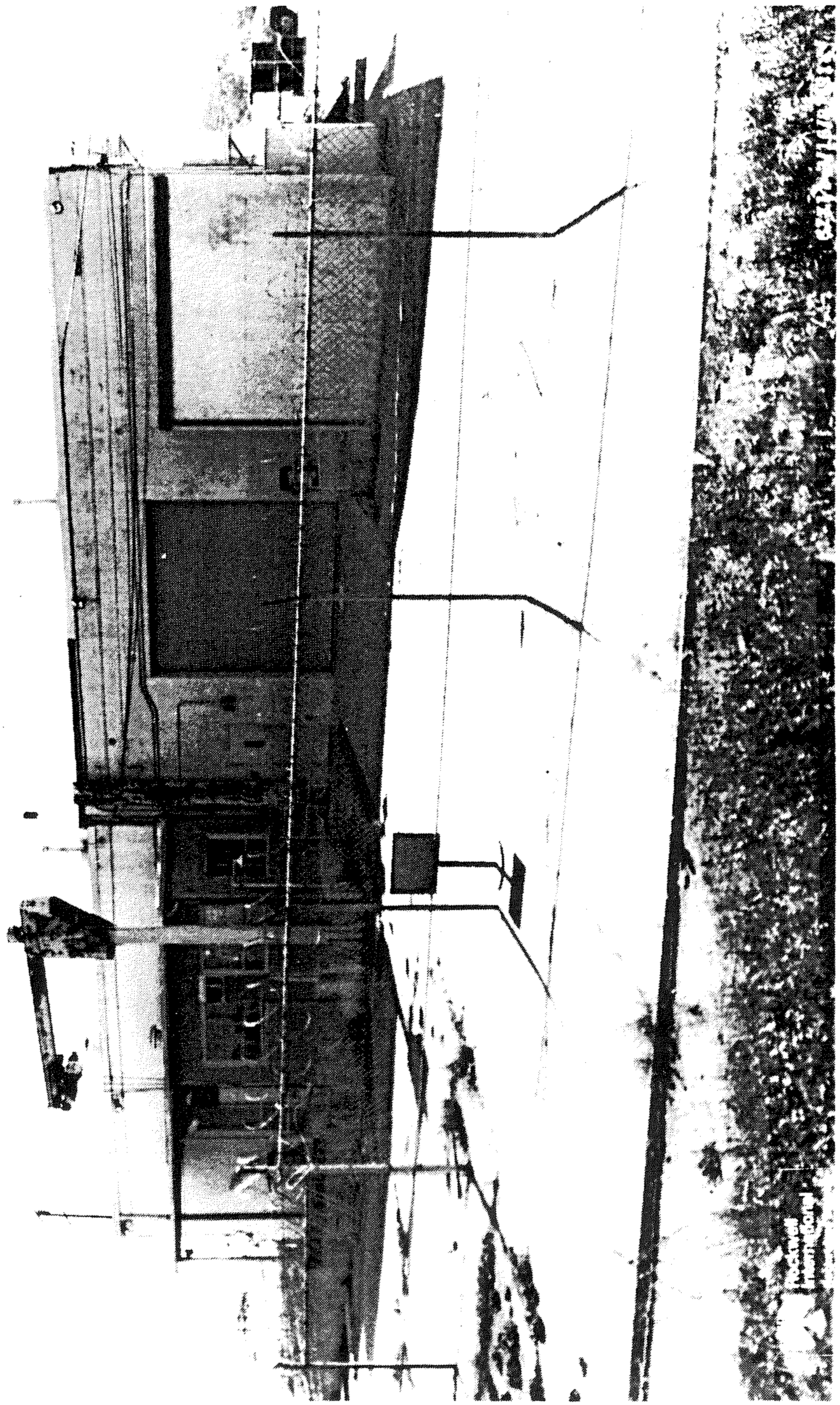


Figure 6. View from East of Building T064 (1987)

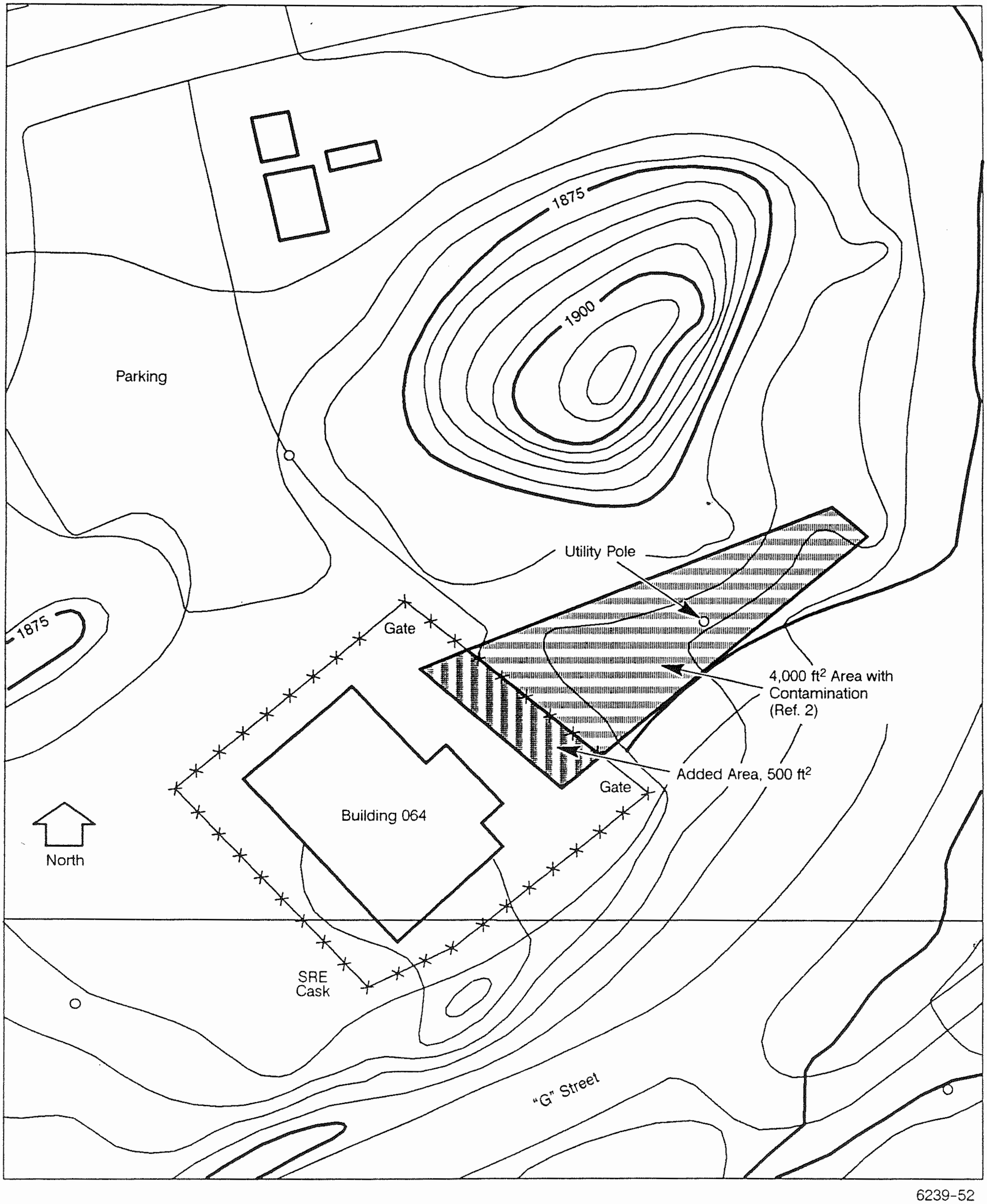


Figure 7. Building T064 Side Yard

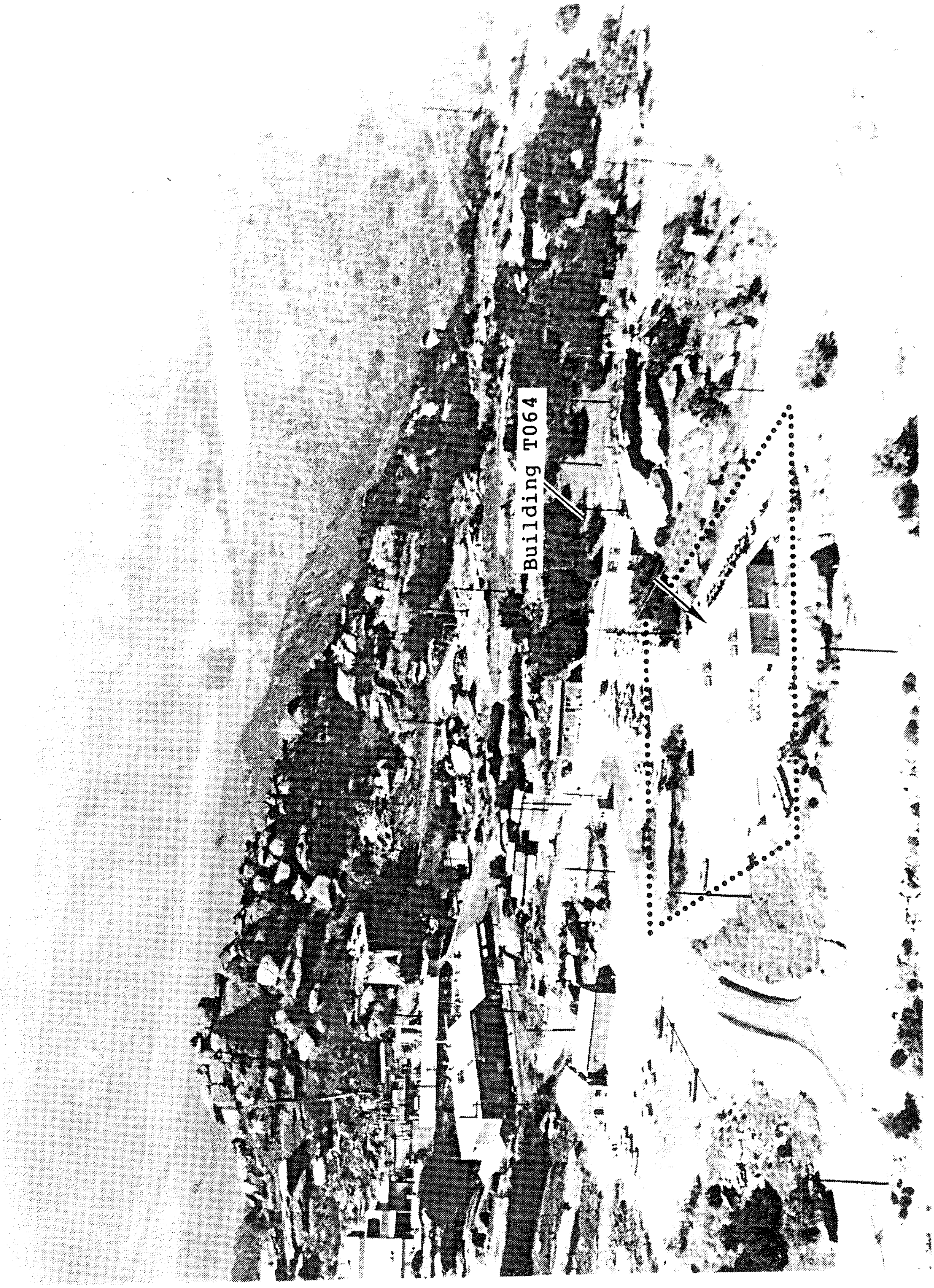
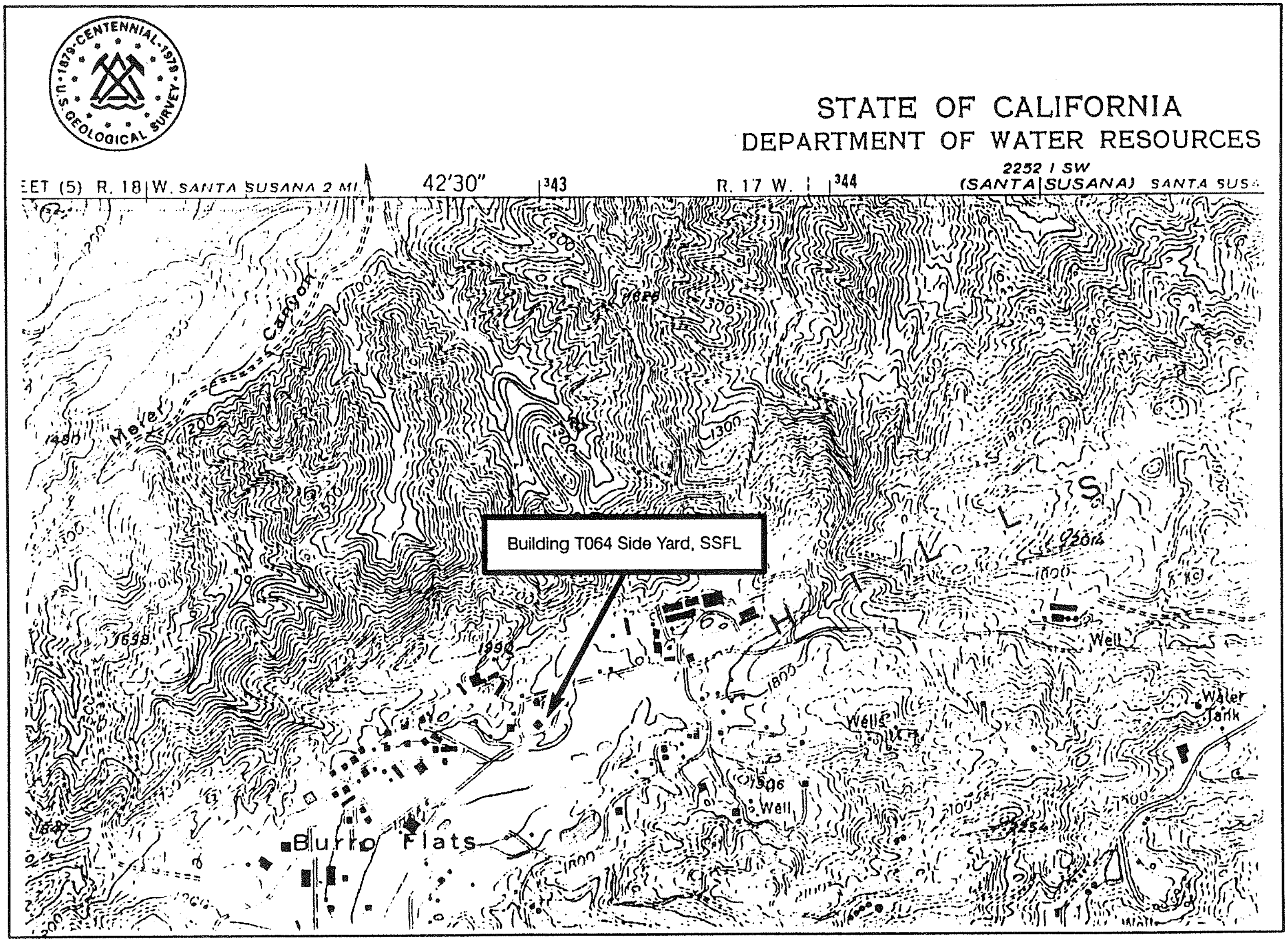


Figure 9. View of Building T064 from a Position South of the Complex (1963)



6239-53

Figure 8. USGS Topographic Map of Portions of Calabasas Quadrangle (Bottom–Left Area Corresponds to SSFL)

the Side Yard where the asphalt was removed during the present effort, the surrounding yard space within the fence remains paved.

Access to the open portion of the Side Yard is from G Street. A paved asphalt road leads to the gated portion of the eastern fence from this street. The fenced–in portion of the yard may be accessed through this southeastern gate or through the second gate in the northeast corner.

2.3 OPERATING HISTORY

Building T064, formerly known as the Source and Special Nuclear Material Storage Facility, has been operated by Rockwell International and its predecessor companies since 1958 in support of US DOE's (and its predecessor agencies') nuclear programs. As the name implies, T064 was used for the storage of packaged items of source material (normal uranium, depleted uranium, thorium) and special nuclear material (enriched uranium, plutonium, U–233). Since nuclear material was only stored there, there was no processing equipment within the building. Following an active period of use until the mid 1970s, most of the major DOE nuclear development and reactor contracts had ended at the facility, and by 1980, most of the material had been sent to other DOE sites. Since then, the building has been used to store non–nuclear DOE components and supplies and equipment for Atomics International. Currently, steel boxes containing soil from several SSFL decontamination operations are stored inside the building prior to their planned disposal. A detailed description of the utilization of T064 during the early years is provided in Ref. 2.

The fenced–in yard surrounding T064 was used on occasion for storing recoverable uranium scrap, irradiated fuel elements, and miscellaneous radioactive wastes. Spent fuel shipping casks and shipping trailers were also stored just outside the western fence line. Except for residual radioactivity from a contamination incident at the eastern section of the fenced–in area in the early 1960's (described below), the remaining yard areas were clean of radioactive material.

During the early 1960's, a special lead–pig cask containing irradiated "Seawolf" fuel elements was stored in the east site of the fenced–in yard. The irradiated fuel elements had probably been transferred to the cask in a fuel–storage pool at the site of their origin. Before shipping to the SSFL, the drain plug on the bottom of the cask should have been removed to drain the radioactive water, but was not. The cask was shipped and stored here while still containing water. The drain plug eventually rusted out, and water leaked out to the yard surface. The water contained mixed fission products which contaminated the area. A large area (~700 ft^2) was excavated, and disposed of. After the removal of the contaminated material, radiation levels were measured to be between 0.04 mrad/h and 0.5 mrad/h, which was considered acceptable. Consequently, the yard was backfilled and repaved. Appendix A is an Internal Letter, dated November 11, 1963, describing the incident.

2.4 SSFL SURVEY PLAN

A broad 1985 radiological survey plan (Ref. 1) was developed for all areas at the SSFL that were involved in operations with radioactive materials. Building T064, the above mentioned yard, and a surrounding 2-acre area were included in the survey plan. In accordance with the plan, a comprehensive radiological survey of the designated areas was performed in 1988 to evaluate the building and the site for residual contamination. The survey and its results are extensively documented in Ref. 2. The survey methods and results applicable to the Side Yard are summarized in the next section of this report.

3. SUMMARY OF 1988 RADIOLOGICAL SURVEY

3.1 OVERVIEW

Upon decontamination and decommissioning (D&D) its radioactive constituents, releasing a facility or area for other unrestricted uses requires a formal radiation survey to demonstrate that the applicable regulatory limits for such a release are met. The survey is performed under an established plan, and a statistical interpretation of the resulting data is made to determine if the regulatory release criteria have been met. Together, the 1988 radiological survey of the Building T064 Side Yard and surrounding areas (Ref. 2) and the follow–up work reported in this document fulfill the requirements for such a survey. For the sake of completeness and ease of future reference, a summary of applicable portions of the 1988 survey is provided in this section.

3.2 SCOPE OF SURVEY

The overall scope of the 1988 survey included the following radiological inspections: the interior building areas were characterized by measuring average, maximum, and removable alpha/beta contamination; the fenced–in storage yard and surrounding 2–acre area were characterized by measuring ambient gamma exposure rates 1 meter above the surface. If the gamma measurements indicated contamination, surface samples were acquired and analyzed by gamma spectrometry or for gross alpha/beta activity. For purposes of comparison, natural background gamma exposure rates were measured at about the same time in the following SSFL locations where no radioactive materials were ever used, handled, or stored: (a) the Building 309 area, (b) the Well No. 13 Road (Dirt), and (c) Incinerator Road (Dirt).

As noted earlier, a 4,500 ft^2 area comprising portions of the fenced–in yard and adjoining portions of the surrounding 2–acre area constitutes the Building T064 Side Yard.

3.3 SURVEY METHODS AND PROCEDURES

3.3.1 Criteria and Their Implementation

Acceptable contamination limits and gamma exposure rates for unrestricted use of a decommissioned facility are prescribed in Department of Energy (DOE) guidelines, the Nuclear Regulatory Commission's (NRC) Regulatory Guide 1.86, the NRC's license SNM–21 to Rocketdyne, and other references. Typically, the lowest (most conservative) limits are chosen. For example, the 5 $\mu R/h$ (above background) limit is used to determine acceptance of a facility for unrestricted use even though the corresponding DOE limit is 20 μR/h, which is a factor of four larger. Table 1 shows the composite of conservative limits derived from the aforementioned references and adopted by Rocketdyne with respect to the Building T064 fenced-in yard and the surrounding 2-acre area surveyed during 1988.

Table 1. Maximum Acceptable Gamma Exposure Rate and Soil Activity Concentration Limits (1988 T064 Yard and 2-Acre Area Survey)

No.	Parameter	Limit, in Unit Specified	Reference
1	Gamma exposure rate[a] (at 1 m from surface)	5 μR/h above background[b]	4
2	Soil activity concentration[c]	a) Alpha: 46 pCi/g (for depth ≤15 cm below surface)	6 and 7
		c) Beta: 100 pCi/g	8

[a]Although DOE Guide (Ref. 5) recommends a value of 20 μR/h above background for gamma exposure rate, the NRC Dismantling Order for the L-85 reactor decommissioning (Ref. 4) required 5 μR/h above background. For conservatism, 5 μR/h above background is used at Rocketdyne to compare survey results.

[b]The average background gamma exposure rate at the SSFL has a value of about 15 μR/h with a range (maximum-minimum) of about 3.5 μR/h (Ref. 2).

[c]Alpha activity concentration limits for enriched uranium (formerly stored in Building T064) is 30 pCi/g (Ref. 6) plus that contribution from naturally occurring radioactivity (about 16 pCi/g, from Ref. 7, p. 93). The total beta activity concentration limit is 100 pCi/g (Ref. 8), including background which is about 24 pCi/g.

D635-0139

During the survey, the ambient gamma exposure rate criterion (5 μR/h above background, shown in Table 1) was first applied. If the surveyor detected radiation, three "action levels" were established and initiated according to the following criteria:

1. <u>Characterization Level</u> – That level of exposure rate which is less than 50% of the maximum acceptable limit. This level encompasses the range of natural background levels at the SSFL and requires no further action.

2. Reinspection Level – That level of exposure rate which is between 50% and 90% of the maximum acceptable limit. A general survey of the area and a few additional soil samples are required in this case.

3. Investigation Level – That level of exposure rate which exceeds 90% of the maximum acceptable limit. Specific investigation of the occurrence is required in this case.

3.3.2 Survey Procedures

For purposes of the T064 radiological survey, the building, the fenced–in storage yard, and the surrounding 2–acre area were treated as separate sample lots for characterization and interpretation. Figure 10 shows the survey sampling area. For the fenced–in yard, a 3–meter square grid was superimposed on the area; for the 2–acre area, a 6–meter square grid was superimposed. This gridding arrangement resulted in obtaining 58 and 168 (total 226) ambient gamma exposure–rate measurements, respectively, in the two areas.

In each 9–m^2 cell (in the fenced–in yard) and in each 36–m^2 cell (in the surrounding area), a gamma exposure–rate measurement was made 1 m from the surface. The particular location in each cell was chosen randomly and identified on a map. A tripod was used to support a 1 in. x 1 in. NaI scintillation crystal (detector) 1 m from the ground. The NaI scintillation detector was coupled to a photomultiplier tube and fed to a Ludlum 2220–ESG scaler. The NaI scintillation detector is sensitive in nearly all directions (i.e., 4π–geometry) and can detect variations in exposure rates down to 0.5 μR/h from counts obtained during one minute. For comparison, if an infinite slab of 20–cm–thick soil were located 15 cm below surface and contaminated with 100 pCi/g of ^{137}Cs (see limits in Table 1), it would produce an estimated excess exposure rate of about 10 μR/h, which is readily within the sensitivity of the device.

The NaI scintillation detector is calibrated quarterly using ^{137}Cs as the calibration source in the mR/h range and, cross–calibrated against a Reuter Stokes High Pressure Ion Chamber in the μR/h range. Count rates were converted to exposure rates using the derived relationship that, at background exposure rates, 215 cpm = 1 μR/h. During the survey, the instrument response was also checked three times daily using a Ra–226 source.

Two soil samples weighing about 2 lb. each were collected during the survey of the yard for information purpose and were identified for their specific location. Each sample was dried in an oven and split into a 450–ml sample and a 2–g sample. The 450–ml

Figure 10. Building T064 Sampling Area

sample was placed in a specialized beaker for counting by gamma spectrometry. The 2–g sample was ground with a mortar and pestle, placed in a 2–in. diameter aluminum planchet, and then counted for gross alpha and beta activity. Additional details on the instruments used and their calibration are provided in Ref. 2

3.3.3 Data Analyses and Statistical Criteria

A statistical procedure is required to validate the applicability of the exposure–rate data collected at selected locations to an entire area or region (such as the fenced–in yard and the surrounding area of T064). A statistical method known as "sampling inspection by variables" (Ref. 9) was used to analyze the data from the survey. This method has been widely applied in industry and the military and is essential where destructive tests must be performed (e.g., in quality control) or where the lot size is impractically large.

In sampling inspections by variables, the number of data points on which measurements are obtained is first chosen to be large so that the distribution of the data is normal (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:

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

TS and $\bar{x}$ are then compared with an acceptance limit, U, (such as those shown in Table 1) to determine acceptance or other plans of action, including rejection of the area. In the above expression k is known as the tolerance factor. The value of k is determined from the sample size and two other statistical sampling coefficients that are related to a consumer's risk of accepting a lot, given that a fraction of the lot has rejectable items in it. The values chosen for these coefficients for the survey correspond to assuring, with 90% confidence, that 90% of the area has residual contamination below 100% of the applicable limit (a 90/90/100 test). The choice of values for the two coefficients is consistent with industrial sampling practices and State of California guidelines (Ref. 10). The sampling coefficients and use of the resulting calculated value of TS for comparison with the acceptance criteria and establishing a plan of action for acceptance are further discussed in Ref. 2.

Data from the survey are typically treated using this statistical approach. The reduced data are plotted against the cumulative gaussian probability on a probability–grade scale. Display of data in this manner permits clear identification of values with significantly greater exposure rates than expected for the lot, based on the gaussian distribution.

Probability plots are shown in the next section for the fenced–in T064 yard and the surrounding 2–acre area. However, a complete treatment of the 1988 survey data for the purpose of determining the test statistics was not necessary because the findings readily revealed the need for remedial action.

3.4 RESULTS

Results from the 1988 survey for the fenced–in T064 yard and the surrounding 2–acre area are presented in this section with some recent corrections. These corrections apply to the portion of these areas that later became known as the Building T064 Side Yard, the subject of the present investigation. Details of the survey results for Building T064 proper may be found in Ref. 2.

3.4.1 Gamma Exposure Rates

Statistical data on the ambient gamma exposure rates measured in the fenced–in T064 yard and the the 2–acre surrounding area are summarized in Table 2. Also shown in this table are the sets of data for the three SSFL background locations. These data show the average ambient gamma exposure rates at the two T064 areas to be 20.1 μR/h and 16.6 μR/h, respectively, compared with the 14.0 μR/h to 16.2 μR/h average for the three background locations. As shown, the standard deviations and ranges (maximum – minimum) are substantially larger than the respective values for the background areas. The maximum values recorded corresponded to 76 μR/h in the fenced–in yard and 110 μR/h in the surrounding 2–acre area, respectively.

Statistical plots of the ambient gamma exposure rates for the five locations identified in Table 2 are shown in Figures 11 through 15. Effects of the large standard deviations and ranges for the data at the fenced–in yard and the 2–acre surrounding area (Figures 11 and 12) can be clearly seen when compared with the three statistical plots (Figures 13, 14 and 15) for the background areas. While the background data show a nearly uniform gaussian distribution, the fenced–in storage yard and the surrounding 2–acre area each show a gaussian–distributed "clean" area, and a set of "outlier" data corresponding to contaminated areas. Changes in the slopes of the statistical plots in Figures 11 and 12 further demonstrate the abnormal distributions obtained from the data for the two T064 area locations.

According to Ref. 2, the grid locations corresponding to the high gamma exposure rates at the fenced–in yard and the surrounding 2–acre area were in an ~4,000 ft^2 area

Table 2. Ambient Gamma Radiation at SSFL Compared to T064 Measurements (before decontamination)

Location	Number of Measurements	Average Exposure Rate (μR/h)	Standard Deviation (μR/h)	Range (μR/h)
Surveyed Areas:				
T064 fenced–in storage yard	58	20.1	14.3	63
T064 surrounding 2–acre area	168	16.6	9.4	98
Background Areas:				
Building 309 Area (1/19/88)	36	15.6	0,8	3.4
Well No. 13 Road (dirt) (4/29/88)	43	16.2	0.5	2.2
Incinerator Road (dirt) (4/29/88)	35	14.0	0.4	1.4

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which borders and is outside the eastern fence. Figure 11 shows twelve outlier data points for the fenced–in yard area, and Figure 12 shows eight outliers in the 2–acre area. However, a recent review of the 1988 survey map of the fenced–in yard showed that six of the locations were right at the fence line and the remaining six data were from inside the fenced–in yard at locations believed to be uncontaminated. This finding raises a question as to whether the additional areas within the fenced–in yard are suspect.

In an attempt to clarify the above situation, the data logs of the surveyor were reexamined and found to contain erroneous recordings for the data obtained at these six locations. In addition, an "indication only" survey was performed at these and other background locations in August 1990 with a Ludlum Model 12S–Micro–R meter. The data from this survey showed that radiation levels at the six suspect locations inside the fenced–in yard indeed correspond to background levels at the SSFL, confirming that all the

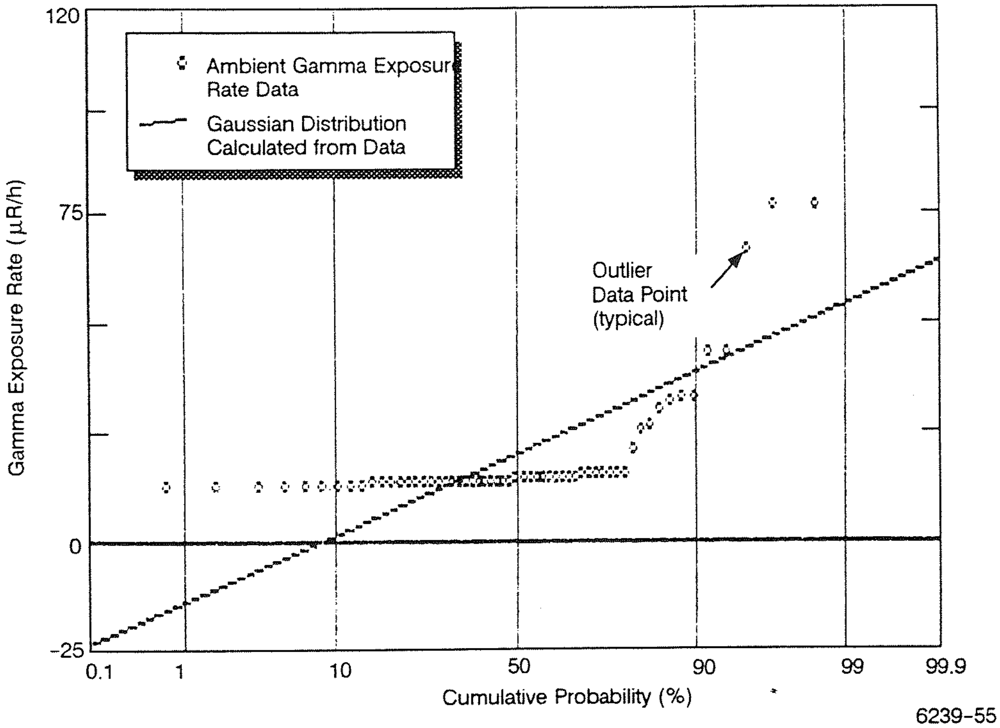

Figure 11. Ambient Gamma Radiation in Fenced-In Storage Yard (1988 Survey)

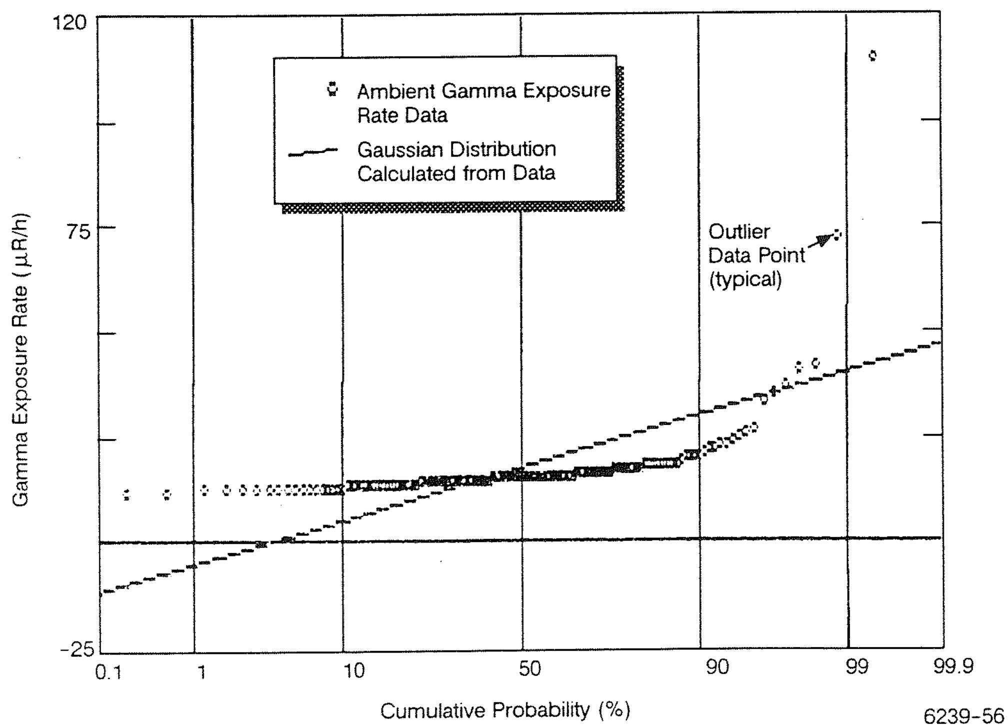

Figure 12. Ambient Gamma Radiation in Surrounding 2-Acre Area (1988 Survey)

contaminated grid points (six, instead of twelve, from Figure 11 and the eight from Figure 12) with ambient exposure rates from 20 to 110 μR/h are at the fence line and east of it.

Figure 16 shows the general vicinity of this contaminated area. Within this area, a 300 ft^2 area was seen as being significantly contaminated with gamma exposure rates in the range of about 50–100 μR/h.

Overall, it is readily seen that the outlier ambient gamma exposure–rate data at the fence line and in the adjoining 2–acre area portion constituting the 4,000 ft^2 area are well above the ambient exposure rates for the three background areas shown in Figures 13, 14, and 15, and, in most instances, exceed the 5 μR/h limit specified in Table 1.

With respect to the background gamma exposure–rate data shown in Figures 13, 14, and 15, their distributions are normal, as would be expected. However, the data also show that the relatively high variability in background gamma exposure rates measured at the SSFL (up to 3.4 μR/h) approaches the acceptance limit of 5 μR/h. This points out the need to select background locations which have similar topographic and other features with respect to the area being compared so that this variability can be minimized. Noting the availability of data from uncontaminated background areas which are topographically

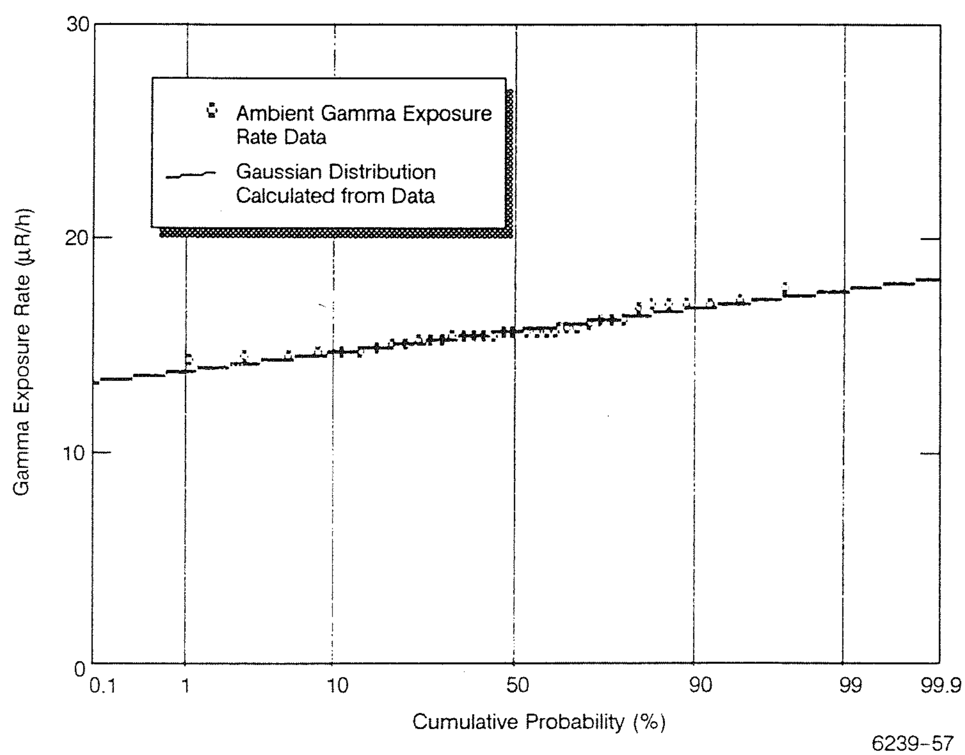

Figure 13. Ambient Gamma Radiation at Area Surrounding Building 309 (Background Distribution)

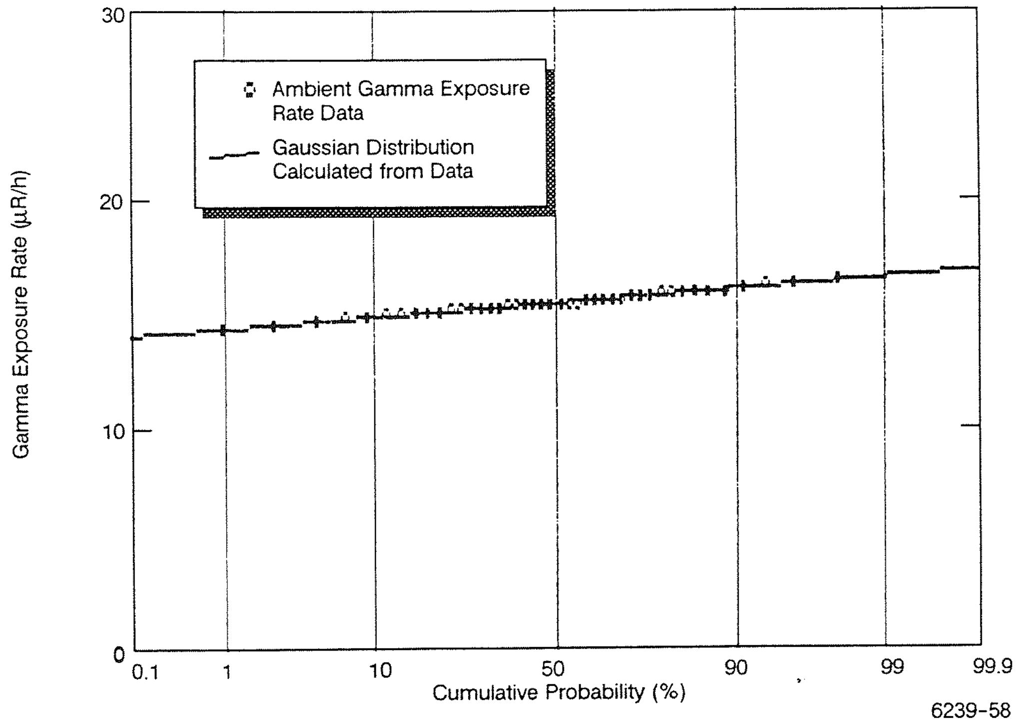

Figure 14. Ambient Gamma Radiation at Area Well No. 13 Road (Background Distribution)

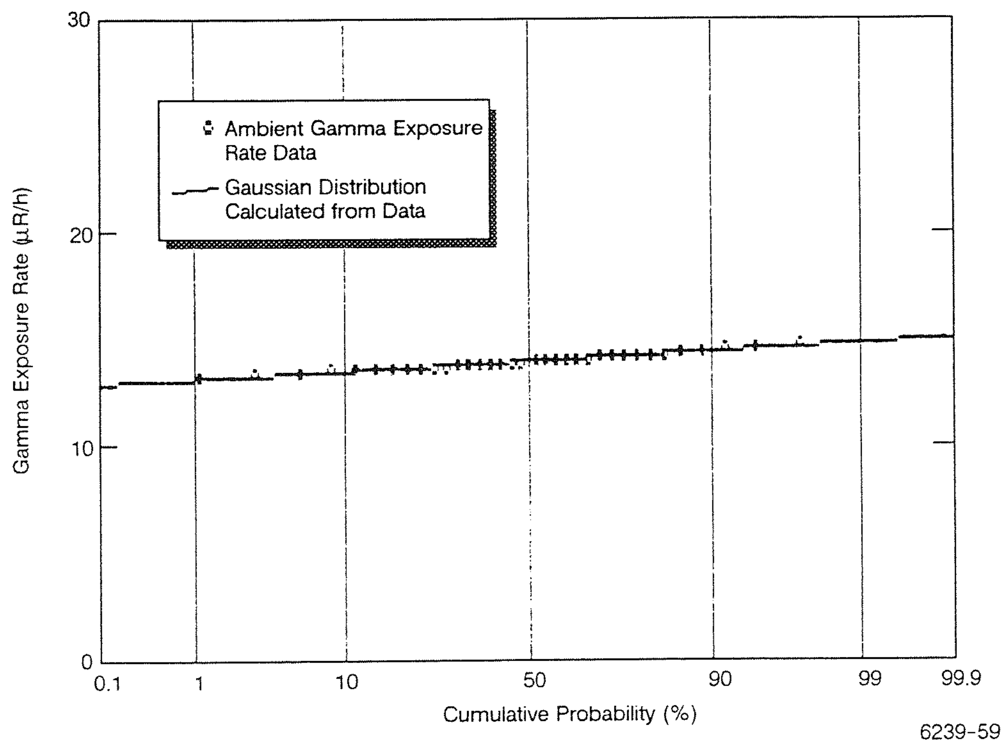

Figure 15. Ambient Gamma Radiation at Incinerator Road (Background Distribution)

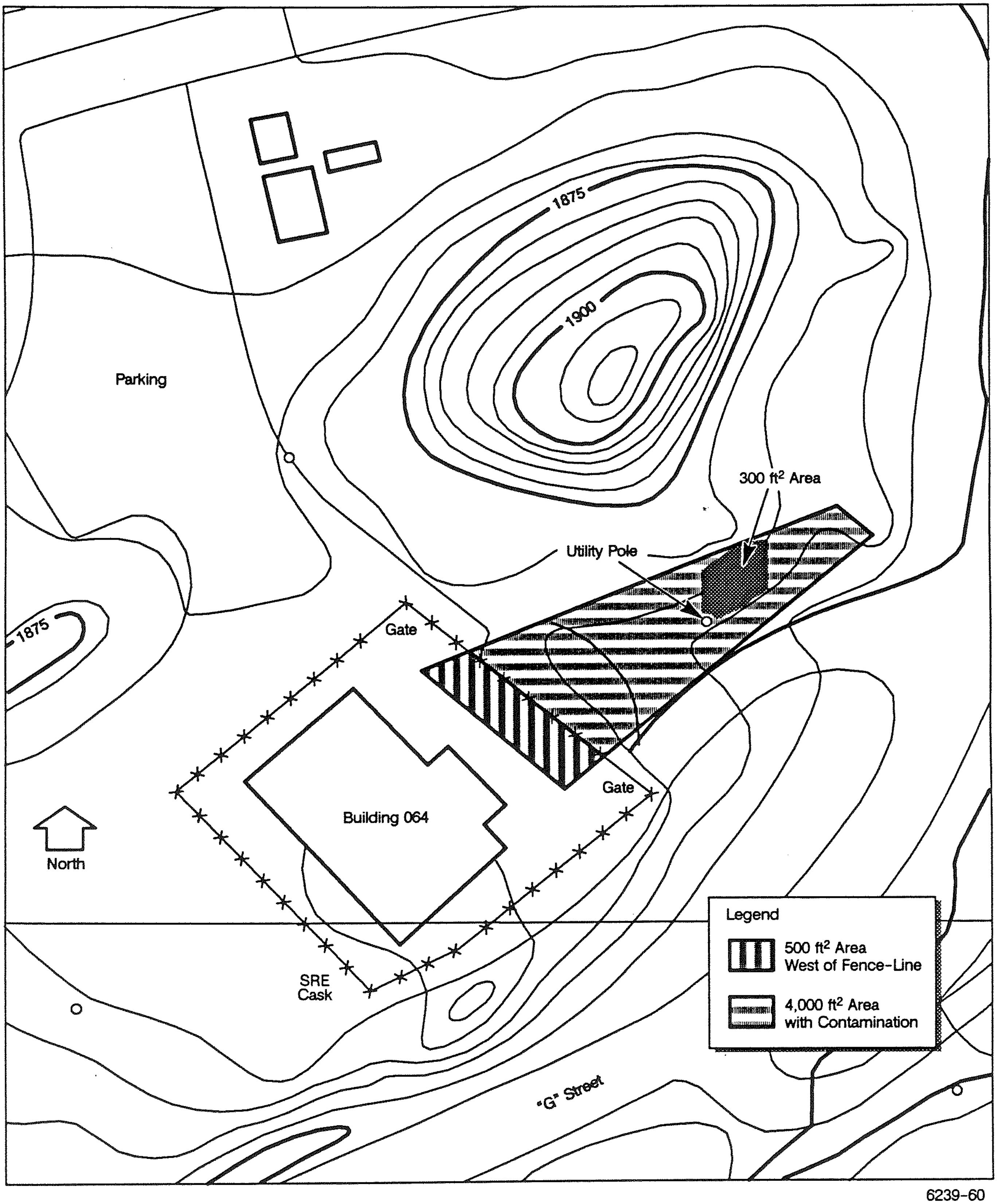

Figure 16. Topographic Map of T064 Showing Contaminated Soil Area

similar to the Side Yard, the most appropriate background exposure rate was established for the present investigation and is discussed in Section 4.3.2.1.

3.4.2 Soil Activity

Alpha analysis results of the 2–g samples from two soil samples collected from the 300 ft^2 area showed alpha activity concentrations of 23.8 and 31.4 pCi/g, which are both below the 46 pCi/g limit shown in Table 1. However, beta analysis results on the same samples showed beta activity concentrations at 1,153 and 1,187 pCi/g, much higher than the 100 pCi/g limit shown in the same table. Additionally, gamma spectrometric analysis of the two 450–ml samples from the same locations showed 2,500 and 2,700 pCi/g of ^{137}Cs activity, which are much higher than normal ^{137}Cs activity concentrations (between 0.1 and 1.0 pCi/g) at the SSFL, and further corroborated the findings of high ambient gamma exposure rates.

3.5 CONCLUSIONS OF 1988 SURVEY

Based on the data obtained, the 1988 radiological survey concluded that contamination existed in a 4,000 ft^2 area bordering and outside the T064 eastern fence (Figure 16). The remaining fenced–in yard and surrounding 2–acre area were determined to have only background radiation levels. The survey report surmised that ^{90}Sr, which usually accompanies ^{137}Cs in mixed fission product contamination, is probably present in the contaminated area. Although the gamma exposure rates and ^{137}Cs activity levels were too high to meet release limits, the survey concluded that the area was not hazardous in its contaminated condition. This conclusion was further confirmed explicitly by RESRAD analyses during this study.

3.6 RECOMMENDATION OF 1988 SURVEY

The 1988 survey report recommended remedial action with respect to the 4,000 ft^2 area identified in Figure 16, as well as further investigation to measure specifically the extent of contamination.

3.7 IMPLEMENTATION OF RECOMMENDATION

In accordance with the recommendation of the 1988 survey, remedial actions were undertaken by removing the top–layer material from contaminated parts of the designated 4,000 ft^2 area plus, as a safeguard, an additional 500 ft^2 area on the western side of the fence. This combined 4,500 ft^2 area, which approximates the trapezoid geometry previously shown in Figure 7, was designated as the Building T064 Side Yard, as shown in Figure 16.

The investigation included collection of additional gamma exposure–rate and soil–activity data at the Side Yard following removal of the top–layer material. For comparison, soil–activity measurements were also made on the soil removed from the site. Finally, an evaluation was made of the consequences of the remaining radioactivity in the soil to potential current and future occupants of the Side Yard using the DOE computer code RESRAD. The technical approach used in performing the recommended investigation, including a description of the salient aspects of the RESRAD code, is provided in the next section. Results and conclusions from the investigation are presented in Sections 5 and 6, respectively.

4. TECHNICAL APPROACH

4.1 OVERVIEW

As recommended by the report on the 1988 radiological survey, remedial actions were undertaken during the summer of 1989 to remove the contamination found in the building T064 Side Yard. Figure 17 shows the affected 4,500 ft^2 area, including the two primary regions from which top soil and asphalt were removed to varying depths. Upon removal of the top layer, exposure rate and soil activity measurements were made to determine if the site is now acceptably free of radioactive contamination. The technical approach used to perform the investigations and the modified criteria established to determine acceptability of the decontaminated area are discussed in this section. Establishment of site–specific criteria was made possible by the availability of the DOE computer code RESRAD during the fall of 1989.

4.2 APPROACH

4.2.1 Decontamination and Survey

The decontamination efforts were performed under a documented procedure (Ref. 11). Accordingly, surface soil, up to an average 16–in. depth, was first removed from the designated areas of the Side Yard. Localization of the soil areas and the extent of soil removal was guided continually by "indication only" surveys using a Ludlum Model 12S–Micro–R meter. In addition, twenty-four 2–lb surface soil samples were collected and analyzed using the gamma spectrometer for ^{137}Cs and other radionuclide activities (see Table B1, Appendix B) at locations being decontaminated. Soil and asphalt removal was continued in this manner until the indications became indistinguishable from ambient conditions. The removal operations became focused in two primary regions, as shown in Figure 17, totalling about 2,050 ft^2, the remainder of the area having no significant indications.

The removed surface soil was stored in 64 type B–12 boxes for subsequent disposal at an authorized site. While these boxes were being loaded, 256 randomly selected 2–lb samples from the removed soil were collected, four from each box. The four 2–lb samples from each box were then uniformly mixed and then subsampled to produce a single 2–lb sample. Combining samples in this manner, 64 such 2–lb samples were obtained for subsequent analysis by gamma spectrometry.

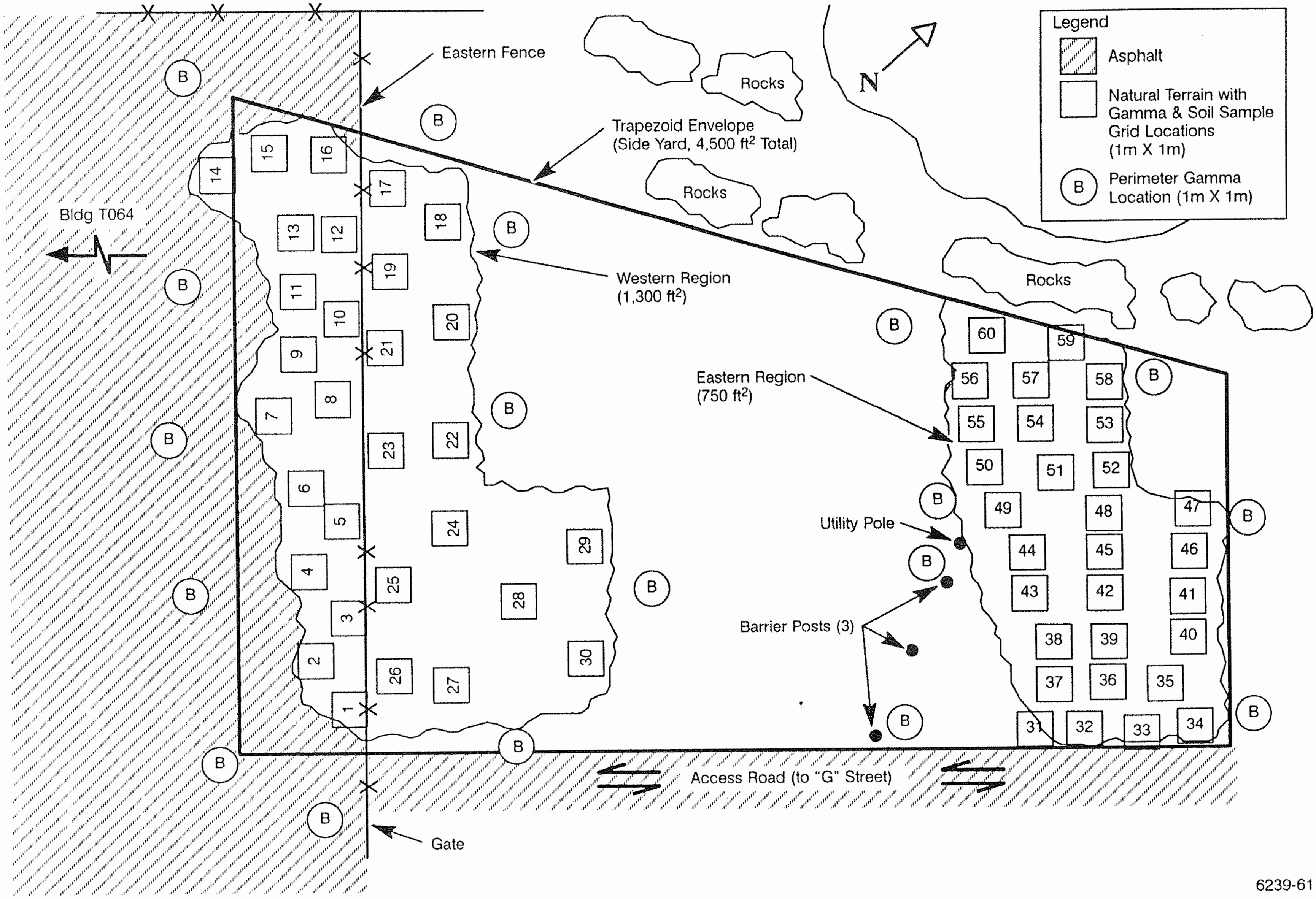

Figure 17. Building T064 Side Yard Decontamination and Survey–Grid Locations

Following removal of the surface soil, a general screening gamma survey "for indication only" was conducted over the surface of the 4,500 ft^2 area using a Ludlum Model 44–9 thin-window pancake GM probe attached to a Ludlum Model 12 countrate meter. The purpose of the survey was to determine if any "measurable" activity could be detected which would indicate the need to remove additional soil. However, no activity was indicated in any part of the Side Yard which was measurably above natural background levels.

After this screening survey, 60 new 1–m x 1–m grids were established in the decontaminated areas for detailed gamma exposure rate and soil activity measurements. These grid locations are also shown in Figure 17. Eighteen additional non–grid gamma exposure rate measurements were also obtained from locations around the perimeter of the two decontaminated regions for comparison measurements. The 1988 survey had shown only natural background activity in these locations, and hence only ambient exposure rates were expected.

4.2.2 Procedures

4.2.2.1 Laboratory Procedures

Upon completion of the soil removal operations, ambient gamma exposure rate measurements were performed using the NaI scintillation detector discussed in Section 3.3.2. Total counts at 1 m above ground were measured and the resulting count rates were then converted to exposure rates using the calibration–derived relationship that 215 cpm = 1 μR/h.

Gross alpha and gross beta determinations were made on 2–g soil samples with a Canberra proportional alpha/beta counter. Gamma spectrometry was performed on the soil samples using a Canberra Series 80 gamma spectrometer. Both the proportional counter, the spectrometer, and the procedures used to calibrate them, are described in Ref. 2.

4.2.2.2 Data Reduction

Two types of spreadsheets, both based on the EXCEL software for Personal Computers, were utilized for data reduction. The first, called SOILTEMP, was used to convert the ambient gamma exposure count data (in total counts) to dose rates (in μR/h), and for converting the total alpha and beta counts obtained (in total counts) from the proportional counter to gross alpha and gross beta values (in pCi/g). The second spreadsheet, called

MCASOIL, was used to convert the multichannel analyzer (MCA) outputs (i.e., quantity of isotope for each peak analyzed) from the gamma spectrometer, in μCi, to concentrations of selected isotopes, and to calculate the alpha and beta activities (both in pCi/g).

Appropriate formulae are included in MCASOIL* to calculate the activities of ^{238}U, and ^{232}Th, based on the activities of their daughter products, and to calculate activities for ^{40}K, ^{137}Cs, ^{134}Cs and ^{60}Co, from which the total alpha and beta activities are derived. These calculations are discussed in detail in Ref. 2. Of these, the gamma exposure rate data from SOILTEMP and the ^{137}Cs data from MCASOIL, were statistically analyzed for comparison with the acceptance limits described in Section 4.3 below. The remaining MCASOIL and SOILTEMP outputs (e.g., the derived total and gross alpha and beta activity data) were obtained for information only, and are included in Appendices B and C, respectively.

4.2.2.3 Statistical Procedures

The techniques discussed in Section 3.3.3 were also used to obtain and display statistical parameters derived from the laboratory data and to compare them against regulatory acceptance criteria to determine compliance. A program called RADSRVY was used to calculate the mean, the standard deviation, and the test statistic (TS) for each data set and to plot the data against the cumulative gaussian probability (e.g., Figure 11). RADSRVY was developed at Rocketdyne and has been extensively used to interpret data of this nature on numerous previous radiological surveys, including, for example, the recent radiological survey of the Old Conservation Yard (Ref. 12).

4.3 REVISED CRITERIA AND THEIR IMPLEMENTATION

4.3.1 Revised Criteria

The ambient gamma exposure rate limit specified in Table 1 applies to the current investigation. The soil activity concentration limits in the table, however, were replaced with the more recent guidelines provided by the DOE, which call for a site-specific determination of acceptable residual radioactive material based on a maximum "basic dose limit" of 100 mrem/year effective dose equivalent to plausible users (Refs. 3 and 13).

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*The original version of MCASOIL discussed in Ref. 2 was implemented using a software program known as SMART (Smartware, Innovative Software, Inc., Lenexa, KS). With minor changes, the work reported here was implemented using the software program EXCEL (Microsoft Corp., Redmond, WA).

The site–specific determination of effective dose equivalent is accomplished by utilizing the DOE–supplied RESRAD code which performs environmental and dietary pathway analyses for measured activities of identified nuclide(s) at a given site, and estimates annual exposures to plausible current or future users based on land use scenarios defined for the site. RESRAD, which is further described in Section 4.3.2.2, provides results both in terms of a calculated activity limit corresponding to a basic radiation dose limit of 100 mrem/year, and in terms of the effective dose equivalents for the users.

Although these results are equivalent, for a given nuclide and a site–specific scenario, the code readily allows establishing two related criteria. First, conservative soil activity acceptance limits can be obtained by treating a contaminated site as being effectively infinitely large. Second, realistic dose estimates can be obtained using RESRAD, with the measured residual radionuclide concentration(s) and the actual dimensions of the affected contamination zone.

Thus, there are three criteria to be met:

1. The external gamma exposure rate, in excess of natural background, shall not exceed the 5 μR/h limit given in Table 1.
2. The site–specific residual activity of man–made nuclides shall not exceed the soil activity concentration limit calculated using the RESRAD code for a credible bounding scenario and for an effectively infinite contamination zone (defined in Section 4.3.2.2 below) for the T064 Side Yard.
3. The site–specific annual effective dose equivalent received by a plausible current or future user of the decontaminated area, calculated using RESRAD with the measured man–made radionuclide activities and with the actual dimensions of the contaminated zone, shall not exceed 100 mrem.

Of the three criteria, criteria No. 1 and No. 2 will determine the acceptability of the decontamination and, hence, the acceptability of the site. Given that criterion No. 2 provides a more restrictive limit than No. 3 for acceptance, satisfying this criterion will automatically result in satisfying criterion No. 3. Nonetheless, criterion No. 3 is specified as a requisite for demonstrating the effectiveness of the cleanup. Dose estimates calculated for this purpose may also be used to compare against similar criteria established by other agencies such as the U.S. Nuclear Regulatory Commission (NRC) for release of sites for unrestricted use. In Ref. 14, for example, the NRC requires its licensees to demonstrate that the dose equivalent not exceed 10 mrem/year.

Satisfying the above criteria is required for accepting the site as radiologically clean. Failure to satisfy the criteria will require additional investigations including remediation efforts. Statistical implementation of the criteria, and establishment of a soil activity limit and dose estimates based on RESRAD calculations, are discussed in the next section.

The criteria above are best suited for application to large open sites and yards. Additional criteria, such as those provided in Ref. 13, should be applied in cases of decontamination of buildings, equipment, etc., or for release of aqueous effluents.

4.3.2 Implementation of Criteria

4.3.2.1 Criterion No. 1

Ambient gamma exposure rate data from the decontaminated T064 Side Yard for the 60 grid locations were processed by SOILTEMP and then examined for comparison with the background measurements discussed in the following paragraphs. The background–subtracted gamma exposure rate data were then statistically compared using RADSRVY with the 5 μR/h limit.

Because the variability in the background gamma exposure rates at the SSFL approaches the 5 μR/h limit shown in Table 1, the choice of an appropriate area to determine the background gamma exposure rate value to be applied to a localized decontaminated site is of critical importance. For the present T064 Side Yard, the natural background exposure rate was determined from the portion of the surrounding 2–acre area which most closely matched the affected area topographically and in other physical features. This area corresponds to an elevated northeastern portion of the 2–acre area previously shown in Figure 10 and includes twenty–four 3m $\times$ 3m grid data points from the 1988 survey (Ref. 2, Appendix D.3).

The 24 data points are shown in Figure 18 plotted against the cumulative gaussian probability. The mean and standard deviation (1σ) of the distribution is 15.5 ± 0.8 μR/h. By comparison, the three "background" areas studied for the 1988 survey yielded ambient gamma exposure values of 15.6, 16.2, and 14.0 μR/h respectively, with an average value of 15.3 μR/h. Although the 15.5 μR/h value used here is slightly higher than the 15.3 μR/h value, the present value is well within the range of variability observed at the SSFL, and best represents the background in the immediate vicinity of the T064 Side Yard. It is also of interest to note that two of the three "background" values used in the 1988 survey are higher than 15.5 μR/h.

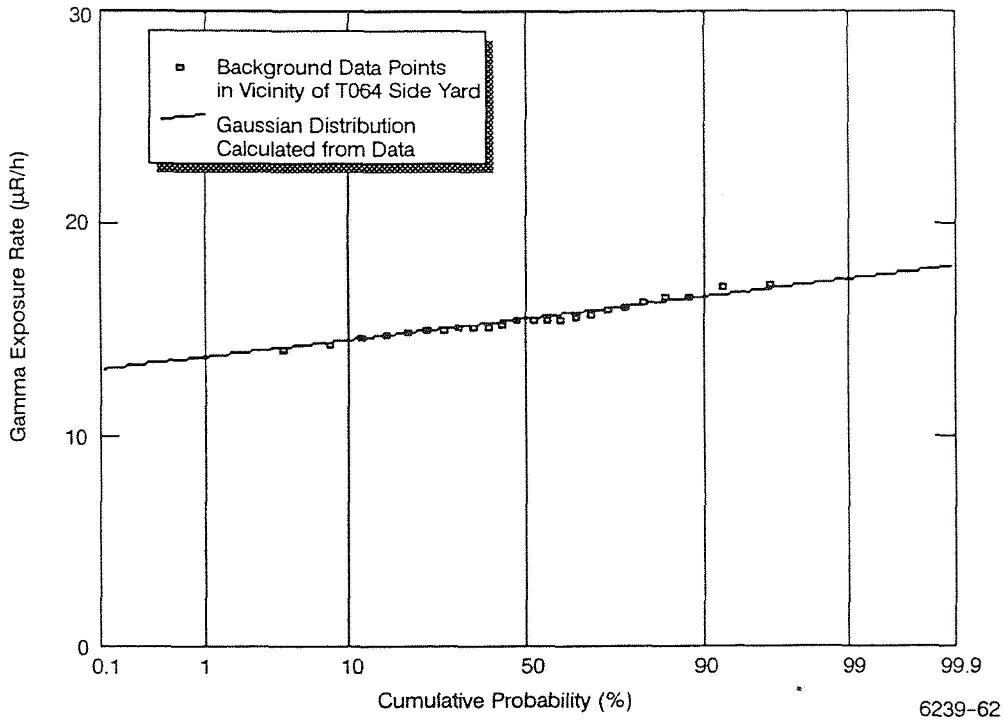

Figure 18. Background Gamma Exposure Rate Data in the Vicinity of the T064 Side Yard Site

4.3.2.2 Implementation of RESRAD (Criteria No. 2 and No. 3)

Gamma spectrometry data for the ten surveyed grid locations were reduced to derived activity values using MCASOIL. The derived soil activities for ^{137}Cs were then statistically compared, using RADSRVY, to the acceptance limits established from the RESRAD code. Although ^{90}Sr activities were not measured at the grid locations, it was assumed that the contamination incident that led to the ^{137}Cs activity in the soil was a result of mixed fission product release and hence an equal activity of ^{90}Sr was also released. Thus, an acceptance limit for ^{90}Sr was also established using RESRAD. An overview of the code, and the approach to establishing the acceptance limits, are discussed in the following paragraphs.

4.3.2.2.1 RESRAD Code Overview

RESRAD calculates the effective dose equivalent to an occupant (current or future) by performing environmental and dietary pathway analyses resulting from the presence and transport of radioactivity through terrestrial media (both living and inanimate). Figure 19 shows the exposure pathway diagram used by RESRAD for calculating the dose to an on–site resident from residual radioactive material.

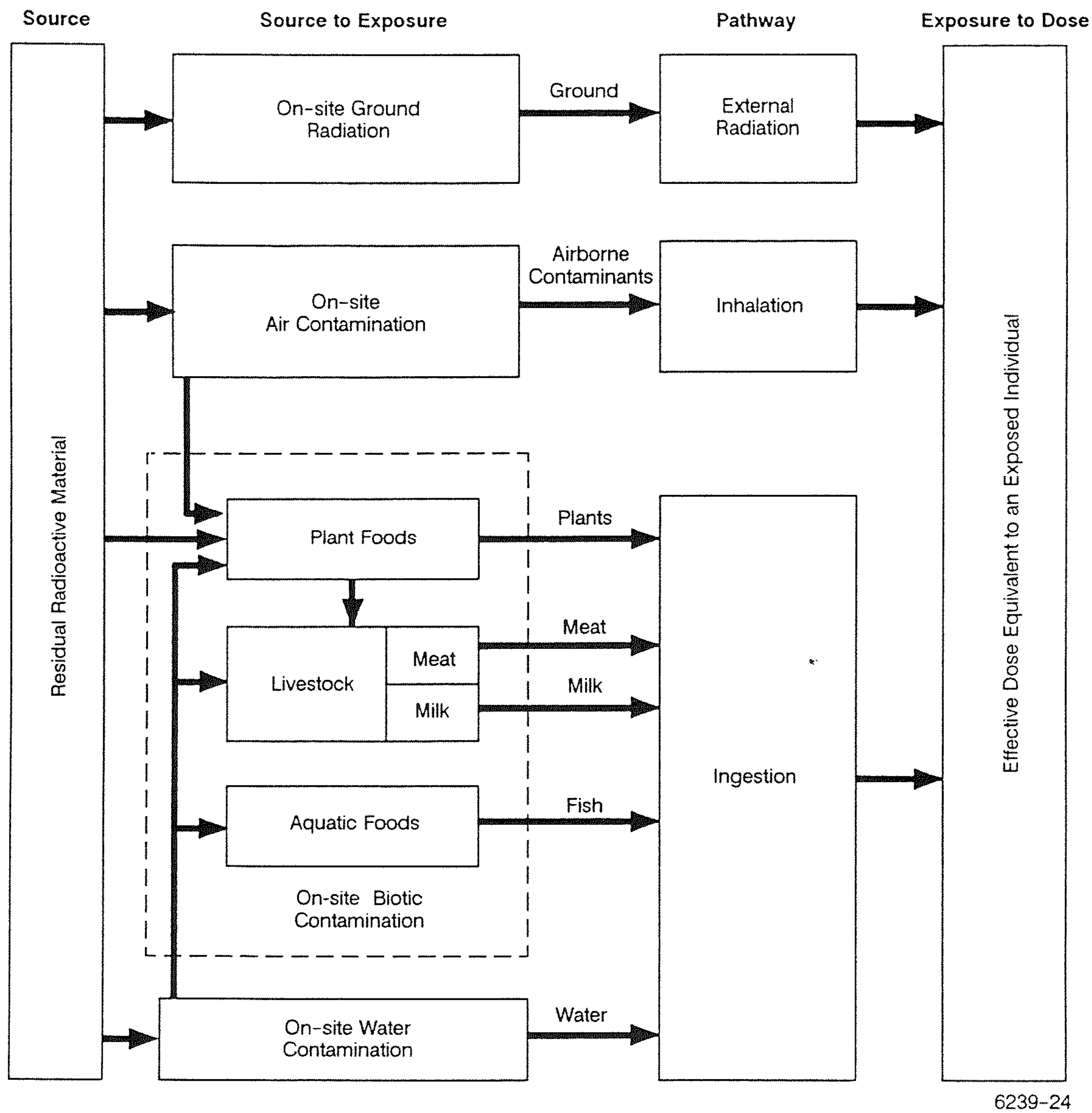

Figure 19. RESRAD Exposure Pathway Diagram (Ref. 3)

The following categories of input data are required to implement RESRAD for a given site: (1) soil activity data, (2) site–specific geohydrological parameters, (3) dietary parameters, and (4) scenario–specific parameters. In all, about 80 input parameters are required. The RESRAD manual (Ref. 3) provides ranges of input values for geohydrological parameters and representative dietary parameters for the United States, from which the code employs a set of "default" input values. The code further allows modifying or eliminating exposure pathways, as necessary, for a given scenario. Thus, using measured soil activity values for isotopes of specific concern and using the default input data, screening estimates of the annual dose (or concentration limit corresponding to the

100 mrem/year basic dose limit) can be obtained for a specified scenario. For obtaining realistic dose estimates, the manual suggests use of site–specific geohydrological parameters whenever such data are available.

For the SSFL in general, as well as the T064 side yard, four potential future land use scenarios were considered. These are:

1. Industrial
2. Residential
3. Wilderness
4. Family Farm

Of the four scenarios, the most credible for the near term is the industrial use scenario, an extension of the present use. In the longer term, either the residential or wilderness use scenarios are most plausible. The family farm scenario is included for completeness even though it is not credible, given the site size, geography, climate, and common land use in this area. Therefore, the credible scenarios for the T064 Side Yard are scenarios 1, 2, and 3.

4.3.2.2.2 RESRAD Input Parameters for Scenarios

As part of a previous effort toward the final decontamination and radiological survey of the Old Conservation Yard at the SSFL (Ref. 12), 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 helped in determining conservative values for input to the code. In general, changes to most of the parameters were found to have a negligible effect on the final results because certain dose pathways were not applicable for the given scenarios. The critical input parameters for the scenarios identified from the screening runs are briefly discussed below:

<u>Dimensions of Contaminated Zone</u>. Based on data from Ref. 2 and subsequent estimates, the actual extent of the contaminated zone at the T064 Side Yard is 4,500 ft^2 (421 m^2) in area and about 32 or 16 in. (0.81 or 0.41 m) in depth before or after cleanup, respectively. Increasing the dimensions of a contaminated zone will have the effect of lowering the maximum soil activity acceptance limit. Comparison of the measured activities (or the statistical parameters related to the measured activities) with a limit corre-

sponding to an infinite size contaminated zone therefore provides the most restrictive (conservative) acceptance criterion. Therefore, soil activity acceptance limits were calculated assuming an "infinite" contamination area and depth rather than the actual values given above. The screening runs showed that using an area of ~100,000 m^2 and a depth of ~1 m lead to asymptotic convergence of the RESRAD results. For the calculations here, a depth value of 35 m (115 ft) was used, corresponding roughly to the distance from the surface to the water table at the T064 Side Yard. The actual dimensions of the site were subsequently used to estimate annual doses (see Sections 4.3.2.2.4 and 5.3).

Occupancy/Inhalation Shielding Factors. The annual dose estimates calculated by RESRAD from either direct exposure or by inhalation (dust) are functions of two linear parameters called the Occupancy and Shielding Factor (FO_1) and the Inhalation Occupancy Factor (FO_2). Equations for the calculation of these factors are provided in the RESRAD manual (Ref. 3). The factors range from 0 to 1 and may be changed by the user to accommodate different land use scenarios. The "default" RESRAD values for the two factors for the family farm scenarios are 0.6 and 0.45. These values are calculated by assuming that 50% of a person's time is spent indoors, 25% is spent outdoors in the contaminated area and 25% is spent outdoors away from the site, and by using indoor gamma dose and dust inhalation attenuation factors of 0.7 and 0.4, respectively. For the present study, the occupancy percentages and the gamma attenuation factor were each modified, as appropriate, for the three credible scenarios considered, yielding correspondingly modified values for FO_1 and FO_2, which are given in Appendix D.

For the industrial and residential scenarios, modification of the default indoor gamma attenuation factor was chosen as a more realistic method of accounting for indoor gamma shielding than the use of a cover layer over the entire affected site. Thus, it was assumed that any residence or office building occupying the site would typically have a 4–in. (0.1 m) concrete slab floor. Gamma attenuation by a 0.1 m slab is ~85%, yielding a modified gamma attenuation factor of 0.15. This attenuation factor is included in the calculation of the FO_1 and FO_2 values shown in Appendix D for these two scenarios.

Dietary Factors. RESRAD input values for consumption of food and water taken from the contaminated site are based on the default family farm scenario, where a significant fraction of the diet is grown or raised on the site. For the three credible scenarios considered here, these dietary values were modified as follows: for the industrial and wilderness scenarios, it was assumed that no water or food would be used that was taken from the contaminated area; thus, all food and water pathways were zeroed out. For the residential scenario, it was assumed that a small fraction (10% of that for a family farm) of the leafy vegetable and fruit consumption would be from material grown on the contaminated site. The values used for this scenario are 16 kg/year and 1.4 kg/year, respectively. As in the industrial and wilderness scenarios, water consumption from the site was zeroed out for the residential scenario.

Input data used in the RESRAD code, for the various scenarios, are given in Appendix D. In all cases, site-specific data, where available, were used for the various input geohydrological parameters. Where the RESRAD default values were used, additional screening calculations showed that variation of the default parameters did not significantly influence the results.

4.3.2.2.3 Soil Activity Acceptance Limits from RESRAD (Criterion No. 2)

The ^{137}Cs and ^{90}Sr soil activity limits (in pCi/g), determined from the RESRAD code for the four different land use scenarios, are summarized in Table 3. As discussed above, for conservatism, the limits were calculated assuming an "infinite" contamination area and depth, rather than the estimated dimensions of the affected area. From the data shown in Table 3, it can be seen that, among the three credible scenarios, the residential scenario leads to the lowest permissible concentrations of ^{137}Cs or ^{90}Sr (70.8 and 409

Table 3. RESRAD-Calculated Soil Activity Limits for Future SSFL Land Use Scenarios

Land Use Scenario	Allowed Single Radionuclide Concentration Limits (pCi/g)[a]	
	^{137}Cs	^{90}Sr
1. Industrial	239	33,020
2. Residential	70.8	409
3. Wilderness	3,830	9,240,000
4. Family Farm[b]	31.7	37.2

[a]Single radionuclide soil activity limits from RESRAD for 100 mrem/year dose, and assuming an approximately infinite contamination extent (see text)

[b]RESRAD default scenario (not credible for the T064 Side Yard)

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pCi/g, respectively) that would result in a 100 mrem annual radiation dose from either nuclide. In the terminology of the DOE guideline document (Ref. 3), the residential scenario therefore corresponds to the "credible bounding scenario."

The above concentrations of ^{137}Cs and ^{90}Sr, therefore, are the acceptance limits against which the measured activities at the T064 Side Yard can be compared. In view of our assumption, however, that both ^{137}Cs and ^{90}Sr are present in equal concentrations, a more appropriate acceptance limit for the T064 Side Yard is one that takes into account both nuclides together. The corresponding two-nuclide limit for the credible bounding residential scenario is 60.4 pCi/g each of ^{137}Cs and ^{90}Sr, which would result in a combined annual exposure of 100 mrem.

Statistical implementation of the site-specific residual activity is performed in a manner similar to the gamma exposure rates discussed in Section 4.3.2.1. That is, the RADSRVY calculated test statistic for the ^{137}Cs soil activity data is compared against the corresponding two-nuclide acceptance limit stated above.

4.3.2.2.4 Dose Estimates from RESRAD (Criterion 3)

For demonstrating the effectiveness of the cleanup (criterion No. 3), estimated annual doses to plausible current or future users of the site were calculated as follows: The RESRAD code was run for each of the scenarios with input ^{137}Cs soil activity data corresponding to the average obtained from the 60 grid points, and an equal value for ^{90}Sr activity. Since both ^{137}Cs and ^{90}Sr are man-made nuclides, it is assumed that the corresponding background activities are zero, even though a small amount exists from global fallout; thus, the measured/assumed activities are already background-subtracted. Values for the area of contamination and depth of contamination for these dose calculations correspond to the actual estimated values, and are further justified in Section 5.3, in terms of the results obtained during the gamma and soil surveys. The resulting RESRAD-calculated dose was then compared with the 100 mrem/year basic dose limit and other limits. For comparison, annual dose estimates are provided for each of the scenarios for conditions prior to and after the present decontamination effort.

4.3.3 Summary

Three criteria, and corresponding acceptance limits, were established for the T064 Side Yard to determine its radiological cleanliness. For gamma exposure rates, the first criterion establishes a 5 μR/h acceptance limit. The test statistic for the background–

subtracted gamma exposure rate data is compared with 5 μR/h. For the present case, the value used for the gamma exposure rate background was determined from a 24–grid area in the vicinity of Bldg. T064, which better represents the area than the three "background" SSFL areas, and thus minimizes the effects of the inherent variability in the natural gamma background at the SSFL.

The second criterion establishes an acceptance limit for the site–specific soil activity. Using site geohydrological parameters, and based on three credible scenarios for current or future site–use, and on the basis of an infinite area and depth of contamination, the RESRAD code established the limit to be 60.4 pCi/g each of ^{137}Cs and ^{90}Sr for the credible bounding scenario. The test statistic for the measured ^{137}Cs soil activity data is compared with the 60.4 pCi/g limit. Statistical behavior of the ^{90}Sr is assumed to follow that of ^{137}Cs.

The T064 Side Yard is determined to be acceptably free of residual radioactive contamination if both test statistics are less than the corresponding acceptance limits.

The third criterion, as an adjunct to the second criterion, permits comparison of the basic dose limit (100 mrem/year) with the calculated annual doses to a plausible current or future user under realistic conditions of the actual dimensions of the contaminated zone and measured values of the extent of residual radioactivity.

Results are presented and discussed in the following section.

5. RESULTS AND DISCUSSION

5.1 GAMMA EXPOSURE RATE DATA (CRITERION NO. 1)

Ambient gamma exposure rates obtained from the 60 grid location in the 4,500 ft^2 survey area, after decontamination, are given in Table 4. Gamma exposure rates ranged from 15.21 to 20.27 μR/h, with a mean value (± 1σ standard deviation) of 17.7 ± 0.9 μR/h. These exposure rates are well above the 0.5 μR/h sensitivity of the NaI detector. Plotted against a cumulative probability scale, these data are also shown in Figure 20. As is evident, the data distribution reasonably follows a gaussian, with no outliers. The outlier data, with maximum values of 76 μR/h (Figure 11) and 110 μR/h (Figure 12) obtained in the 1988 survey of these locations are now absent.

Figure 21 shows the background–subtracted T064 Side Yard gamma exposure–rate data plotted against the cumulative probability. Here, the value of 15.5 μR/h determined from the immediately adjacent area was used for background substraction. The upper limit of the graph is the acceptance limit of 5 μR/h. All of the background–subtracted data are below the acceptance limit. Furthermore, the intersecting dashed lines show that the test statistic of 3.6 μR/h for this distribution is below the acceptance limit, thus satisfying criterion No. 1. The mean of the background–subtracted data is 2.2 μR/h. Comparison of this value with the residual soil activity measured at the T064 Side Yard is provided in Section 5.3

5.2 SOIL ANALYSIS DATA (CRITERION NO. 2)

As discussed in Section 4.2.1, gamma spectrometry analyses were performed on soil samples collected from the 64 B–12 boxes, and from the 60 grid locations established for the final T064 Side Yard decontamination survey. The spectrometry results were data–reduced using the in–house spreadsheet code RADSRVY, resulting in derived activity values (in pCi/g) for certain specific isotopes, including ^{137}Cs, which was found in significantly above–normal levels in the original survey conducted in 1988. For the purpose of the present survey, only the ^{137}Cs data from the grid locations are discussed here. For completeness, however, the results of the MCASOIL analysis for all derived quantities, including data for the removed soil, and data from the 2–g sample analyses, are given in Appendices B and C, respectively.

Results of the spectrometric analyses for ^{137}Cs on soil samples from the 60 survey grids are given in Table 5. Measured activities ranged from < 0.2 to 17.6 pCi/g, with an

Table 4. Ambient Gamma Exposure Rates in the T064 Side Yard Grids After Decontamination

Grid Number*	Exposure Rate (μR/h)	Grid Number*	Exposure Rate (μR/h)
G-1	17.08	G-31	17.45
G-2	16.80	G-32	18.32
G-3	17.27	G-33	18.19
G-4	15.21	G-34	18.19
G-5	16.83	G-35	17.50
G-6	16.68	G-36	16.93
G-7	18.51	G-37	16.65
G-8	16.82	G-38	18.00
G-9	16.28	G-39	19.04
G-10	16.88	G-40	19.54
G-11	16.78	G-41	19.17
G-12	17.68	G-41	18.40
G-13	17.71	G-42	18.97
G-14	17.42	G-43	18.17
G-15	17.10	G-44	17.91
G-16	17.09	G-46	17.72
G-17	16.74	G-47	18.25
G-18	18.58	G-48	18.45
G-19	17.70	G-49	17.45
G-20	18.27	G-50	18.10
G-21	16.69	G-51	18.28
G-22	18.16	G-52	17.56
G-23	17.13	G-53	18.08
G-24	18.01	G-54	17.67
G-25	17.62	G-55	17.05
G-26	17.01	G-56	17.77
G-27	18.25	G-57	17.61
G-28	18.42	G-58	17.86
G-29	19.81	G-59	18.18
G-30	20.27	G-60	16.75
Maximum:	*20.27*		
Minimum:	*15.21*		
Average:	*17.73*		

*See Figure 17 for grid locations at the T064 Side Yard.

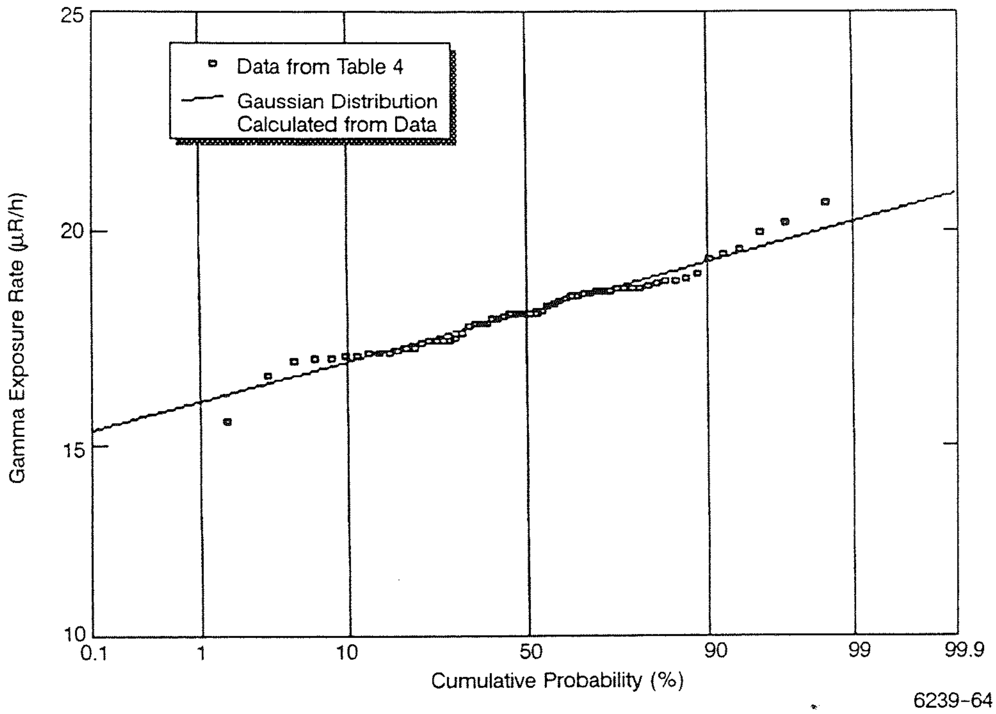

Figure 20. Ambient Gamma Exposure Rates in T064 Side Yard Grids After Decontamination

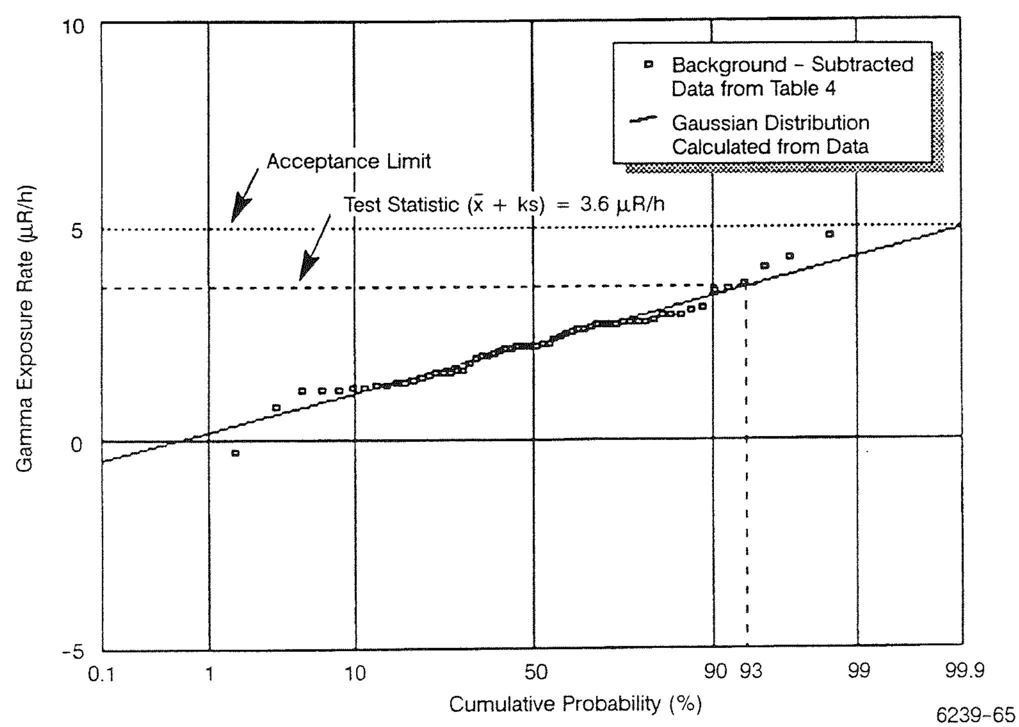

Figure 21. Background-Subtracted Gamma Exposure Rates in the T064 Side Yard After Decontamination

Table 5. Measured Residual ^{137}Cs Activity in T064 Side Yard Grids After Decontamination

T064 Site Grid Number[a]	Measured ^{137}Cs Activity (pCi/g)	T064 Site Grid Number[a]	Measured ^{137}Cs Activity (pCi/g)
G–1	11.4	G–31	5.3
G–2	17.6	G–32	8.2
G–3	10.1	G–33	4.5
G–4	17.1	G–34	6.5
G–5	5.5	G–35	9.3
G–6	3.5	G–36	8.7
G–7	<0.2	G–37	8.9
G–8	0.7	G–38	7.0
G–9	2.1	G–39	5.7
G–10	1.3	G–40	5.9
G–11	1.4	G–41	4.6
G–12	13.0	G–41	3.0
G–13	1.9	G–42	3.6
G–14	5.1	G–43	1.3
G–15	3.7	G–44	9.1
G–16	9.9	G–46	16.7
G–17	0.4	G–47	1.0
G–18	12.0	G–48	2.1
G–19	3.0	G–49	0.9
G–20	5.6	G–50	<0.2
G–21	2.0	G–51	0.2
G–22	1.3	G–52	1.7
G–23	5.3	G–53	1.9
G–24	12.8	G–54	0.4
G–25	2.1	G–55	0.3
G–26	2.8	G–56	0.3
G–27	1.7	G–57	2.1
G–28	2.7	G–58	2.0
G–29	6.2	G–59	2.6
G–30	5.4	G–60	1.0
Mean:	*4.9*		
Standard Deviation (1σ):	*4.5*		

[a]See Figure 17 for grid locations at the T064 Side Yard

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average value of 4.9 pCi/g, well above the lower detection limit of 0.2 pCi/g for the spectrometer system. This average value of 4.9 pCi/g after decontamination is lower than: (1) the average of 32.8 pCi/g for the soil removed from the decontamination operations (average of 64 samples from the B–12 boxes, Appendix B, Table B2), (2) the average of 277 pCi/g for the surface soil samples collected in the early stages of decontamination (average of 24 samples, see Appendix B, Table B1), and (3) the 2,500 and 2,700 pCi/g values obtained in the 1988 survey (two samples, see Section 3.4.2). If the 277 pCi/g ^{137}Cs activity concentration is taken as a representative average of the extent of contamination prior to cleanup, then a factor of 56.5 (277 ÷ 4.9) reduction was achieved.

In Figure 22, the ^{137}Cs results are plotted versus the cumulative probability. The intersecting dashed lines indicate the test statistic (TS) for this distribution, which is 11.7 pCi/g. The two previously calculated RESRAD limits are also shown, one corresponding to the single radionuclide limit of 70.8 pCi/g, and the second corresponding to the two–nuclide limit of 60.4 pCi/g for equal activities of ^{137}Cs and ^{90}Sr. Of significance is the fact that the TS of 11.7 pCi/g for the ^{137}Cs data distribution in the Side Yard grids is substantially below the two–nuclide (and single nuclide) acceptance limit and hence criterion

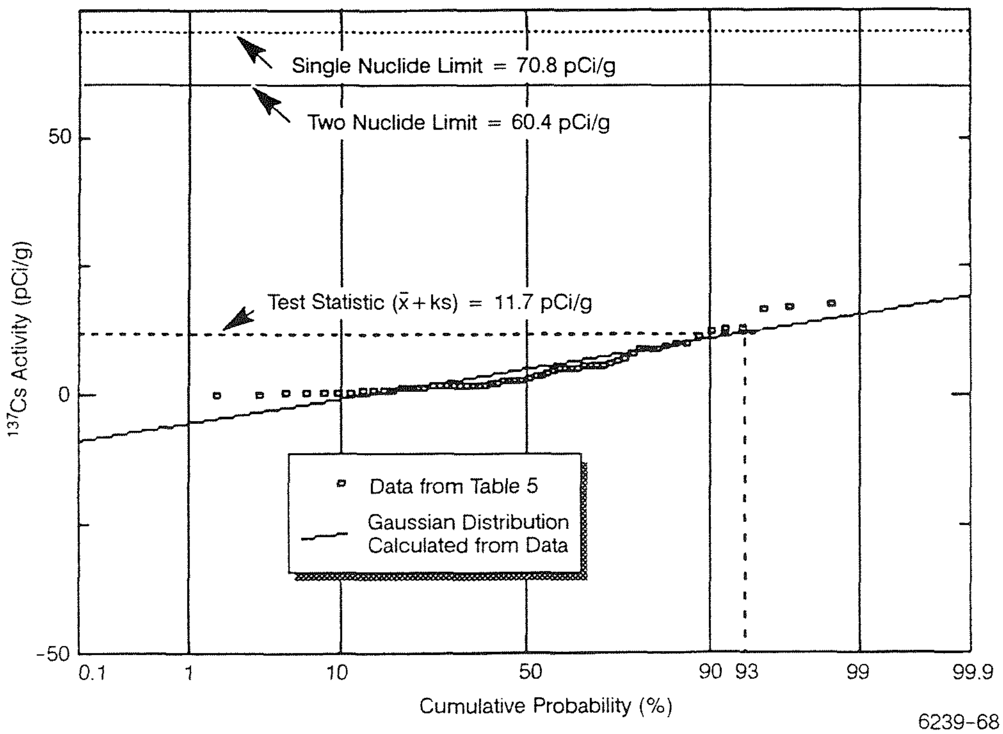

Figure 22. Measured ^{137}Cs activity in T064 Side Yard Grids After Decontamination

No. 2 is satisfied. The TS and the average are also lower than the 1988 survey's criterion of 76 pCi/g beta (Table 1 -- 100 pCi/g total minus 24 pCi/g background) for soil activity.

5.3 DOSE ESTIMATES (CRITERION NO. 3)

To demonstrate the effectiveness of the cleanup, RESRAD was used to provide annual dose estimates to plausible current or future users for each of the four scenarios, before and after decontamination. These dose values are calculated for times of 0, 1, 10, 100, and 1,000 years into the future. Using the results presented in Sections 5.1 and 5.2 above, the values chosen for the area, depth, and residual activity concentrations for performing the "before" and "after" dose calculations are explained below, following which the calculated dose estimates for the four scenarios and for the selected time periods are presented.

5.3.1 Area

The portion of the T064 Side Yard which was decontaminated consisted of two separate regions, as shown in Figure 17. The western region lies immediately adjacent to the Building T064 east fence, and the eastern region lies below the rock peak area ~75 ft east of the fence. The areas of these two regions are ~1,300 and ~750 ft^2, respectively, for a total area of ~2,050 ft^2. As a safeguard, however, the contaminated area is assumed to comprise the trapezoidal area encompassing both regions, resulting in a total assumed contaminated area of ~4,500 ft^2. This larger area is used to calculate estimated doses to potential current and future users of the site.

5.3.2 Depth and Concentrations

5.3.2.1 The "Before" Case

The 1988 survey assumed, for purposes of calculation, a depth of contamination of ~12 in. The actual average depth of soil that was removed during the decontamination, however, is calculated to be ~16 in. This value is based on the mass of soil in the 64 B-12 boxes and the area of the two decontaminated sections. For the purpose of calculating dose estimates before decontamination, the depth of the original contaminated layer is conservatively assumed to be ~32 in., or twice the calculated amount.

The average ^{137}Cs concentration measured in the removed 16 in. of soil, from Table B2 in Appendix B, is 32.8 pCi/g. Although the remaining soil at the T064 Side Yard shows an average residual activity of only 4.9 pCi/g (Table 5), in order to conservatively calculate the surface gamma dose rate, the 32.8 pCi/g value was assumed for the entire 32-in. depth. An equal activity of ^{90}Sr was also assumed.

5.3.2.2 The "After" Case

For this "after" case, the average measured ^{137}Cs value of 4.9 pCi/g from Table 5 was used for ^{137}Cs and ^{90}Sr. The depth of the contaminated soil remaining at the side yard is assumed to be ~16 in., which is equal to the depth of original soil removed during the decontamination. The 16-in. depth value is consistent with the measured background-subtracted ambient gamma exposure rate of 2.2 μR/h for the T064 site. This is evidenced by the fact that the gamma exposure rate calculated by RESRAD for the T064 Side Yard credible bounding scenario is 19.0 mrem/yr or 2.17 μR/h. This calculation assumed a depth of 16 in. and a ^{137}Cs contamination of 4.9 pCi/g; all environmental pathways were suppressed, except for the continuous and unshielded direct gamma exposure pathway. Increasing the soil depth beyond the 16-in. value results in a negligible increase in the calculated RESRAD gamma exposure rate because of gamma shielding by the upper soil layers. Conversely, reducing the thickness to less than 16 in. unrealistically reduces the gamma exposure rate. Thus, the 16-in. value can be considered as an effective upper limit for the purpose of establishing the external gamma exposure to any potential current or future occupant of the site.

5.3.3 Results

Results are shown in Table 6. The estimated post-decontamination annual doses to a potential current (time = 0 years) occupant of the T064 Side Yard site range from 0.09 to 5.2 mrem/year for the three credible scenarios and 13.3 mrem/year for the family farm scenario. All values, including that for the family farm scenario, are significantly less than the basic dose limit of 100 mrem/year. The "after" exposure values in Table 6 are about a factor of 6 to 8 lower than those calculated to have resulted if no decontamination efforts had been undertaken.

The values shown in the table decrease further with time as a result of radioactive decay and other time-dependent site parameters. The dose for an occupant under the credible bounding residential scenario is 5.2 mrem/year, which is well below the DOE basic dose limit of 100 mrem/year for release without radiological restriction, thus satisfying Criterion No. 3. The 5.2 mrem/year is also below the 10 mrem/year NRC limit for release of the site for unrestricted use.

Table 6. Estimated Annual Dose (Above Background) from Residual Radionuclide Activity at T064 Side Yard

Time (years)	Estimated Annual Dose from Residual Contamination (mrem/year)							
	Industrial		Residential[a]		Wilderness		Family Farm	
	Before[b]	After[c]	Before	After	Before	After	Before	After
0	9.9	1.5	36.4	5.2	0.62	0.09	105	13.3
1	9.7	1.4	35.6	5.0	0.60	0.09	102	12.9
10	7.9	1.2	28.8	4.1	0.49	0.07	80	10.1
100	1.0	0.1	3.5	0.5	0.06	< 0.01	8.0	1.0
1000	≪0.01	≪0.01	≪0.01	≪0.01	≪0.01	≪0.01	≪0.01	≪0.01

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[a]Credible bounding scenario
[b]"Before" represents conditions prior to soil removal
[c]"After" represents conditions following soil removal

5.4 STATUS

Figures 23 and 24 show photographs of the T064 Side Yard taken during the 1989 decontamination efforts at the two regions previously shown schematically in Figure 17. The fenced–in and open portions of the Side Yard are not presently being used. Building T064 currently stores the slightly contaminated soil removed from the Side Yard and from other SSFL locations, pending their planned disposal at an authorized site. A final survey and safety review of the building proper should be performed following these activities. Findings from Ref. 2 that are applicable to the building should be reviewed as part of this safety review.

A decommissioning file for the T064 Side Yard site has been established and is currently archived at Rockwell's SSFL Building T100. Appendix E contains a list of items documented in this file.

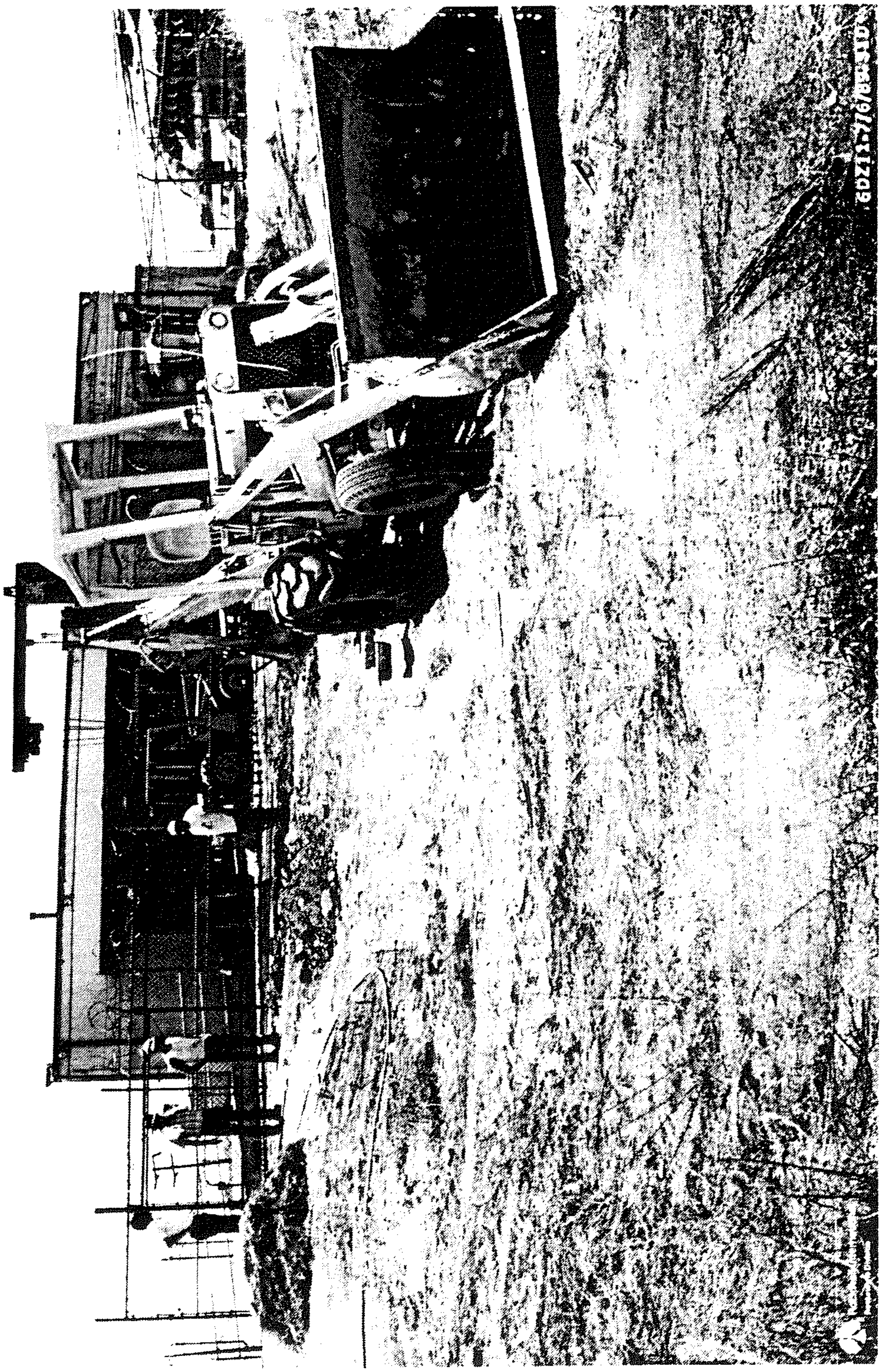

Figure 23. Photograph of the T064 Side Yard Taken During the July 1989 Decontamination of the 1,300 ft^2 Area Adjoining the Eastern Fence

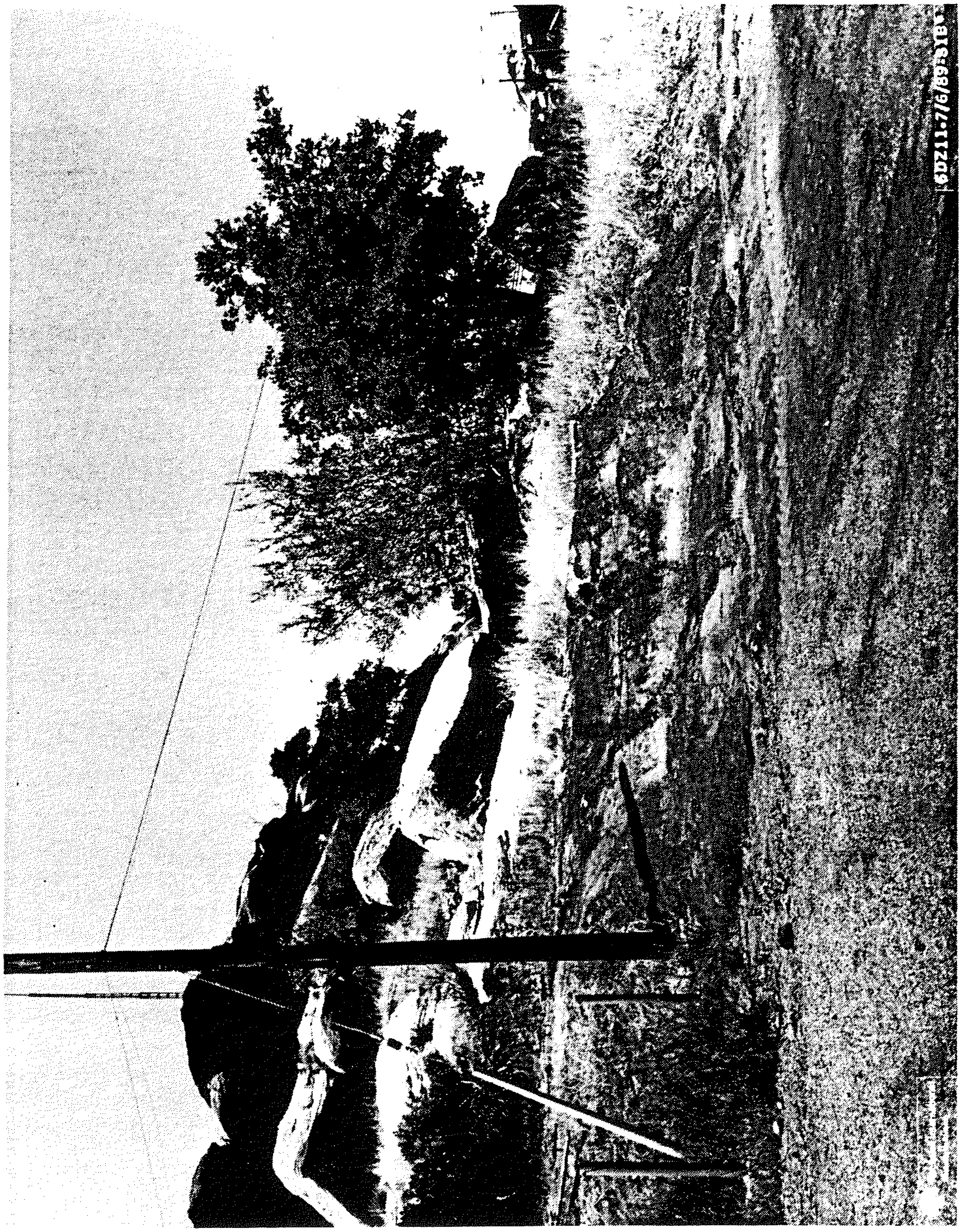

Figure 24. Photograph of the T064 Side Yard Taken During the July 1989 Decontamination of the 750 ft^2 Area, 75 ft East of the Eastern Fence

6. CONCLUSIONS

In accordance with the recommendation of the report on the 1988 radiological survey of Building T064, its fenced-in yard, and a 2-acre surrounding area at the SSFL, the topsoil layer was removed in a 4,500 ft^2 area of the Building T064 Side Yard where ^{137}Cs contamination had been found. Additional gamma exposure surveys and soil analyses were performed. The required analyses of the consequences due to the remaining activity in the soil to plausible current and future users of the affected area were also performed. The following specific and overall conclusions are drawn from these evaluations.

6.1 SPECIFIC CONCLUSIONS

1. The average of the measured ambient gamma exposure rates in the decontaminated area is 17.7 μR/h. For comparison, the background ambient gamma exposure rate in the immediate vicinity of the T064 Side Yard has an average value of 15.5 μR/h.

2. The test statistic for the distribution of the background-subtracted gamma exposure rates in the decontaminated area is 3.6 μR/h, which is below the acceptance limit of 5 μR/h (Criterion No. 1).

3. The calculated values of the allowable, site-specific single radionuclide concentration limits for the T064 Side Yard are 70.8 pCi/g of ^{137}Cs and 409 pCi/g of ^{90}Sr for a credible bounding residential use scenario. The corresponding acceptance limit for the assumed case of both isotopes being present in equal concentrations at the Side Yard is 60.4 pCi/g of each radionuclide.

4. The test statistic for the measured ^{137}Cs soil activity distribution is 11.7 pCi/g, which is well below the acceptance limit of 60.4 pCi/g (Criterion No. 2).

5. The average measured ^{137}Cs activity presently in the decontaminated area is 4.9 pCi/g, compared to the average of 277 pCi/g measured prior to decontamination. Thus, the present decontamination effort resulted in a reduction of ^{137}Cs activity by a factor of about 60.

6. A plausible occupant of the decontaminated area under the credible bounding use scenario will receive a current annual dose of 5.2 mrem/year, which is well below the 100 mrem/year basic dose limit (Criterion No. 3).

7. The 2.2 μR/h background-subtracted gamma exposure value is consistent with the assumed 16-in. depth and the 4.9 pCi/g contamination value for residual contamination at the T064 Side Yard. Increasing the assumed contaminated soil thickness beyond 16 in. results in essentially no further increase in the external gamma dose to an occupant of the site.

6.2 OVERALL CONCLUSIONS

1. Based on the results of the investigations reported here, the Building T064 Side Yard is acceptably free of radioactive contamination.
2. Based on results of the 1988 survey, the remaining surveyed fenced–in yard and 2–acre surrounding area are also acceptably free of radioactive contamination.
3. The Building T064 fenced–in yard and the 2–acre surrounding area meet all the acceptance criteria, and, therefore, may be released for use without radiological restrictions.

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APPENDIX A

INTERNAL LETTER, F. H. BADGER TO R. M. HILL, "CONTAMINATION INCIDENT SS VAULT, SANTA SUSANA," NOVEMBER 11, 1963.

APPENDIX A

INTERNAL LETTER

NORTH AMERICAN AVIATION, INC.

TO	R. M. Hill *RMH*	DATE	November 11, 1963
ADDRESS	Dept. 779-210 Building 040, SanSu	FROM ADDRESS	F. H. Badger ✓ Dept. 779-210 Building 040, SanSu
		PHONE	

SUBJECT Contamination Incident SS Vault, Santa Susana

On the 18th of February, 1963, during a routine survey, the soil east of the exclusion fence at the SS Vault at Santa Susana, was found to be contaminated with radioactive material in excess of permissible limits. Since that time, three subsequent surveys of the area by the Health and Safety Operations unit, and analysis of the soil by the Health and Safety laboratory unit, revealed an area of approximately 700 ft^2 of asphalt and soil to be contaminated with mixed fission products with a maximum of 700mrad/hr at 2 inches. A complete investigation of the area on previous surveys were impossible, do to storage of material in the area at the time of the previous surveys.

An investigation into the possible source of contamination failed to revealeconcrete evidence. Only by process of deduction, can it be ascertained what the source of contamination was. Two irradiated fuels have been stored at the vault that contained enough mixed fission products to have caused the incident. One item was an irradiated solution of uranyl sulphate from the KEWB reactor. The fuel was shipped from the vault to RMDF, where it was inspected and surveyed prior to solidification. No detectable contamination was found on the fuel containers at that time. The only other fuel container to be considered was the cask containing irradiated fuel pins from the Seawolf (submarine reactor). They were received at the vault, stored, transfered to the CDFC (Dept. 733) for inspection, and returned to the vault for storage. After storing the fuel for about 1.5 to 2 years total, it was shipped back to Westinghouse about May of 1962. Sometime during this storage period, the drain plug probably rusted through, permitting any fluid, contained within the cask, to spill onto the asphalt.

The surface contamination was first discovered on February 18, 1963. A soil sample was taken and submitted to the laboratory for analysis. The analysis indicated $1X10^6$ d/m/gram of Cs^{137} and $2X10^5$ d/m/gram of Cs^{134}. Alpha activity in all samples submitted was negligible. A survey of the area, with an air proportional alpha survey, failed to indicate the presence of any alpha emitters. The lack of alpha emitters further substantiates the discounting of the uranyl sulphate as the source of contamination.

A meeting was held between Health and Safety, and Dept. 782 Supervision, to arrange the recovery of the area. Those in attendance were J. Trevillyan (Dept. 798), J. M. Young (782), D. D. Busick (779-210, and F. H. Badger. Subsequently, J. M. Young issued an IL requesting maintenance to decontaminate and repair the area. Co-ordination with Industrial Security to prohibit violation of the vault security was also requested.

TO: L. M. Hill
FROM: F. H. Badger
SUBJECT: Contamination Incident SS Vault, Santa Susana

Approximately 2,365 gallons of soil and asphalt were removed reducing the maximum dose rate to 0.5mrad/hr. Approximately 95% of the area indicated readings of background (.04mr/hr). It was only necessary to remove the asphalt from the paved areas to reduce the dose rate to background. Maintenance removed ~3 inches of soil from all the contaminated soil areas before an attempt was made to remonitor the area. Approximately 80% of the area was found to be free of contamination upon resurveying. The remainder had to be excavated to about 1 to 1½ feet. At this point, 34 drums of R/A waste ~~were~~ removed from the area to RMDF using the charge number (PR 59-222) furnished by W. Martin, Supervisor of Dept. 782. The reduction in background radiation caused by the removal of the waste, revealed an additional area within or tangent to the excavated area. Nine more drums of soil were removed and transfered to RMDF for disposal effectively reducing the contamination level to 0.5mrad/hr.

After the radiological controls were removed on October 18, 1963, Industrial Security was notified, along with Maintenance and W. Martin.

Fill soil was brought in by maintenance, returning the soil level to normal. The paved area will be replaced by outside contractor on an open contract after the exclusion fence has been returned to the normal perimeter. This will complete the recovery operation.

It is difficult to make comments on an incident occurring from 1½ years to 3½ years ago. Complete changes in personnel and procedures compounds the problem. However, a thorough review of handling and operating proceduresfrom a radiological safety standpoint will be effected in an effort to prevent similar occurrances in the future. Incidents of this nature are embarrassing to Atomics International to say the least. Every effort should be made to preclude the possibility of similar occurrence.

F. H. Badger, Senior Analyst
Health and Safety Section
Santa Susana Operations

FHB:mc
dc: D. D. Busick
H. E. Clow
F. Corning
J. C. Lang
W. Martin
R. Weed
J. M. Young

APPENDIX B

DERIVED ALPHA, BETA, AND RADIONUCLIDE DATA FROM BUILDING 064 SIDE YARD AFTER DECONTAMINATION

During the course of the decontamination of the Side Yard, gamma spectrometry data were obtained for three sets of soil samples. These included: (1) 18 randomly selected scoping samples taken from the surface prior to decontamination, (2) 64 soil samples randomly taken from the soil removed from the Side Yard area during decontamination and subsequently stored in B–12 boxes, and (3) 60 soil samples taken from the survey grids established after decontamination. Soil samples for analysis were collected in July and August 1989.

In each case, samples ranging in mass from about 600 to 900 g were analyzed using the Canberra instrument discussed in Section 4.2.2 and Ref. 2. Following analyses, the results were input to the MCASOIL spreadsheet, which in turn calculated derived quantities for total alpha and total beta activity, and derived activities for selected man–made radionuclides and for several naturally occurring radionuclides. A zero value in the data tables indicates that the signal was less than the detection limit of the Canberra instrument. For ^{137}Cs (the nuclide of interest), this detection limit was ~0.2 pCi/g.

Tables B1 through B3, present the data for the three different soil sample sets.

Table B1. Gamma Spectrometry Data from Initial Scoping Survey of the Side Yard Area

	39	40	41	42	43	44	45	46	47	48	49	50<
1	BUILDING 064 PRE-DECON SOIL SURVEY DATA											
2	(Samples Analyzed: 7/10/89 to 7/12/89)											
3	Excel File:	064lnit.xls										
4												
5			picocuries per gram of each radionuclide									
6					186 keV	185.6 keV						
7			U-238	Th-232	U-235	U-235	K-40	Cs-137	Cs-134	Co-60	Derived Alpha	Derived Beta
8					(from	(from					pCi/g	pCi/g
9					Ra-226)	U-238)						
10												
11	Sample	Mass	c32*1e6/	c33*1e6/	c34*1e6/	c41*.045	c35*1e6/	c36*1e6/	c37*1e6/	c38*1e6/	8*c41+6*c42	6*c41+4*c42+4*
12	Description	(grams)	c2	c2	c2		c2	c2	c2	c2	+7*c43	c43+sum(c44:48)
13												
14	2	610.0	0.00	0.00	0.00	0.00	21.66	943.44	0.00	0.00	0.00	965.10
15	3 (12 IN. DEEP)	686.5	0.72	1.04	0.00	0.03	22.21	0.28	0.00	0.00	11.98	30.99
16	7	638.0	0.00	0.00	0.00	0.00	20.27	1341.69	0.00	0.00	0.00	1361.96
17	8	697.0	0.00	0.00	0.00	0.00	18.55	1598.28	0.00	0.00	0.00	1616.83
18	10	848.5	0.72	0.67	0.00	0.03	19.18	50.91	0.00	0.00	9.75	77.10
19	13	678.0	0.00	0.99	0.00	0.00	19.71	813.72	0.00	0.00	5.93	837.38
20	14	591.0	0.83	2.19	0.00	0.04	25.69	99.90	0.00	0.00	19.82	139.39
21	16-A	645.3	0.98	1.30	0.00	0.04	22.73	29.35	0.00	0.00	15.61	63.19
22	16-B	711.0	0.99	1.26	0.00	0.04	26.05	4.87	0.00	0.00	15.43	41.91
23	16-C	575.3	0.94	1.02	0.00	0.04	25.50	0.83	0.00	0.00	13.64	36.09
24	16-D	733.0	1.54	1.35	0.09	0.07	25.16	1.74	0.00	0.00	21.05	41.97
25	16-E	724.0	0.91	1.05	0.00	0.04	24.77	6.82	0.00	0.00	13.60	41.31
26	19	672.0	0.96	1.42	0.00	0.04	24.32	0.92	0.00	0.00	16.18	36.70
27	20	720.0	0.97	4.25	0.00	0.04	24.10	0.40	0.00	0.00	33.22	47.33
28	21	731.7	0.90	1.32	0.00	0.04	23.12	2.18	0.00	0.00	15.08	35.99
29	22	739.0	1.25	1.28	0.00	0.06	25.35	9.56	0.00	0.00	17.68	47.58
30	23	779.6	0.00	1.18	0.00	0.00	23.56	65.62	0.00	0.00	7.07	93.90
31	24	840.0	0.77	1.05	0.00	0.03	21.95	11.35	0.00	0.00	12.46	42.15

Table B2. Gamma Spectrometry Data on Randomly Selected Soil Samples Taken From the Side Yard Area During Soil Removal (Sheet 1 of 3)

	39	40	41	42	43	44	45	46	47	48	49	50
1	BLDG 064 SIDEYARD SOIL DATA FROM B-12 BOXES											
2	(Soil Analyzed: 8/4/89 to 8/9/89)											
3	Excel File:	064boxes.xls										
4												
5							picocuries per gram of each radionuclide					
6					186 keV	185.6 keV						
7			U-238	Th-232	U-235	U-235	K-40	Cs-137	Cs-134	Co-60	Derived Alpha	Derived Beta
8					(from	(from					pCi/g	pCi/g
9					Ra-226)	U-238)						
10												
11	Sample	Mass	c32*1e6/	c33*1e6/	c34*1e6/	c41*.045	c35*1e6/	c36*1e6/	c37*1e6/	c38*1e6/	8*c41+6*c42	6*c41+4*c42+4*
12	Description	(grams)	c2	c2	c2		c2	c2	c2	c2	+7*c43	c43+sum(c44:48)
13												
14	64-1	741.5	1.05	0.95	0.00	0.05	22.52	16.94	0.00	0.00	14.08	49.59
15	64-2	768.3	0.67	1.11	0.00	0.03	18.99	47.14	0.00	0.00	12.01	74.61
16	64-3	780.6	0.91	1.26	0.00	0.04	21.02	15.62	0.00	0.00	14.86	47.19
17	64-4	713.7	0.94	1.43	0.00	0.04	23.90	15.43	0.00	0.00	16.07	50.71
18	64-5	664.1	0.76	1.22	0.00	0.03	20.66	41.42	0.00	0.00	13.40	71.56
19	64-6	758.0	0.00	1.01	0.00	0.00	18.88	44.68	0.00	0.00	6.04	67.59
20	64-7	743.6	0.00	1.16	0.00	0.00	19.34	38.81	0.00	0.00	6.95	62.78
21	64-8	766.5	0.00	1.24	0.00	0.00	22.64	52.28	0.00	0.00	7.46	79.88
22	64-9	732.2	0.00	1.28	0.00	0.00	20.04	110.72	0.00	0.00	7.69	135.88
23	64-10	702.6	0.90	1.17	0.00	0.04	21.90	29.85	0.00	0.00	14.26	61.90
24	64-11	708.2	0.97	1.28	0.00	0.04	21.22	35.27	0.00	0.00	15.47	67.50
25	64-12	760.4	0.87	1.34	0.00	0.04	21.67	28.27	0.00	0.00	15.02	60.58
26	64-13	744.7	1.54	1.41	0.00	0.07	21.65	110.43	0.00	0.00	20.77	147.03
27	64-14	777.7	0.00	1.44	0.00	0.00	26.33	51.22	0.00	0.00	8.63	83.30
28	64-15	831.5	0.87	1.11	0.00	0.04	20.78	8.01	0.00	0.00	13.62	38.48
29	64-16	795.2	0.87	1.39	0.00	0.04	22.28	52.43	0.00	0.00	15.27	85.50
30	64-17	754.9	0.00	1.41	0.00	0.00	21.16	79.16	0.00	0.00	8.44	105.95
31	64-17 (resample)	756.0	0.90	1.14	0.00	0.04	24.76	29.31	0.00	0.00	14.05	64.08
32	64-18	724.4	0.88	1.06	0.00	0.04	21.45	67.48	0.00	0.00	13.38	98.47
33	64-19	842.1	0.96	1.08	0.00	0.04	17.75	24.96	0.00	0.00	14.17	52.85
34	64-20	762.9	0.77	1.37	0.00	0.03	24.93	19.96	0.00	0.00	14.38	55.03
35	64-21	827.3	1.91	1.19	0.13	0.09	22.02	7.39	0.00	0.00	23.34	46.25
36	64-22	785.6	0.00	1.29	0.00	0.00	22.54	45.67	0.00	0.00	7.75	73.38

Table B2. Gamma Spectrometry Data on Randomly Selected Soil Samples Taken From the Side Yard Area During Soil Removal (Sheet 2 of 3)

	39	40	41	42	43	44	45	46	47	48	49	50
37	64-23	801.0	0.89	1.43	0.00	0.04	22.12	25.49	0.00	0.00	15.75	58.75
38	64-24	788.0	1.02	1.12	0.00	0.05	24.96	8.49	0.00	0.00	14.83	44.06
39	64-25	758.0	0.90	1.30	0.00	0.04	22.69	31.39	0.00	0.00	15.01	64.72
40	64-26	755.9	0.96	1.69	0.00	0.04	21.80	50.28	0.00	0.00	17.83	84.66
41	64-27	818.3	1.18	1.08	0.00	0.05	20.14	51.75	0.00	0.00	15.91	83.34
42	64-28 (resample)	735.4	0.00	0.00	0.00	0.00	23.05	96.23	0.00	0.00	0.00	119.28
43	64-28	788.4	0.00	1.75	0.00	0.00	19.52	136.10	0.00	0.00	10.52	162.63
44	64-28 (2)	751.4	0.00	1.60	0.00	0.00	20.87	168.49	0.00	0.00	9.61	195.76
45	64-29	714.0	0.00	0.00	0.00	0.00	19.31	105.83	0.00	0.00	0.00	125.14
46	64-30	651.0	1.22	1.33	0.00	0.06	24.09	2.24	0.00	0.00	17.75	39.02
47	64-31	747.0	0.94	1.46	0.00	0.04	21.77	15.38	0.00	0.00	16.32	48.70
48	64-32	741.0	0.74	1.61	0.00	0.03	22.15	1.48	0.00	0.00	15.58	34.54
49	64-33	780.0	0.85	1.09	0.00	0.04	20.76	35.56	0.00	0.00	13.33	65.81
50	64-34	755.0	0.80	1.13	0.00	0.04	21.54	7.89	0.00	0.00	13.18	38.78
51	64-35	803.8	0.89	1.22	0.00	0.04	21.14	10.70	0.00	0.00	14.45	42.10
52	64-36 (resample)	698.0	1.12	1.36	0.00	0.05	23.07	10.53	0.00	0.00	17.16	45.84
53	64-36	760.4	0.98	1.26	0.00	0.04	22.44	11.60	0.00	0.00	15.41	45.01
54	64-36(2)	818.6	0.00	1.13	0.00	0.00	20.40	144.03	0.00	0.00	6.79	168.95
55	64-37	761.0	0.82	1.03	0.00	0.04	22.42	7.12	0.00	0.00	12.71	38.59
56	64-38	783.7	0.00	1.21	0.00	0.00	22.32	28.00	0.00	0.00	7.25	55.15
57	64-39	637.7	0.00	1.33	0.00	0.00	22.31	8.77	0.00	0.00	7.95	36.38
58	64-40	733.7	1.03	1.12	0.00	0.05	20.49	5.82	0.00	0.00	14.93	36.99
59	64-41	674.0	0.99	1.32	0.00	0.04	21.97	10.96	0.00	0.00	15.84	44.20
60	64-42	676.8	0.92	1.40	0.00	0.04	22.64	2.23	0.00	0.00	15.80	36.06
61	64-43	637.9	0.00	1.72	0.00	0.00	20.60	69.15	0.00	0.00	10.29	96.61
62	64-44	717.3	0.66	1.37	0.00	0.03	22.98	3.09	0.00	0.00	13.49	35.53
63	64-45	734.3	0.75	1.25	0.00	0.03	17.80	8.56	0.00	0.00	13.55	35.93
64	64-46	748.3	0.73	1.07	0.00	0.03	19.59	4.87	0.00	0.00	12.31	33.19
65	64-47	740.7	0.77	0.87	0.00	0.03	20.09	6.28	0.00	0.00	11.34	34.48
66	64-48	709.9	0.80	1.19	0.00	0.04	21.58	8.20	0.00	0.00	13.56	39.39
67	64-49	651.1	0.51	1.16	0.00	0.02	24.87	10.02	0.00	0.00	11.03	42.60
68	64-50	643.6	0.80	1.13	0.00	0.04	22.00	8.40	0.00	0.00	13.18	39.75
69	64-51	631.6	1.00	1.09	0.00	0.04	23.67	6.08	0.00	0.00	14.52	40.14
70	64-52	755.3	0.66	1.25	0.00	0.03	21.62	12.30	0.00	0.00	12.79	42.92
71	64-53	618.0	0.90	1.07	0.00	0.04	20.44	1.51	0.00	0.00	13.68	31.71
72	64-54	758.6	0.89	1.25	0.00	0.04	20.58	4.63	0.00	0.00	14.58	35.56

Table B3. Gamma Spectrometry Data on Soil Samples Taken from the Post-Decontamination Side Yard Grids (Sheet 1 of 3)

	39	40	41	42	43	44	45	46	47	48	49	50
1	BLDG 064 SIDEYARD GRID DATA (AFTER DECONTAMINATION)											
2	(Samples Analyzed: 8/29/89 to 9/19/89)											
3	Excel File:	064Yard.xls										
4												
5			picocuries per gram of each radionuclide									
6					186 keV	185.6 keV						
7			U-238	Th-232	U-235	U-235	K-40	Cs-137	Cs-134	Co-60	Derived Alpha	Derived Beta
8	Sample				(from	(from					pCi/g	pCi/g
9	Description				Ra-226)	U-238)						
10												
11	Remarks	Mass	c32*1e6/	c33*1e6/	c34*1e6/	c41*.045	c35*1e6/	c36*1e6/	c37*1e6/	c38*1e6/	8*c41+6*c42	6*c41+4*c42+4*
12		(grams)	c2	c2	c2		c2	c2	c2	c2	+7*c43	c43+sum(c44:48)
13												
14	T/064 Sample Grid G-1	724.0	0.80	1.10	0.00	0.04	20.91	11.36	0.00	0.00	12.98	41.49
15	T/064 Sample Grid G-2	829.0	0.83	1.30	0.00	0.04	19.81	17.60	0.00	0.00	14.41	47.60
16	T/064 Sample Grid G-3	726.0	0.84	1.12	0.00	0.04	23.07	10.08	0.00	0.00	13.45	42.71
17	T/064 Sample Grid G-4	737.0	1.13	1.28	0.07	0.05	19.35	17.10	0.00	0.00	17.22	48.68
18	T/064 Sample Grid G-5	799.0	0.75	1.34	0.00	0.03	20.65	5.49	0.00	0.00	14.05	36.05
19	T/064 Sample Grid G-6	882.0	0.81	1.01	0.00	0.04	20.26	3.49	0.00	0.00	12.58	32.71
20	T/064 Sample Grid G-7	736.0	0.85	1.25	0.04	0.04	18.07	0.00	0.00	0.00	14.58	28.36
21	T/064 Sample Grid G-8	770.0	0.93	1.08	0.05	0.04	20.81	0.75	0.00	0.00	14.31	31.72
22	T/064 Sample Grid G-9	812.0	0.65	0.82	0.00	0.03	20.92	2.08	0.00	0.00	10.19	30.26
23	T/064 Sample Grid G-10	819.0	1.02	1.44	0.08	0.05	22.11	1.26	0.00	0.00	17.37	35.63
24	T/064 Sample Grid G-11	725.0	0.87	1.15	0.00	0.04	18.57	1.41	0.00	0.00	13.83	29.81
25	T/064 Sample Grid G-12	782.0	0.80	1.30	0.00	0.04	22.54	12.97	0.00	0.00	14.19	45.54
26	T/064 Sample Grid G-13	782.0	0.88	1.47	0.00	0.04	19.46	1.90	0.00	0.00	15.91	32.59
27	T/064 Sample Grid G-14	751.0	0.95	1.09	0.07	0.04	20.91	5.07	0.00	0.00	14.68	36.39
28	T/064 Sample Grid G-15	793.0	1.14	1.07	0.10	0.05	20.10	3.69	0.00	0.00	16.23	35.36
29	T/064 Sample Grid G-16	831.0	0.84	1.26	0.00	0.04	21.41	9.87	0.00	0.00	14.22	41.35
30	T/064 Sample Grid G-17	619.0	1.09	1.50	0.06	0.05	22.00	0.41	0.00	0.00	18.20	35.28
31	T/064 Sample Grid G-18	783.0	1.09	1.13	0.08	0.05	17.80	12.05	0.00	0.00	16.11	41.31
32	T/064 Sample Grid G-19	761.0	0.95	1.08	0.00	0.04	23.06	2.95	0.00	0.00	14.02	36.03
33	T/064 Sample Grid G-20	777.0	1.27	1.30	0.11	0.06	18.35	5.61	0.00	0.00	18.80	37.32

Table B3. Gamma Spectrometry Data on Soil Samples Taken from the Post-Decontamination Side Yard Grids (Sheet 2 of 3)

	39	40	41	42	43	44	45	46	47	48	49	50
34	T/064 Sample Grid G-21	804.0	0.88	1.35	0.00	0.04	22.23	1.98	0.00	0.00	15.16	34.95
35	T/064 Sample Grid G-22	807.0	0.92	1.12	0.06	0.04	19.36	1.29	0.00	0.00	14.47	30.91
36	T/064 Sample Grid G-23	801.0	0.80	1.16	0.00	0.04	20.81	5.28	0.00	0.00	13.34	35.55
37	T/064 Sample Grid G-24	759.0	0.90	1.22	0.00	0.04	21.96	12.84	0.00	0.00	14.56	45.15
38	T/064 Sample Grid G-25	790.0	0.80	1.10	0.00	0.04	22.32	2.07	0.00	0.00	12.99	33.62
39	T/064 Sample Grid G-26	770.0	0.82	1.25	0.00	0.04	20.29	2.84	0.00	0.00	14.06	33.08
40	T/064 Sample Grid G-27	929.0	0.85	1.20	0.00	0.04	19.75	1.73	0.00	0.00	14.00	31.42
41	T/064 Sample Grid G-28	800.0	0.89	1.25	0.00	0.04	21.14	2.73	0.00	0.00	14.64	34.26
42	T/064 Sample Grid G-29	610.0	1.09	1.29	0.07	0.05	22.56	6.19	0.00	0.00	17.00	40.81
43	T/064 Sample Grid G-30	882.0	1.34	1.04	0.10	0.06	19.44	5.38	0.00	0.00	17.69	37.50
44	T/064 Sample Grid G-31	784.0	0.78	1.26	0.00	0.04	21.15	5.30	0.00	0.00	13.81	36.21
45	T/064 Sample Grid G-32	810.0	0.80	1.89	0.00	0.04	21.57	8.15	0.00	0.00	17.78	42.14
46	T/064 Sample Grid G-33	829.0	1.25	1.14	0.08	0.06	22.23	4.46	0.00	0.00	17.46	39.16
47	T/064 Sample Grid G-34	759.0	0.92	1.25	0.00	0.04	22.49	6.49	0.00	0.00	14.84	39.53
48	T/064 Sample Grid G-35	697.0	1.27	1.23	0.08	0.06	21.84	9.33	0.00	0.00	18.15	44.11
49	T/064 Sample Grid G-36	669.0	1.32	1.67	0.10	0.06	20.84	8.74	0.00	0.00	21.37	44.70
50	T/064 Sample Grid G-37	593.0	1.00	1.44	0.00	0.05	24.45	8.90	0.00	0.00	16.68	45.16
51	T/064 Sample Grid G-38	725.0	1.13	1.74	0.08	0.05	21.32	6.95	0.00	0.00	20.08	42.42
52	T/064 Sample Grid G-39	748.0	1.08	1.20	0.08	0.05	20.78	5.66	0.00	0.00	16.40	38.08
53	T/064 Sample Grid G-40	760.0	0.99	1.17	0.00	0.04	21.71	5.87	0.00	0.00	14.94	38.24
54	T/064 Sample Grid G-41	826.0	1.30	1.07	0.08	0.06	21.73	4.55	0.00	0.00	17.40	38.75
55	T/064 Sample Grid G-42	736.0	1.05	1.38	0.00	0.05	20.46	3.02	0.00	0.00	16.72	35.38
56	T/064 Sample Grid G-43	872.0	1.02	1.35	0.07	0.05	19.21	3.63	0.00	0.00	16.76	34.68
57	T/064 Sample Grid G-44	744.0	0.88	1.29	0.00	0.04	16.69	1.30	0.00	0.00	14.80	28.50
58	T/064 Sample Grid G-45	843.0	0.97	1.12	0.00	0.04	19.77	9.14	0.00	0.00	14.51	39.28
59	T/064 Sample Grid G-46	796.0	0.84	1.13	0.00	0.04	17.11	16.68	0.00	0.00	13.50	43.39
60	T/064 Sample Grid G-47	833.0	0.92	1.08	0.00	0.04	18.08	0.96	0.00	0.00	13.87	28.94
61	T/064 Sample Grid G-48	632.0	1.79	1.24	0.12	0.08	22.69	2.07	0.00	0.00	22.56	40.99
62	T/064 Sample Grid G-49	755.0	0.76	1.52	0.00	0.03	22.08	0.89	0.00	0.00	15.19	33.64
63	T/064 Sample Grid G-50	825.0	1.12	1.17	0.08	0.05	18.64	0.00	0.00	0.00	16.52	30.40
64	T/064 Sample Grid G-51	877.0	0.90	1.04	0.04	0.04	17.26	0.25	0.00	0.00	13.69	27.25
65	T/064 Sample Grid G-52	883.0	1.59	1.34	0.10	0.07	19.78	1.66	0.00	0.00	21.47	36.82
66	T/064 Sample Grid G-53	825.0	1.39	1.43	0.09	0.06	20.30	1.92	0.00	0.00	20.32	36.69

Table B3. Gamma Spectrometry Data on Soil Samples
Taken from the Post-Decontamination Side Yard Grids (Sheet 3 of 3)

	39	40	41	42	43	44	45	46	47	48	49	50
67	T/064 Sample Grid G-54	788.0	0.90	1.27	0.00	0.04	19.11	0.43	0.00	0.00	14.81	30.05
68	T/064 Sample Grid G-55	826.0	1.00	1.27	0.00	0.04	20.07	0.27	0.00	0.00	15.60	31.45
69	T/064 Sample Grid G-56	844.0	1.05	1.20	0.00	0.05	20.32	0.34	0.00	0.00	15.59	31.80
70	T/064 Sample Grid G-57	784.0	0.97	1.03	0.00	0.04	19.52	2.13	0.00	0.00	13.94	31.63
71	T/064 Sample Grid G-58	745.0	0.99	1.06	0.00	0.04	19.25	2.04	0.00	0.00	14.27	31.51
72	T/064 Sample Grid G-59	756.0	1.06	1.36	0.06	0.05	20.13	2.59	0.00	0.00	17.04	34.80
73	T/064 Sample Grid G-60	737.0	1.48	1.62	0.11	0.07	26.31	1.03	0.00	0.00	22.34	43.22

APPENDIX C

GROSS ALPHA AND GROSS BETA ACTIVITY DATA ON T064 SIDE YARD SOIL SAMPLES AFTER DECONTAMINATION

Gross alpha and gross beta measurements were performed on 2-g soil samples from the 60 grid locations within the Building T064 Side Yard decontaminated area. Soil samples for analysis were collected and analyzed in June and July 1989.

Table C1 gives the gross alpha and gross beta results for the grid locations. Shown in the table are the net counts taken over a 100 minute time period, and the resulting calculated alpha and beta activities in pCi/g. Estimates of the standard deviation in the activity values are also shown. The data were compiled using the SOILTEMP spreadsheet.

Table C1. Gross Alpha and Gross Beta Measurements on 2–g Side Yard Soil Samples (Sheet 1 of 2)

Grid Number	Alpha Activity (pCi/g)	Standard Deviation (1σ)	Beta Activity (pCi/g)	Standard Deviation (1σ)
1	42.5	3.4	34.4	1.1
2	42.5	3.4	34.0	1.0
3	44.3	3.5	50.1	1.3
4	44.3	3.5	41.9	1.2
5	40.6	3.4	29.6	1.0
6	37.9	3.3	26.8	0.9
7	27.7	2.9	22.8	0.9
8	35.0	3.2	25.7	0.9
9	37.7	3.3	26.5	0.9
10	41.1	3.4	25.3	0.9
11	43.3	3.5	27.5	0.9
12	43.8	3.5	38.5	1.1
13	43.0	3.5	28.7	1.0
14	38.9	3.3	29.8	1.0
15	41.1	3.4	27.3	0.9
16	32.6	3.1	30.7	1.0
17	33.5	3.1	26.4	0.9
18	42.8	3.5	37.6	1.1
19	37.2	3.2	27.3	0.9
20	39.1	3.3	30.7	1.0
21	31.1	3.0	27.2	0.9
22	35.5	3.2	26.2	0.9
23	37.7	3.3	27.4	0.9
24	44.5	3.5	38.5	1.1
25	33.8	3.1	26.3	0.9
26	41.8	3.4	25.6	0.9
27	33.5	3.1	27.2	0.9
28	36.2	3.2	29.4	1.0
29	33.0	3.1	31.7	1.0
30	33.0	3.1	30.2	1.0
31	41.1	3.4	30.3	1.0
32	38.9	3.3	37.9	1.1
33	35.7	3.2	29.9	1.0
34	34.3	3.1	32.0	1.0
35	38.9	3.3	32.0	1.0
36	40.1	3.4	33.4	1.0
37	40.6	3.4	35.9	1.1
38	45.5	3.5	32.4	1.0
39	34.0	3.1	31.2	1.0

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Table C1. Gross Alpha and Gross Beta Measurements on 2–g Side Yard Soil Samples (Sheet 2 of 2)

Grid Number	Alpha Activity (pCi/g)	Standard Deviation (1σ)	Beta Activity (pCi/g)	Standard Deviation (1σ)
40	45.0	3.5	31.0	1.0
41	45.0	3.5	29.3	1.0
42	37.2	3.2	28.1	1.0
43	36.9	3.2	29.7	1.0
44	44.7	3.5	27.2	0.9
45	48.4	3.6	34.7	1.1
46	49.1	3.7	43.1	1.2
47	37.7	3.3	26.1	0.9
48	47.2	3.6	27.9	1.0
49	41.8	3.4	26.7	0.9
50	44.7	3.5	26.1	0.9
51	43.8	3.5	27.0	0.9
52	37.7	3.3	27.7	1.0
53	38.4	3.3	27.1	0.9
54	45.0	3.5	27.4	0.9
55	33.0	3.1	26.7	0.9
56	35.7	3.2	27.8	1.0
57	36.5	3.2	28.7	1.0
58	38.4	3.3	28.5	1.0
59	39.6	3.3	27.7	1.0
60	34.5	3.1	27.1	0.9

D635–0139

APPENDIX D

INPUT DATA FOR RESRAD CODE CALCULATIONS

RESRAD calculations were performed for four different potential current and future land use scenarios for the T064 Side Yard area. Each scenario was analyzed three times to yield acceptance limits for ^{137}Cs and ^{90}Sr (in pCi/g) and to provide realistic current and future dose estimates (in mrem/year) for the pre– and post–decontamination conditions.

Each of these 12 analyses involved the input of about 80 different parameters, many of which were researched to provide site specific values for the SSFL Side Yard area in question. The values input to RESRAD for each of the three runs for each scenario are summarized in Table D1. For comparison, the "default" values assumed by RESRAD are shown in the last column.

Table D1. Input Parameters for T064 Side Yard RESRAD Runs (Sheet 1 of 3)

RESRAD PARAMETER	Industrial Scenario			Residential Scenario			Wilderness Scenario			Family Farm Scenario			RESRAD
	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Default
Area of contaminated zone (m**2)	421	421	100000	421	421	100000	421	421	100000	421	421	100000	10000
Thickness of contaminated zone (m)	0.81	0.41	34.9	0.81	0.41	35	0.81	0.41	35	0.81	0.41	35	1
Length parallel to aquifer flow (m)	34	34	316	34	34	316	34	34	316	34	34	316	100
Basic radiation dose limit (mrem/yr)	100	100	100	100	100	100	100	100	100	100	100	100	100
Times for calculations (yr)	1	1	1	1	1	1	1	1	1	1	1	1	1
Times for calculations (yr)	10	10	10	10	10	10	10	10	10	10	10	10	10
Times for calculations (yr)	100	100	100	100	100	100	100	100	100	100	100	100	100
Times for calculations (yr)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Times for calculations (yr)	0	0	0	0	0	0	0	0	0	0	0	0	10000
Times for calculations (yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Times for calculations (yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Times for calculations (yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Times for calculations (yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial principal radionuclide (pCi/g): Cs-137	32.8	4.9	4.9	32.8	4.9	4.9	32.8	4.9	4.9	32.8	4.9	4.9	0
Initial principal radionuclide (pCi/g): Sr-90	32.8	4.9	4.9	32.8	4.9	4.9	32.8	4.9	4.9	32.8	4.9	4.9	0
Cover depth (m)	0	0	0	0	0	0	0	0	0	0	0	0	0
Density of cover material (g/cm**3)													1.6
Cover depth erosion rate (m/yr)													0.001
Density of contaminated zone (g/cm**3)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.6
Contaminated zone erosion rate (m/yr)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Contaminated zone total porosity	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Contaminated zone effective porosity	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Contaminated zone hydraulic conductivity (m/yr)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10
Contaminated zone b parameter	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Evapotranspiration coefficient	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6
Precipitation (m/yr)	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	1
Irrigation (m/yr)	0	0	0	0	0	0	0	0	0	1	1	1	0.2
Irrigation mode	ditch	ditch	ditch	ditch	ditch	ditch	ditch	ditch	ditch	overhead	overhead	overhead	overhead
Runoff coefficient	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.5	0.5	0.5	0.2
Watershed area for nearby stream or pond (m**2)	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000

Table D1. Input Parameters for T064 Side Yard RESRAD Runs (Sheet 2 of 3)

RESRAD PARAMETER	Industrial Scenario			Residential Scenario			Wilderness Scenario			Family Farm Scenario			RESRAD
	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Default
Density of saturated zone (g/cm**3)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Saturated zone total porosity	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.4
Saturated zone effective porosity	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.2
Saturated zone hydraulic conductivity (m/yr)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	100
Saturated zone hydraulic gradient	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Saturated zone b parameter	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Distance from surface to water table (m)	35	35	35	35	35	35	35	35	35	35	35	35	5
Water table drop rate (m/yr)	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.001
Well pump intake depth (m below water table)	10	10	10	10	10	10	10	10	10	10	10	10	10
Model: Nondispersion (ND) or Mass-Balance (MB)	MB	MB	ND	MB	MB	ND	MB	MB	ND	MB	MB	ND	ND
Individual's use of groundwater (m**3/yr)	1E-10	1E-10		1E-10	1E-10		1E-10	1E-10		150	150		150
Number of unsaturated zone strata	1	1	0	1	1	0	1	1	0	1	1	0	1
Unsat. zone 1, thickness (m)	34.19	34.59		34.19	34.59		34.19	34.59		34.19	34.59		4
Unsat. zone 1, soil density (g/cm**3)	1.4	1.4		1.4	1.4		1.4	1.4		1.4	1.4		1.6
Unsat. zone 1, total porosity	0.4	0.4		0.4	0.4		0.4	0.4		0.4	0.4		0.4
Unsat. zone 1, effective porosity	0.2	0.2		0.2	0.2		0.2	0.2		0.2	0.2		0.2
Unsat. zone 1, soil-specific b parameter	5.3	5.3		5.3	5.3		5.3	5.3		5.3	5.3		5.3
Unsat. zone 1, hydraulic conductivity (m/yr)	10000	10000		10000	10000		10000	10000		10000	10000		100
Distribution coefficients for Cs-137													
Contaminated zone (cm**3/g)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Unsaturated zone 1 (cm**3/g)	1000	1000		1000	1000		1000	1000		1000	1000		1000
Saturated zone (cm**3/g)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leach rate (/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution coefficients for Sr-90													
Contaminated zone (cm**3/g)	30	30	30	30	30	30	30	30	30	30	30	30	30
Unsaturated zone 1 (cm**3/g)	30	30		30	30		30	30		30	30		30
Saturated zone (cm**3/g)	30	30	30	30	30	30	30	30	30	30	30	30	30
Leach rate (/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table D1. Input Parameters for T064 Side Yard RESRAD Runs (Sheet 3 of 3)

RESRAD PARAMETER	Industrial Scenario			Residential Scenario			Wilderness Scenario			Family Farm Scenario			RESRAD
	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Before	After	Infinite	Default
Inhalation rate (m**3/yr)	8400	8400	8400	8400	8400	8400	8400	8400	8400	8400	8400	8400	8400
Mass loading for inhalation (g/m**3)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Occupancy and shielding factor, external gamma	0.08	0.08	0.08	0.27	0.27	0.27	0.005	0.005	0.005	0.6	0.6	0.6	0.6
Occupancy factor, inhalation	0.14	0.14	0.14	0.48	0.48	0.48	0.005	0.005	0.005	0.45	0.45	0.45	0.45
Shape factor, external gamma	0.96	0.96	1	0.96	0.96	1	0.96	0.96	1	0.96	0.96	1	1
Mixing height for airborne dust, inhalation (m)	3	3	3	3	3	3	3	3	3	3	3	3	3
Fruits, vegetables and grain consumption (kg/yr)	0	0	0	16	16	16	0	0	0	160	160	160	160
Leafy vegetable consumption (kg/yr)	0	0	0	1.4	1.4	1.4	0	0	0	14	14	14	14
Milk consumption (L/yr)	0	0	0	0	0	0	0	0	0	92	92	92	92
Meat and poultry consumption (kg/yr)	0	0	0	0	0	0	0	0	0	63	63	63	63
Fish consumption (kg/yr)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Other seafood consumption (kg/yr)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Drinking water intake (L/yr)	410	410	410	410	410	410	410	410	410	410	410	410	410
Fraction of drinking water from site	0	0	0	0	0	0	0	0	0	1	1	1	1
Fraction of aquatic food from site	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
Livestock fodder intake for meat (kg/day)	68	68	68	68	68	68	68	68	68	68	68	68	68
Livestock fodder intake for milk (kg/day)	55	55	55	55	55	55	55	55	55	55	55	55	55
Livestock water intake for meat (L/day)	50	50	50	50	50	50	50	50	50	50	50	50	50
Livestock water intake for milk (L/day)	160	160	160	160	160	160	160	160	160	160	160	160	160
Mass loading for foliar deposition (g/m**3)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Depth of soil mixing layer (m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Depth of roots (m)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Drinking water fraction from ground water	0	0	0	0	0	0	0	0	0	1	1	1	1
Livestock water fraction from ground water	0	0	0	0	0	0	0	0	0	1	1	1	1
Irrigation fraction from ground water	0	0	0	0	0	0	0	0	0	1	1	1	1

APPENDIX E

LIST OF ITEMS IN THE BUILDING T064 SIDE YARD DECOMMISSIONING FILE

The following is an annotated list of documents on the decontamination of the Building T064 Side Yard. The documents listed below are archived in Building T100 of Rockwell International's Santa Susana Field Laboratory (SSFL).

1. Chapman, J. A., "Radiological Survey of the Source and Special Nuclear Material Storage Vault–Bldg. T64," Energy Technology Engineering Center Report GEN–ZR–0005, August 19, 1988.
   - The primary document reporting the comprehensive radiological survey of Building T064, its fenced–in yard, and a 2–acre surrounding area. Of the open areas (the fenced–in yard and 2–acre surrounding area) surveyed, a 4,000 ft^2 area in the vicinity of the eastern fence was found to be contaminated with ^{137}Cs and a larger, 4,500 ft^2 total area was subsequently designated as the Building T064 Side Yard. The above report recommended further investigations of the Side Yard area.
2. Parker, D., "Building 064 Soil Decontamination," Rockwell International Detailed Work Procedure N001DWP000023, July 31, 1989.
   - Describes the operational procedures used to decontaminate the Building T064 Side Yard.
3. Five photographs taken during the Side Yard decontamination operations.
4. SOILTEMP spreadsheets corresponding to data from the 78 (60 grid locations and 18 perimeter locations) gamma exposure rate, 60 soil gross alpha, and 60 soil gross beta measurements.
5. Gamma Mass Spectrometric Analysis (MCA) printouts and corresponding MCASOIL spreadsheets for the following: (1) 18 scoping analyses (pre–decon) soil sample, (2) 64 soil samples from the B–12 boxes, and (3) 60 post–decontamination soil samples from the T064 Side Yard grid locations.
6. Twelve RESRAD summary outputs (10 pages each) corresponding to (1) the industrial, (2) residential, (3) wilderness, and (4) family farm use scenarios. There are three outputs for each scenario showing (a) the estimated annual doses for a plausible current or future user "before" decontamination of the Side Yard, (b) the estimated doses "after" decontamination of the Side Yard, and (c) calculated values of radionuclide concentration limits established with "infinitely" large dimensions for the contamination zone.
7. Subbaraman, G., and Oliver, B.M., "Final Decontamination and Radiological Survey of the Building T064 Side Yard," Rockwell International Safety Review Report N704SRR990031, October 1990.

APPENDIX F

EXCAVATION AND SAMPLING FOLLOWING THE ORISE SURVEY

During the independent verification survey performed by the Oak Ridge Institute of Science and Education (ORISE), two hot spots were detected in the Building T064 Side Yard. ("Verification Survey of the Old Conservation Yard, Building T064 Side Yard and Building T028, Santa Susana Field Laboratory, Rockwell International, Canoga Park, California," ORISE, Draft Report, December 1992.)

The ORISE data is summarized below:

Location	Area (m^2)	Cs-137 (pCi/g)	Criterion* (pCi/g)	Pass/Fail
19.5N, 8.5W	1	210	604	Pass
19.5N, 8.5W	100	27.5	60.4	Pass
9N, 19.5W	1	35.1	604	Pass
9N, 19.5.W	100	7.5	60.4	Pass

*Criterion for average of $100m^2$ is 60.4 pCi/gm based or 100 mrem/y. Hot spot criterion for area $\leq$ lm^2 is $(100/A)^{1/2}$ x 60.4 = 604 pCi/g (assuming equal quantities of Cs-137 and Sr-90).

All ORISE sample data met the published Rocketdyne criteria based on 100 mrem/y.

At the March 1993 IVC meeting, DOE imposed a 10 mrem/y dose criterion on the T064 Side Yard retroactively. This resulted in the soil concentration criterion being reduced by a factor of 10 and the above table then changed to:

Location	Area (m^2)	Cs-137 (pCi/g)	Criterion* (pCi/g)	Pass/Fail
19.5N, 8.5W	1	210	60.4	Fail
19.5N, 8.5W	100	27.5	6.04	Fail
9N, 19.5W	1	35.1	60.4	Pass
9N, 19.5.W	100	7.5	6.04	Fail

*Based on retroactive DOE imposed limit of 10 mrem/year, 6.04 pCi/gm for 100 m^2 average, 60.4 pCi/gm for lm^2 hot spot (assuming equal quantities of Cs-137 and Sr-90).

The two hot spots therefore now failed the revised soil concentration limits.

The two lm^2 hot spot locations were excavated during July 1993 and additional samples taken. One sample was taken from each hot spot location. In addition, two composite samples were prepared from each 100 m^2 area. Each composite sample included soil from the hot spot plus four additional locations from within the 100 m^2 area using the same protocol as ORISE. Each sample was submitted to gamma spectoscopy for Cs–137 and results were as follows:

Location	Area (m^2)	Cs–137 (pCi/g)	Criterion* (pCi/g)	Pass/Fail
19.5N, 8.5W	1	4.4	70.8	Pass
19.5N, 8.5W	100	3.5	7.08	Pass
9N, 19.5W	1	2.2	70.8	Pass
9N, 19.5.W	100	2.8	7.08	Pass
*Based on retroactive DOE imposed limit of 10 mrem/year for a single Cs–137 isotope, 7.08 pCi/gm for 100 m^2 average, 70.8 pCi/gm for lm^2 hot spot.				

Since the ORISE sample results confirmed very low levels of Sr–90, the combined Cs–137/Sr–90 limit of 6.04 pCi/gm has been replaced in the above table by the single Cs–137 isotope limit of 7.08 pCi/gm (see Page 50).

Based on these results, the hot spots detected by ORISE have been removed and the remaining soil meets the revised hot spot (70.8 pCi/gm) and average (7.08 pCi/gm) limits based on a 10 mrem/year limit to a residential user.

EXHIBIT VI

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DOCUMENTATION FOR DECONTAMINATION AND DECOMMISSIONING OF FACILITY 4064

Department of Energy
Energy Technology Engineering Center Project Office
P.O. Box 1446
Canoga Park, CA 91304

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May 21, 1992

Dr. D. C. Gibbs
General Manager
Energy Technology Engineering Center
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309

Subject: Approved NEPA Categorical Exclusions for DOE EM-Funded Projects

Dear Dr. Gibbs:

DOE-SF has reviewed the proposed actions to perform four EM-funded projects at ETEC. It has been determined that the requirements for a CX has been met. The two week time period for DOE-HQ (EH-25) comments has been made available. This letter serves as approval to proceed with the projects described in the enclosures.

Should you have any questions, please contact me (818) 586-5417 or Donna Spencer (818) 586-5420.

Sincerely,

R. R. Le Chevalier
DOE-ETEC Site Manager

Enclosures: (1) ET-EM-92-7
(2) ET-EM-92-10
(3) ET-EM-92-11
(4) ET-EM-92-12

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DOE San Francisco Field Office (ERWM)

Categorical Exclusion (CX) Determination for Environmental Remediation of Bldg. 064, a Former Special Nuclear Materials Facility

Susan Brechbill, Acting AMEMS

In accordance with DOE NEPA Guidelines, Section D, and SEN-15-90, I have determined that the subject project satisfies the requirements for exclusion from further NEPA review based on the following:

CX DETERMINATION

NEPA Document Number: ET-EM-92-11

Proposed Action: Environmental Remediation of Building 064 by Decontamination and Removal and Disposal of Hazardous and Radioactive Waste

Location: Energy Technology Engineering Center (ETEC), Santa Susana Field Laboratory, Ventura County, CA

Description: Remove stored equipment from and decontaminate Building 064 and adjacent grounds to remove low level radioactivity contamination, and restore them to conditions suitable for use without radiological restrictions. Also, excavate, as needed, adjacent grounds to remove hazardous and radioactively contaminated soil and debris. Package the hazardous and radioactively contaminated fixtures, surplus equipment and debris, and ship it to an approved radioactive waste disposal facility.

CX To Be Applied (from Section D, DOE NEPA Guidelines):

CX as identified in Federal Register Volume 55, Number 174, dated September 7, 1990, for "1. The removal actions and other actions described below, if it is determined that such an action would not threaten a violation of applicable statutory, regulatory or permit requirements, including requirements of DOE Orders; would not require siting and construction or major expansion of waste

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disposal, recovery, or treatment facilities (including incinerators and facilities for treating waste water, surface water, or ground water); and would not adversely affect environmentally sensitive areas.... c. Removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (including those taken as final response actions and those taken before remedial action) and actions similar in scope under the Resource Conservation and Recovery Act (RCRA) and other authorities (including the Atomic Energy Act, as amended) and those taken as partial closure actions and those taken before corrective action.... (12) Use of chemicals and other materials to retard the spread of the release or to mitigate its effects, where the use of such chemicals would reduce the spread of, or direct contact with, the contamination; {and}.... (16) Treatment (including incineration), recovery, storage or disposal of wastes at existing facilities permitted for the type of waste resulting from the removal action, where needed, to reduce the likelihood of human, animal, or food chain exposure."

The project will not affect historic, archaeological, or architecturally significant properties; will not impact environmentally sensitive areas or critical habitats; is not located in a floodplain, wetland, or prime agricultural land; and will not utilize special sources of water, sole source aquifers, well heads, or other resources vital to the region.

I have determined that the proposed action meets the requirements for the CX referenced above. Therefore, I have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

/s/ JTD
James T. Davis
Acting Manager

cc: D. Williams, EM-443
A. Kluk, EM-443
C. Borgstrom, EH-25