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Building T028 Decontamination

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Final Decontamination and Radiological Survey of Building T028

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ABSTRACT

SSFL Building T028 originally housed the STIR test reactor. The reactor was removed, and the facility was decontaminated and decommissioned for release for unrestricted use in 1976. Subsequent uranium-oxide melting experiments conducted in the facility resulted in some recontamination of equipment and localized areas. Following completion of the uranium experiments, the facility underwent additional decontamination and decommissioning operations in 1988, and the above-grade structures were demolished and removed in 1989. As part of this effort, a final radiological survey was conducted (prior to demolition), which included both indication-only surveys, and detailed grid surveys of total and removable alpha/beta activity, and ambient gamma exposure rate.

The results and statistical analysis of the final radiological survey data are presented in this report. The data show very small levels of residual radioactive contamination (just above background) in isolated areas of the facility, but at levels that are far below any regulatory limits. Ambient gamma exposure rates were observed to be slightly higher in the basement area, but still at levels below allowable limits. Some evidence of residual activation in the concrete wall adjacent to the removed STIR reactor was noted, but also at levels below the allowable limits. Based on the present results, it is concluded that residual radioactivity in all areas of Building T028 is below applicable limits. Therefore, these areas meet the requirements of DOE Order 5400.5, "Radiation Protection of the Public and Environment" (February 1990), and are suitable for release without radiological restrictions.

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FORM 734-C REV. 12-84

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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 Laboratories (SSFL). During D&D of these facilities, reasonable efforts are being made to eliminate radioactive contamination or to reduce residual contamination to levels that are as low as reasonably achievable (ALARA). Upon completion of D&D, radiological surveys are performed, using formal procedures, to determine that any remaining radioactivity does not exceed applicable regulatory limits. The scope of these surveys includes both known and suspected areas of contamination.

To promote efficient use of the facilities at SSFL, buildings are often decontaminated and decommissioned following one use with radioactive materials and then reused in new projects that may or may not involve radioactive materials. Building T028 has been recycled in this manner, starting as a research reactor facility which was decommissioned, and then reused for research on simulated accident conditions involving molten uranium oxide. Following completion of this latter project, it was determined that there would be no future need for the building and so the subsequent decontamination was followed by demolition of the above–grade structures.

Prior to demolition, the building was completely surveyed for detectable radioactive contamination. Small areas that indicated some contamination were completely decontaminated before releasing the above–grade structure to contractors for demolition. All contaminated material was sent to the RMDF for eventual disposal at an authorized site. After the sections of the building that were to remain in place were decontaminated, a final radiological survey was performed. The results of the final radiological survey are described in this report.

The findings presented in this SRR include a statistical treatment of measured gamma radiation exposure rates and surface contamination from sections of the above–grade structure prior to demolition, and the present below–grade portion of Building T028. The gamma exposure rates and the surface contamination are compared with regulatory acceptance limits. These comparisons show that residual radioactivity is well below acceptable levels and that the remaining structure is suitable for release without radiological restrictions.

This report is organized as follows: A background on Building T028 that includes its location and operating history is provided in the next section (Section 2). The scope of the survey and applicable regulatory limits are given in Section 3. Section 4 summarizes the statistical techniques used to interpret the survey data. Section 5 summarizes the survey methods and procedures. Results are provided and discussed in Section 6, and Section 7 states the conclusions drawn from the review.

Additional data and information pertaining to Building T028 are provided in Appendices A through E. Appendix A describes the method used to determine the applicable regulatory limit for ambient gamma exposure rate above background in a concrete vault area; Appendices B, C, and D list the various radiological data obtained during the final release survey; and Appendix E provides a list of items collected during the decontamination and decommissioning operation which are archived at Rockwell.

2.0 BACKGROUND

2.1 LOCATION

Building T028 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. Location of the SSFL relative to Los Angeles and vicinity 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 T028 is located. A drawing (plan view) of Building T028, as it existed prior to above-grade demolition, is shown in Figure 4.

Figure 5 shows the relevant portion of a 1967 edition of the U.S. Geological Survey (USGS) topographic map of the Calabasas Quadrangle where the SSFL is located. Using USGS terminology, the description for Building T028 is: Section 25 of Township T2N: Range R18W: Calabasas Quadrangle.

2.2 AREA CHARACTERISTICS

Figures 6 and 7 are photographs of Building T028 taken from the west end of the facility. Figure 6 shows the remaining slab floor after demolition and removal of the above-grade structures. Figure 7 shows the remaining below-grade structure, consisting of the original test vault area.

The terrain throughout most of the SSFL areas is uneven due to rock outcroppings. Rock outcroppings exist upslope from the facility to the north, and to the south and west. Water runoff is primarily to the west at the western end of the facility. Surrounding the facility in all directions is asphalt paving. The minimum distance to the SSFL boundary is approximately 300 ft. This boundary lies in a northeasterly direction (Simi Valley direction). Grade floor elevation is approximately 1,800 ft above sea level.

2.3 OPERATING HISTORY

Building T028 was originally constructed to perform tests of space reactor shields using a fission plate driven by neutrons from the thermal column of a 50-kW swimming pool-type reactor. This reactor was designated the Shield Test Reactor (STR) and operated from 1961 to 1964, when it was modified to operate at 1 MW. This latter configuration was renamed the Shield Test and Irradiation Reactor (STIR) and operated through 1972. Following shutdown of the test program and removal of the reactor, the facility was decommissioned and made available for alternate use in March 1976 (Ref. 1).

In 1977, operations were started to investigate the behavior of molten UO_2 relative to simulated reactor accidents; in particular, its reaction with floor and structural

6239-17

Figure 1. Map of Los Angeles Area

6239-2

Figure 2. Map of Neighboring SSFL Communities

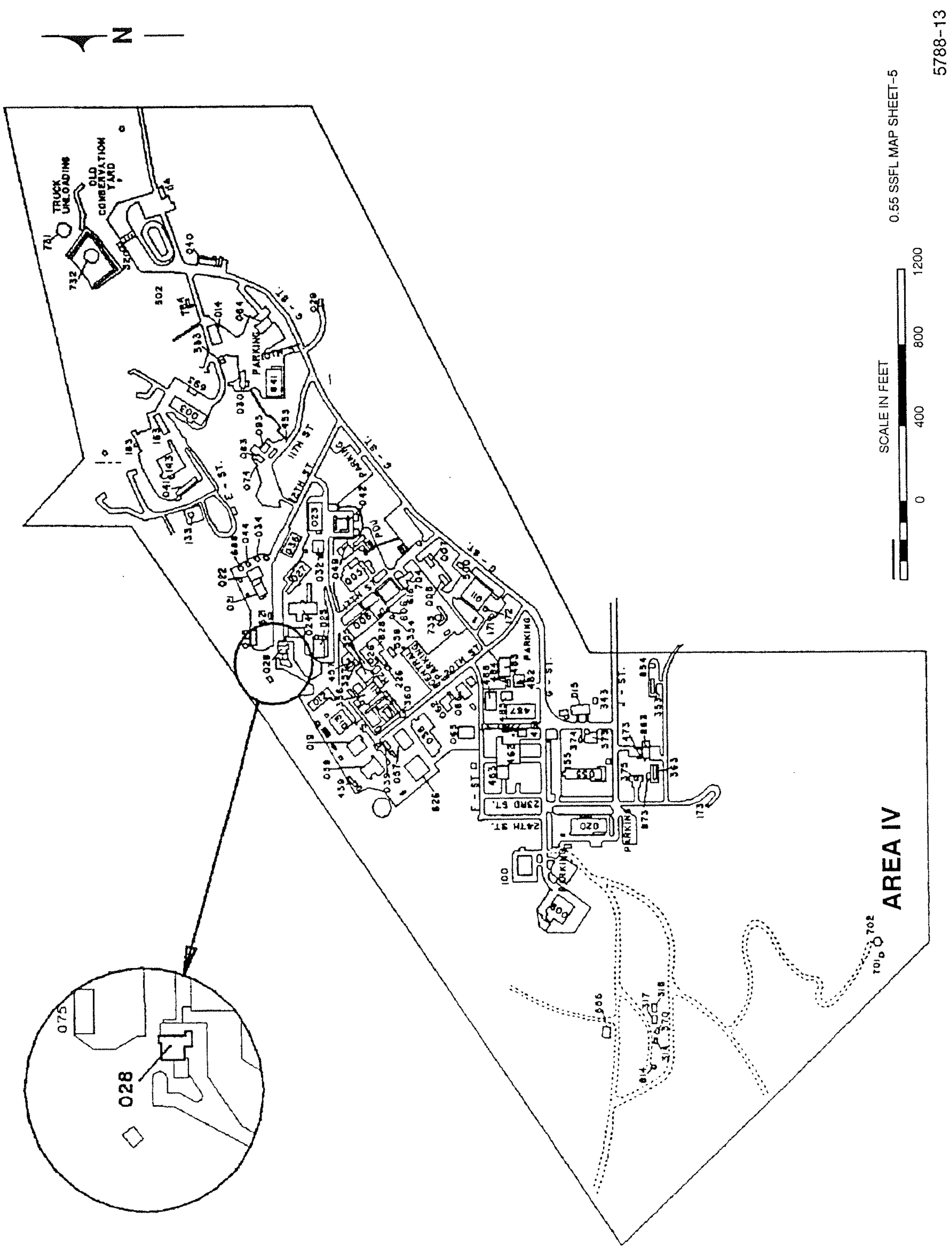

Figure 3. SSFL Layout Showing Location of Building T028

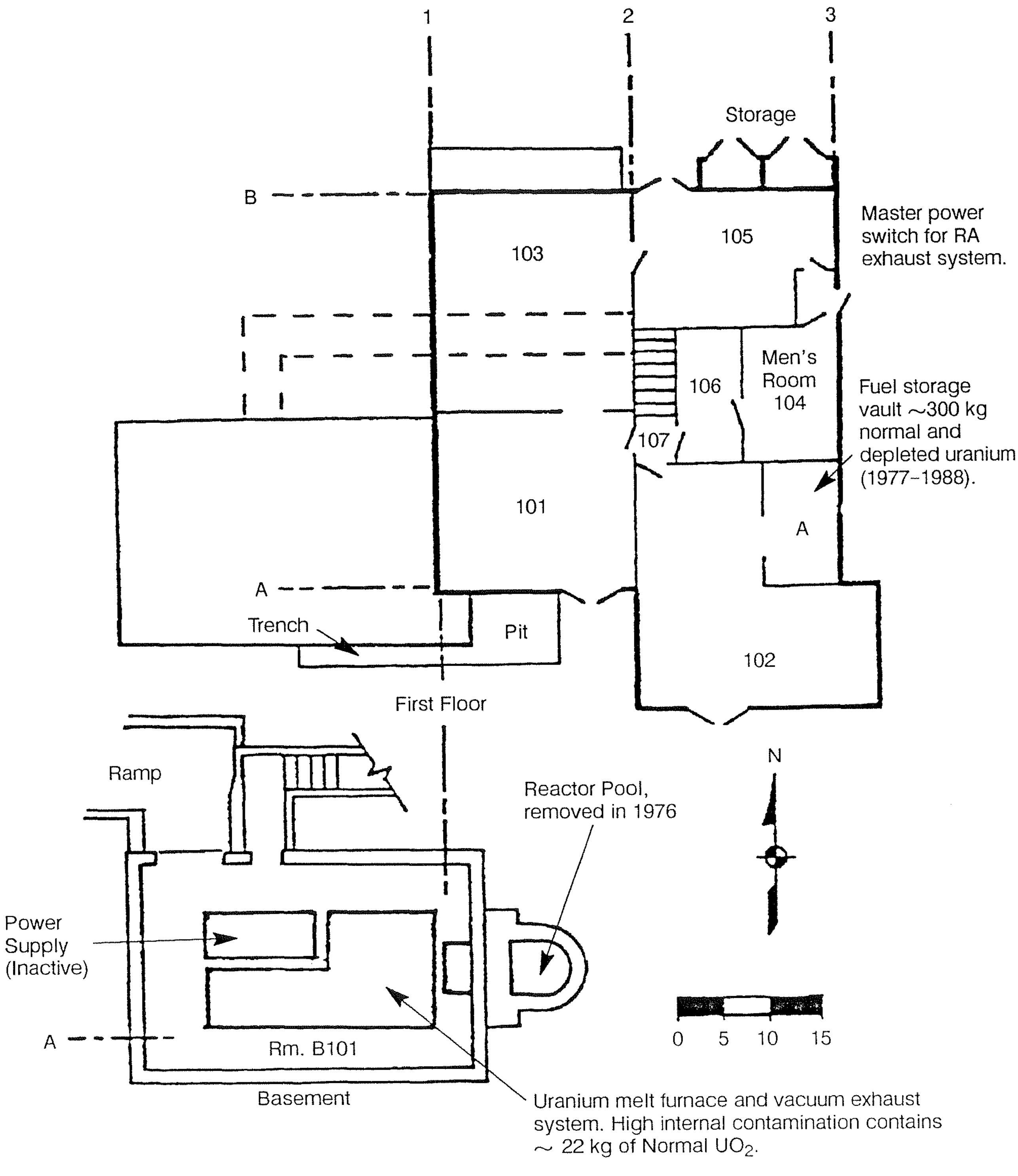

Figure 4. Plan View of Building T028 Prior to Decontamination and Above-Grade Demolition (1977–1988)

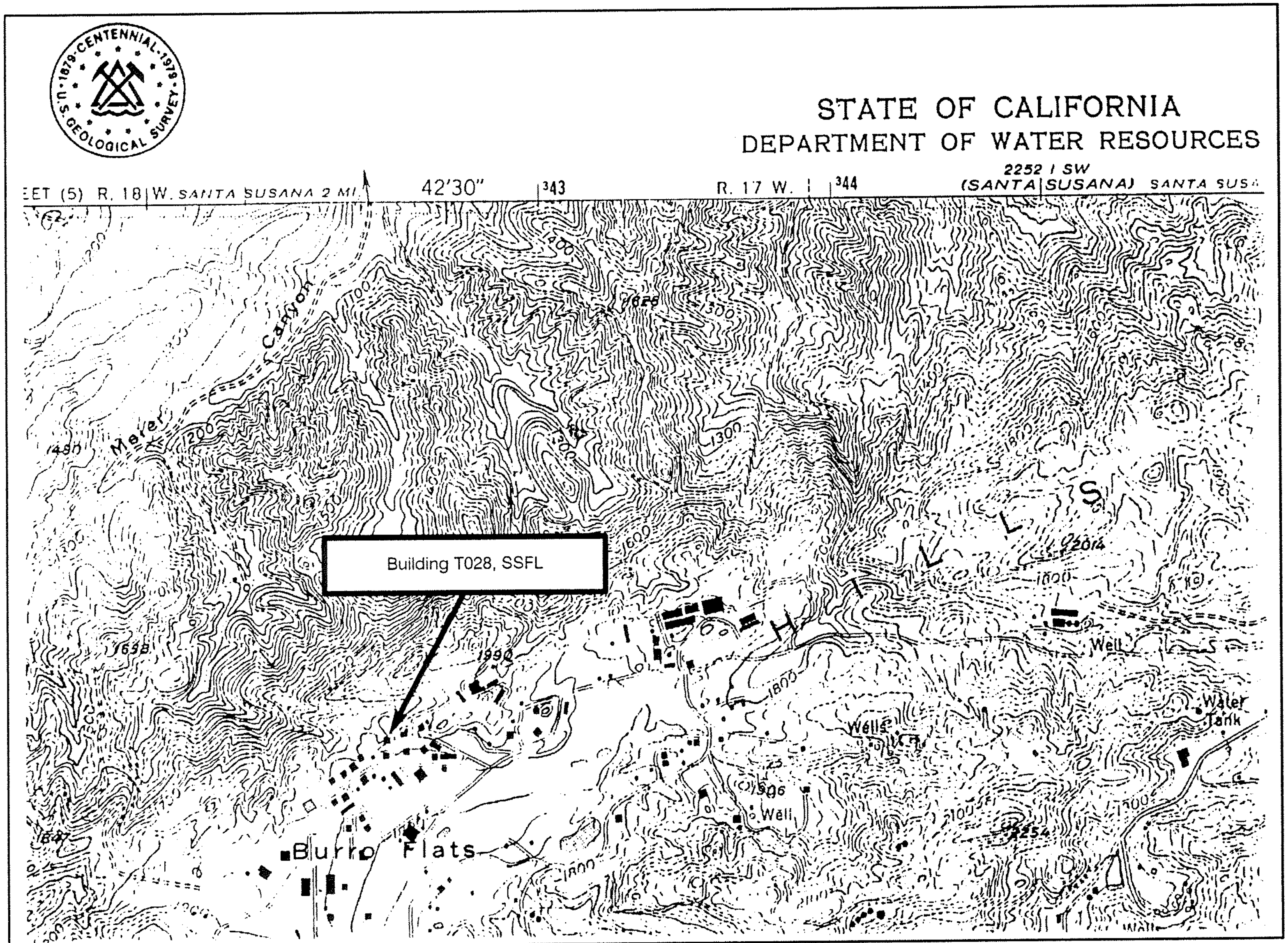

Figure 5. USGS Topographic Map of Portion of Calabasas Quadrangle (Bottom–Left Area Corresponds to the SSFL)

5788–15

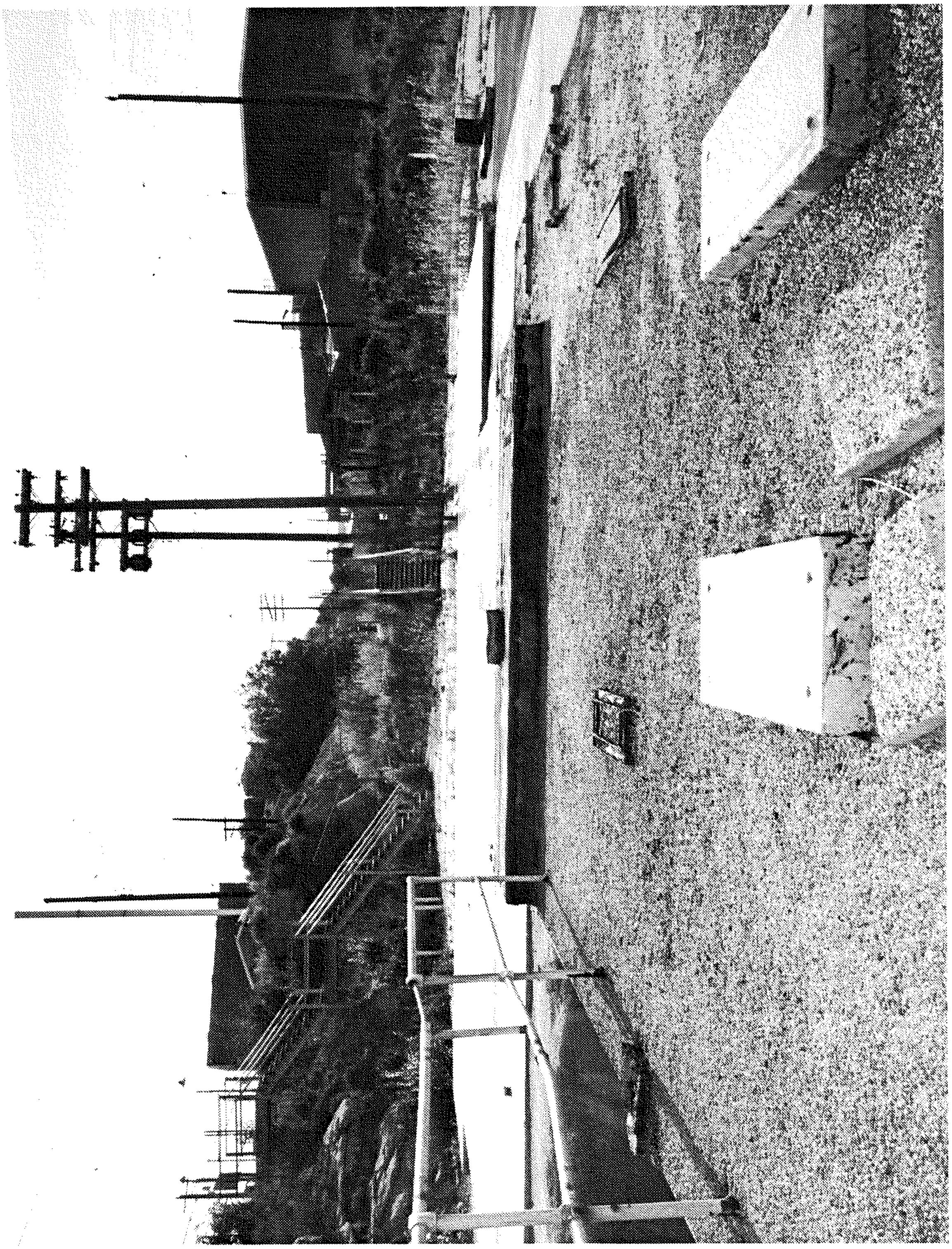

Figure 6. Above-Grade Portion of Building T028 After Demolition

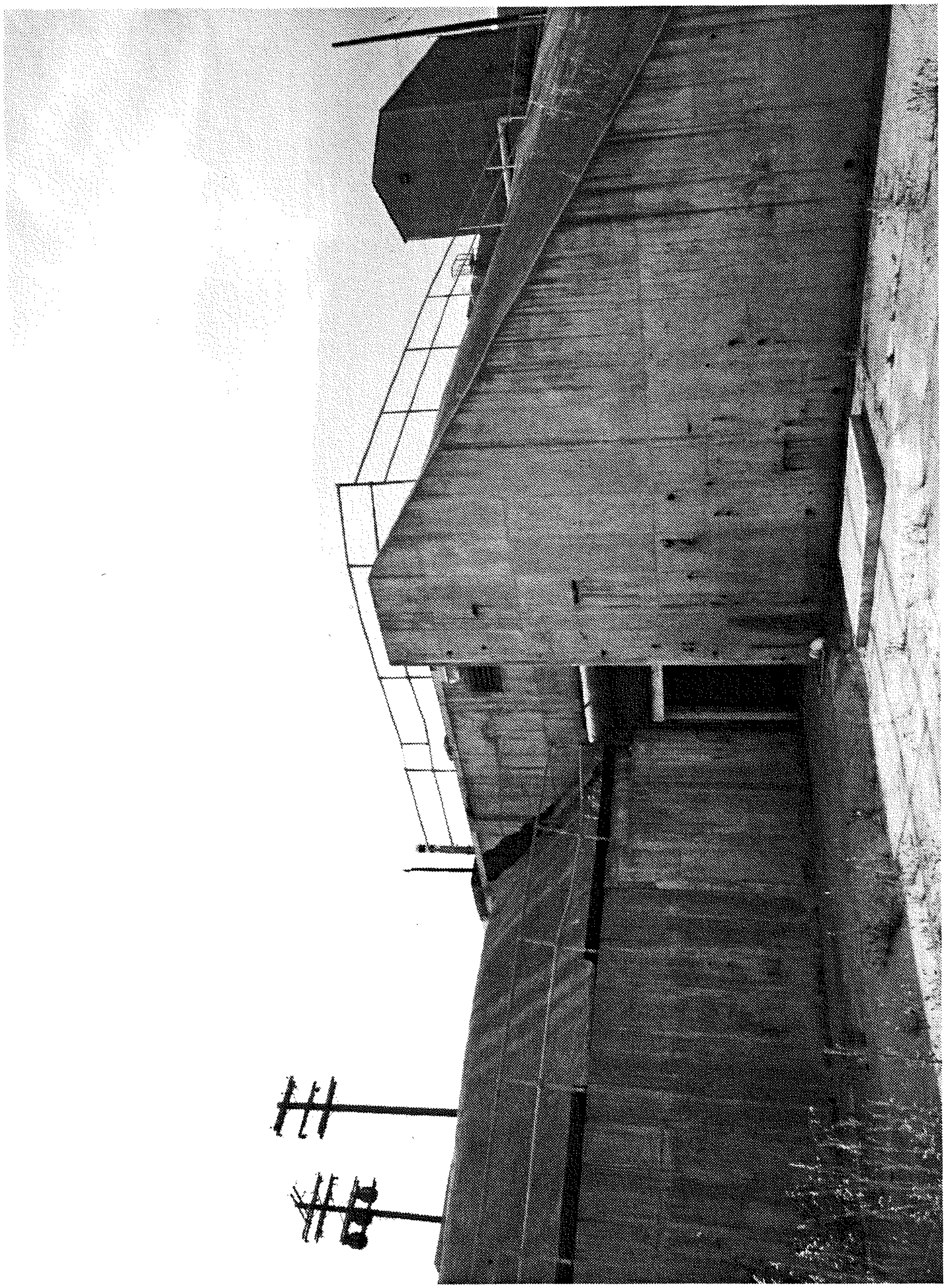

Figure 7. Existing Below-Grade Portion of Building T028

materials . These experiments resulted in some recontamination of various parts of the building that were used for the preparation and the melting of the UO_2. Tests continued intermittently through 1981. Some facility modifications were done after that, and a decision to terminate operations was made in 1984. The building remained inactive, under periodic surveillance, until 1988 when cleanout and decontamination began.

In April 1989 it was determined that there was no remaining radioactive contamination in the above–grade portion of the building and that part of the structure was demolished. Only the concrete floor and the below–grade test vault and stairway currently remain.

2.4 SUMMARY OF DECONTAMINATION ACTIVITIES

Decontamination and decommissioning (D&D) of the Building T028 facility occurred from about July through December 1988. All work was done following approved written procedures. Details of the work are discussed in Ref. 2.

Briefly, the D&D steps involved were (1) removal of surplus normal and depleted uranium oxide; (2) decontamination and removal of equipment and electrical components, including the furnace system used for the uranium–oxide experiments; (3) removal of the R/A ducting system; (4) building surfaces decontamination, including scabbling of Room 101A concrete floor; (5) final miscellaneous cleanup operations; and (6) final radiological survey of the T028 building facility (above–grade and basement).

Following qualitative analysis of the final radiological survey data, which showed no residual radionuclide contamination above acceptable levels (Ref. 3), the building was released to Taylor Wrecking Co. for demolition and removal of the above–grade structures. The structure demolition and removal work was completed in July 1989.

All radioactive waste from the facility D&D was sent to the RMDF for packaging and shipment to Hanford, Washington. A total of about 1,200 ft^3 of waste was shipped to Hanford.

3.0 SCOPE OF SURVEY

The scope of the decontamination and decommissioning (D&D) survey included radiological inspections of the interior above-grade building areas and the basement area which had been used previously for uranium-oxide melting experiments. With the exception of Rooms 102 and 102A, all above-grade interior rooms were inspected by indication-only surveys with a μR survey meter and with a thin-window pancake GM survey meter. No activity above background levels was observed in these areas.

Rooms 102, 102A, and the basement (Room B101), which had potential for uranium and activation product contamination, were quantitatively characterized by measuring total and removable alpha/beta activity on surfaces, and ambient gamma exposure rates 1 m above the floor. Total and removable alpha/beta activity was measured in 67, 1 m^2 wall, floor, and ceiling locations, and in 30 selected areas covering several structural features remaining in B101. Gamma exposure rates were measured in 29 floor grids, ranging in size from ~1 m to 2.4 m in size.

Total and removable alpha/beta surface contamination is reported in disintegrations per minute per 100 cm^2 area (dpm/100 cm^2). Indication-only alpha/beta measurements are reported as No Detectable Activity (NDA), or less than 20 or 50 dpm/100 cm^2, respectively. Ambient gamma exposure rates are reported in micro-roentgens per hour (μR/h). All quantitative data were statistically analyzed against appropriate residual contamination acceptance limits.

3.1 UNRESTRICTED-USE ACCEPTANCE LIMITS

Comparison of the survey data with unrestricted-use acceptance limits was performed using a statistical sampling inspection by variables. This approach is discussed further in Section 4. Acceptance limits for contamination and gamma exposure rates are those prescribed in DOE guidelines (Ref. 4), Regulatory Guide 1.86, NRC license SNM-21, and other references.

Typically, the lowest (most conservative) limits are chosen. Table 1 shows the composite of conservative limits derived from the aforementioned references and adopted by Rocketdyne with respect to Building T028.

Two limits are indicated for ambient gamma exposure rate. The first, 5μR/h above background, applies to large open areas outside buildings or to the interior of buildings with standard concrete slab floor and standard above-grade construction. For areas either largely or totally surrounded by concrete, such as shielded basement rooms, a somewhat modified approach can be taken, and this is discussed below.

3.1.1 Radiation Exposure Limit in Concrete Vaults

The State of California Radiologic Health Branch has recognized the difficulty in determining the exposure rate corresponding to "natural" background in a concrete vault. An approximate estimate has been developed by the State, as described in Appendix A, that permits estimation of the interior background as being 3 μR/h greater than the outside background. This discussion also presents the consideration that because of the all–encompassing nature of a concrete vault, 10 μR/h at one meter from a surface closely corresponds to 5 μR/h from a single plane area, and states that a limit of 10 μR/h may be applied in such circumstances.

Table 1. Maximum Acceptable Contamination Limits

Parameter	Limit
Total surface alpha/beta activity	5,000 dpm/100 cm^2
Removable surface alpha/beta activity	1,000 dpm/100 cm^2
Ambient gamma exposure rate (at 1 m)	5 μR/h above background[a]
	10 μR/h above background[b]

[a] Limit applicable for outside areas or building interiors with standard slab floor and standard above-grade construction. The average background gamma exposure rate at the SSFL has a value of about 15 μR/h with a range (maximum–minimum) of about 4 μR/h. Although DOE guidelines (Ref. 5) recommend a value of 20 μR/h above background for gamma exposure rate, the NRC Dismantling Order for the L–85 reactor decommissioning (Ref. 6) required 5 μR/h above background. For conservatism, 5 μR/h above background is used at Rocketdyne to compare survey results.

[b] Limit applicable for areas such as concrete shielded vaults. For this case, the ambient gamma rate background to be applied is the average outside ambient gamma rate increased by 3 μR/h (see text and Appendix A).

3.2 ACTION LEVELS

Three specific action levels were established for the survey. If the surveyor detected radiation, action was initiated according to the following criteria:

1. **Characterization Level**. 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 resampling of the area 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.

4.0 STATISTICAL ANALYSIS

A statistical procedure is required to validate the applicability of radiological survey data collected at selected locations to an entire area or region. A statistical method known as "sampling inspection by variables" (Ref. 7) was used to analyze the data from the present survey. This method has been widely applied in industry and the military and it is both effective and efficient for cases where destructive tests must be performed (e.g., in quality control) or for cases where the lot size is impractically large. A detailed description of this method is given in Ref. 8. For completeness, however, the technique is summarized below.

In sampling inspections by variables, the number of data points on which measurements are obtained is first chosen to be sufficiently large (greater than ~30) so that the distribution of the data should be normal (i.e., Gaussian). The mean of the distribution, x_m, and its standard deviation, s, then determine a "test statistic," TS, as follows:

$$TS = x_m + ks.$$

TS and x_m are compared with an acceptance limit, U, 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 the "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. 9).

Data from the present survey are 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 a Gaussian distribution.

5.0 SURVEY METHODS AND PROCEDURES

A detailed working procedure was developed and used for the final radiological survey of Building T028 (Ref. 10). Relevant details from this procedure are repeated below.

5.1 SAMPLING PLAN

For the final radiological survey, Building T028 was divided into two general survey areas. These areas were those determined to have potential for radionuclide contamination based on the previous use history of the building. The selected areas were the above-grade rooms 102 and 102A, and the basement test vault, Room B101. Details on the sampling plan for both areas are given below.

For purposes of the present final radiological survey report, total and removable alpha/beta contamination measurements from both areas were treated together as two individual lots for comparison with acceptance limits. Because of expected increased gamma exposure rate in a concrete vault (see Table 1), however, the gamma exposure rate measurements for the above-grade sections (Rooms 102 and 102A) were treated separately from the basement measurements (Room B101).

All other areas of the facility were given an indication-only survey using a μR survey meter and a thin-window pancake GM survey meter. No above normal indications were seen in the indication-only survey.

5.1.1 Walls, Floors, and Ceilings

A minimum of 11% of the total surface area of all walls, floors, and ceilings was surveyed. Measurements for total and removable alpha/beta contamination, and ambient gamma exposure rates, were made in the three sample lots. The sampling inspection plan used was based on a uniform 3-m square grid (9 m^2) superimposed on a uniform inspection area. A 3-m square grid has been adopted to be consistent with NRC and State of California guidance for releasing a facility for unrestricted use. Within each 3-m x 3-m grid, one 1-m x 1-m area was selected for survey. This area was randomly selected, except, that where possible, it was biased toward that area which was expected to have the highest contamination level. To obtain a sufficient number of data points for later statistical analysis, a higher density of sampling grids, within each 3-m x 3-m area, was used for the ambient gamma exposure rate measurements.

A grid was superimposed on walls, floors, and ceilings. Each survey area was designated by its location and number (e.g., F-1 indicates the number 1 floor grid). A drawing was made of each area to clearly show the location of each survey grid. This gridding arrangement resulted in obtaining 67 total and removable alpha/beta measurements and 29 ambient gamma exposure-rate measurements for the T028 facility. Figure 8 shows the basement vault Room B101, with some of the 1-m square survey grids indicated.

Figure 8. Building T028 Test Vault (Room B101) After Decontamination. Evident in the photograph are some of the 1 m square grids used in the final radiological survey.

5.1.2 Structural Surfaces

Structural surfaces consisted of beams, pipes, conduits, and other surfaces that were not amenable to large surface measurements. Except as otherwise noted, for these surfaces, 20% of the surface area was surveyed. Structural surfaces surveyed included the overhead bridge crane and rails, and light fixtures, all in Room B101.

5.2 DATA ACQUISITION

In each selected survey area, total and removable alpha/beta contamination and ambient gamma exposure rates were measured. The exact location within the survey area where the measurements were made was left to the surveyor's judgment; it was to be the area that was most likely to have retained the greatest amount of contamination. This decision was based on surface discoloration, stains, or chemical residues, debris, and crevices or cracks in tile and concrete. This procedure provides a uniform survey biased toward the high end of the distribution. Locations of noticeably greater radioactivity were to be noted. Upon any indication, surrounding locations were to be surveyed.

5.3 DATA REDUCTION

Each radiological measurement data value was input into a spreadsheet code developed at Rocketdyne. This code allows multiple computations to be performed on raw data values. Columns were established to calculate the total, maximum, and removable alpha/beta contamination per 1 m^2 in dpm/100 cm^2 and surface ambient gamma exposure rate in μR/h. The standard deviation of each measurement was also calculated. Software was developed in Microsoft QuickBASIC® to read data from the spreadsheet file and then plot the radiological measurements against the Gaussian cumulative distribution function. For convenience, the distribution function, G(x), is plotted as the abscissa (probability grades), and x, the measurement value, is plotted as the ordinate (linear grades).

Input for this data reduction was:

1. Room number
2. Grid location; e.g., W–1 west wall, grid 1
3. Alpha total activity, averaged over 1 m^2 (counts in 5 min)
4. Alpha maximum activity for hot spot, if present (counts in 5 min)
5. Alpha removable activity from 100 cm^2 smear (counts in 5 min)
6. Beta total activity, averaged over 1 m^2 (counts in 5 min)
7. Beta maximum activity for hot spot, if present (counts in 5 min)
8. Beta removable activity from 100 cm^2 smear (counts in 5 min)

9. Alpha survey instrument background (5 min), efficiency factor (dpm/cpm), and area factor

10. Alpha gas–proportional detector background (5 min) and efficiency factor (dpm/cpm)

11. Beta survey instrument background (5 min), efficiency factor (dpm/cpm), and area factor

12. Beta gas–proportional detector background (5 min) and efficiency factor (dpm/cpm)

13. Ambient gamma exposure rate (counts in 5 min, cpm)

14. Gamma survey instrument background (5 min)

15. Gamma survey instrument efficiency factor (μR/h/cpm)

Output for the Gaussian plots was:

1. Alpha total activity averaged over 1 m^2 and standard deviation (dpm/100 cm^2)

2. Alpha maximum activity and standard deviation (dpm/100 cm^2), only if observed

3. Alpha removable activity and standard deviation (dpm/100 cm^2)

4. Beta total activity averaged over 1 m^2 and standard deviation (dpm/100 cm^2)

5. Beta maximum activity and standard deviation (dpm/100 cm^2), only if observed

6. Beta removable activity and standard deviation (dpm/100 cm^2)

7. Ambient gamma exposure rate and standard deviation (μR/h)

5.4 DATA ANALYSIS

An arithmetic mean and standard deviation of the radiological measurement values is calculated for each data set. The test statistic, $x_m + ks$, is also calculated for each distribution. The acceptance criteria presented in Section 3.2 is applied to each sampling distribution using the acceptance limits given in Table 1.

From the plot of measurement values vs cumulative probability, and assuming a Gaussian distribution of data, the mean radiological value of the lot is the point on the ordinate axis where the distribution intersects the 50% cumulative probability. When an acceptance limit is applied to a test case, a horizontal line is displayed on the graph at the acceptance limit for comparison with the calculated test statistic, TS.

5.5 DIRECT ALPHA/BETA CONTAMINATION MEASUREMENTS

Direct alpha/beta contamination measurements were made using Ludlum model 2220–ESG portable scalers to detect pulses from a Ludlum 43–1 alpha scintillation probe and a Ludlum 44–9 thin–window pancake GM beta probe, respectively.

5.5.1 Instrument Calibration

Each detector was calibrated two or three times daily by the operator (see Ref. 10). The alpha detector was calibrated with ^{230}Th; the beta detector with ^{99}Tc. Background levels were determined by 5–min measurements on a representative area outside the facility survey plan.

5.5.2 Data Acquisition and Reduction

Each location where a measurement was made was identified on a map and in matrix notation. The gross number of alpha and beta counts recorded in 5 min along with the matrix notation location was input into the spreadsheet code. Columns were established to calculate total–average alpha and beta surface activity and the standard deviation (in dpm/100 cm^2) according to Eq. 5–1 and 5–2. Conversion from gross counts observed to dpm/100 cm^2 is given by:

$$SA = \frac{(C - B) \cdot EF \cdot 100}{5 \cdot A} \tag{5-1}$$

where

SA = surface activity
C = total counts in 5 min
5 = count time, min
B = background count in 5 min (generally 0–5 for alpha and about 440–460 for beta)
EF = Efficiency factor, dpm/cpm (averages about 4.8 for alpha and about 3.5 for beta)
100 = 100 cm^2 standard area
A = probe sensitive area (71 cm^2 for Ludlum model 43–1 circular alpha scintillator; 20 cm^2 for Ludlum model 44–9 pancake GM).

Note that the analysis is done using counts rather than count rates. The standard deviation of the measurement in dpm/100 cm^2 is given by:

$$S = \frac{\sqrt{C + B} \cdot EF \cdot 100}{5 \cdot A} \tag{5-2}$$

5.5.3 Data Analysis

Total–average alpha/beta radioactivity in dpm/100 cm^2 per square meter were plotted, in order of magnitude from left to right, against the cumulative probability. The test statistic, $x_m + ks$, was also calculated for the lot, and compared against the acceptance limits in Table 1. Criteria for accepting the area as uncontaminated are presented in Section 3.2.

If the measurements taken are represented by a Gaussian distribution, the data will fall along a straight line. Large breaks or changes in slope in the distribution will indicate some specific areas are contaminated to differing levels.

5.6 REMOVABLE ALPHA/BETA CONTAMINATION MEASUREMENTS

A 100 cm^2 area of each square meter surveyed for fixed alpha/beta contamination was sampled for removable alpha/beta contamination. Each smear sample was placed in a gas–flow proportional counter for analysis.

5.6.1 Instrument Calibration

The Canberra Model 2201 gas–flow proportional counter was calibrated twice daily by the operator (Ref. 10). Alpha efficiencies were determined by using a ^{230}Th calibration source. Beta efficiencies were determined by using a ^{99}Tc calibration source. A "clean" smear–paper was used to determine background radiation levels.

5.6.2 Data Acquisition and Reduction

Gross alpha and beta counts for each sample location were entered into the spreadsheet code. Columns were established for input of instrument efficiency and background. Removable surface activity is converted to dpm/100 cm^2 by the expression:

$$SA = \frac{(C - B) \cdot EF}{5} \tag{5-3}$$

where the appropriate alpha and beta backgrounds and efficiency factors were used. Backgrounds (B) are typically 0–2 counts for alpha and 40–50 counts for beta in a 5–min time period. Efficiency factors (EF) are about 3.5 for alpha and 3.9 for beta.

The standard deviation, s, of this measurement (in dpm/100 cm^2) is:

$$s = \frac{\sqrt{(C + B)} \cdot EF}{5} \tag{5-4}$$

5.6.3 Data Analysis

Removable alpha/beta radioactivity in dpm/100 cm^2 per square meter were plotted, in order of magnitude from left to right, against the cumulative probability. The same analytical criteria apply here as those presented in Section 5.5.3.

5.7 AMBIENT GAMMA EXPOSURE RATE

Measurements of ambient gamma exposure rate were made by using a 1 in. by 1 in. NaI scintillation crystal coupled to a Ludlum Model 2220–ESG portable scaler. This device was mounted on a tripod so that the sensitive crystal was 1 m from the floor. The detector is nearly equally sensitive in all directions, i.e., 4π geometry, and can detect variations in exposure rate down to about 0.5 μR/h, using the digital scaler for a 1-min count time. Because of the natural variability of ambient radiation (particularly outdoors), a 3 to 5 μR/h exposure rate above "background" is considered the practical instrument sensitivity in terms of identifying increased exposure values. At this level, a surveyor would decide to collect additional measurements.

5.7.1 Instrument Calibration

The gamma detection system is calibrated quarterly using ^{137}Cs as the calibration source. A voltage plateau is plotted and the voltage is set at a nominal 800 V. The detector is placed on a calibration range and readings taken at 5, 2, 1, 0.9, 0.5, 0.4, 0.3, and 0.2 μR/h. A detector efficiency plot as a function of exposure rate is then generated.

Because of an exposure rate–dependent effect and because the calibration range does not read less than 200 μR/h, this instrument was cross–calibrated against a Reuter Stokes High Pressure Ion Chamber (HPIC). Count rates were converted to exposure rates using the relationship that 215 cpm = 1 μR/h, at background exposure rates.

Instrument response was checked three times a day using a ^{226}Ra source. The source was placed 1 ft from the detector and counted for 5 min. If the scaler reading fell within ±5% of the nominal value, then the instrument was qualified as operable for the day, under the calibration conditions previously described. Recalibration because of "instrument out of tolerance" was not necessary during the period this survey took place.

5.7.2 Data Acquisition and Reduction

Each location where a gamma measurement was made was identified on a map and in matrix notation. The gross number of counts recorded in 5 min along with the matrix location was put into the spreadsheet code. Columns were established to calculate the total exposure rate (μR/h) and its standard deviation according to Eq. 5–5 and 5–6. Gamma scintillations produced by a NaI detector were converted from gross counts to exposure rate R (μR/h) by:

$$R = \frac{C \cdot EF}{5} \quad (5\text{–}5)$$

where

C = gross counts in 5 min (cpm)
EF = efficiency factor (0.00465 μR/h/cpm) based on cross calibration with the HPIC.

The standard deviation, s, of a single measurement then becomes Eq. 5–6:

$$s = \frac{\sqrt{C} \cdot EF}{5} \quad (5\text{–}6)$$

5.7.3 Data Analysis

Analysis and interpretation of gamma exposure rate data is a five–step process:

1. Plot, in order of magnitude from left to right, total–gross exposure rates in μR/h against cumulative probability for at least three independent areas considered to be "natural background" at SSFL. These survey locations should be from areas where no radioactive material has ever been used, handled, stored, or disposed. If available, these areas should be of similar geologic characteristics to those of the inspected areas. Calculate the average, standard deviation, and range for each distribution. These distributions give the baseline for "natural" variability of exposure rate as a function of SSFL terrain.

2. Plot total–gross exposure rates in μR/h against the cumulative probability for each subject sampling lot. Calculate the average, standard deviation, and range for each distribution. Compare these statistics and probability distributions against "natural background" distributions.

3. Determine if there are any trends indicated by the probability plots of each subject sampling lot which show a potentially contaminated area. If necessary, investigate elevated measurements and/or trends in the distribution.

4. Determine whether the "natural background" distributions adequately represent "ambient background" for the tested areas. Determine if any nuclear–related operations in the local area are influencing "ambient background" in the test area. If so, make corrections.

5. Subtract the estimated "natural background" from each test–area measurement and compare the results against the acceptance criteria listed in Table 1. Use inspection by variables techniques to test for acceptance. Calculate the average, standard deviation, and test statistic, $x_m + ks$, for each test–area distribution. If "ambient background" in the test areas differs from "natural background," correct the data accordingly and retest. Often, "ambient background" is less than "natural background." When this is the case, a better

estimate of "ambient background" is the median gross–total exposure rate value from the same uncorrected data set. The median is an unbiased estimator of "ambient background."

The most critical step in the analysis of gamma exposure rate measurements is assessing what true "ambient background" radiation is for a test area. "Ambient background" accounts for three effects which result in the production of an electronic pulse from the gamma instrument (a count), which under ideal measurement conditions would not occur:

1. "Natural background" radiation from outer space, primordial radionuclides, and global fallout
2. Secondary influence of gamma exposure rate due to nearby facilities which handle radioactive materials or radiation producing machines
3. Instrument noise.

These individual contributions to "ambient background" complicate data interpretation against acceptable limits because both the NRC and DOE criteria for acceptance for unrestricted use are given in μR/h above background. In natural–terrain areas, significant deviations in "natural background" radiation occur as a function of landscape geometry. For example, when the detector is placed near a large sandstone outcropping, the exposure rate may increase by almost 4 μR/h. This increase is due to naturally occurring radionuclides in the sandstone, and a change in source geometry, from a planar 2π–steradian surface to a rocky 3π–steradian surface. "Natural background" is also more variable when measurements are made over, at, or near large metal pieces, scrap components, and other objects. "Natural background" is also different indoors and varies with construction materials, particularly concrete, and typically is higher in concrete–lined rooms.

Once all the best corrections for "ambient background" have been made, resulting distributions are compared against the appropriate acceptance limit. The test statistic, $x_m + ks$, is calculated for each distribution. Statistical acceptance criteria presented in Section 3.2 then apply.

6.0 SURVEY RESULTS AND DISCUSSION

A radiological survey of Building T028 was performed using the survey plan described in Ref. 10, and outlined in Section 5. Three sample lots were established for analyzing and interpreting radiological data: (1) total and removable alpha/beta activity measurements for the whole facility, (2) ambient gamma exposure rate measurements for the above–grade section of T028, and (3) ambient gamma exposure rate measurements for the basement section of T028.

Analytical interpretation using Gaussian statistics of gamma exposure rate measurements and total and removable alpha/beta contamination measurements show slight contamination in some areas, but at levels far below acceptance limits. Further investigation is not required in any location.

6.1 INDICATION–ONLY SURVEYS

As part of the final release survey, indication–only surveys were first conducted using a μR survey meter and a pancake GM survey meter to search for contamination in those areas not specifically selected for grid measurements in the survey plan. No detectable activity (NDA) was observed in any of these areas.

6.2 GRID MEASUREMENTS

Total and removable alpha/beta activity was measured in 67 floor, wall, and ceiling locations in Rooms 102, 102A, and B101. Ambient gamma exposure rates were measured in 29 floor locations in the same areas. The results of all these measurements are listed in Appendixes B and C and summarized in Table 2. The table shows four parameters for each of the three data sets: average value, maximum value, standard deviation of the distribution, and the test statistic TS ($TS = x_m + ks$).

6.2.1 Total Alpha/Beta Activity

Total alpha/beta measurements were made in all of the 67 survey grid locations, including 14 locations in Room 102, 16 locations in Room 102A, and 37 locations in the basement room B101. These data are shown plotted vs the cumulative probability in Figures 9 and 10 (negative values occur when the observed count is less than the value adopted for background). As is evident in Figure 9, there is some deviation from a Gaussian distribution, with a few possible outliers. No outliers are evident in the total beta data set in Figure 10.

These same two data sets are shown on reduced scales in Figures 11 and 12 to more clearly display the survey results relative to the acceptance limits. Here, the appropriate acceptance limit of 5,000 dpm/100 cm^2 is shown as the top limit of each graph. As is clear, both data sets show TS values which are well below the acceptance limit, and

Table 2. Summary of Survey Results for Building T028

Data Set	Data Points	Average Value	Maximum Value	Standard Deviation	Test Statistic	Acceptance Limit
Total alpha (grids)[a]	67	12.3	72.8	15.9	36.2	5,000
Total beta (grids)[a]	67	523	1,303	413	1,148	5,000
Removable alpha (grids)[a]	67	5.1	109	18.7	33.3	1,000
Removable beta (grids)[a]	67	14.7	307	49.7	89.9	1,000
Ambient gamma (102, 102A)[b]	16	0.2	1.0	0.6	1.3	5
Ambient gamma (B101)[c]	13	-0.7	2.3	2.2	3.4	10
Removable alpha (structures)[d]	30	1.3	14.7	3.0	6.2	1,000
Removable beta (structures)[d]	30	11.8	50.4	12.2	31.8	1,000

[a] Total and removable alpha/beta measurements on 67 grid locations in Rooms 102, 102A, and B101.

[b] Background subtracted ambient gamma exposure rates in the above-grade Rooms 102 and 102A. The ambient background gamma rate subtraction was 11.2 μR/h, which is the median of the data set (see text).

[c] Background subtracted ambient gamma exposure rate in basement room B101. The ambient background gamma rate subtraction was 17.9 μR/h (see text).

[d] Removable alpha/beta measurements on various structures remaining at the facility.

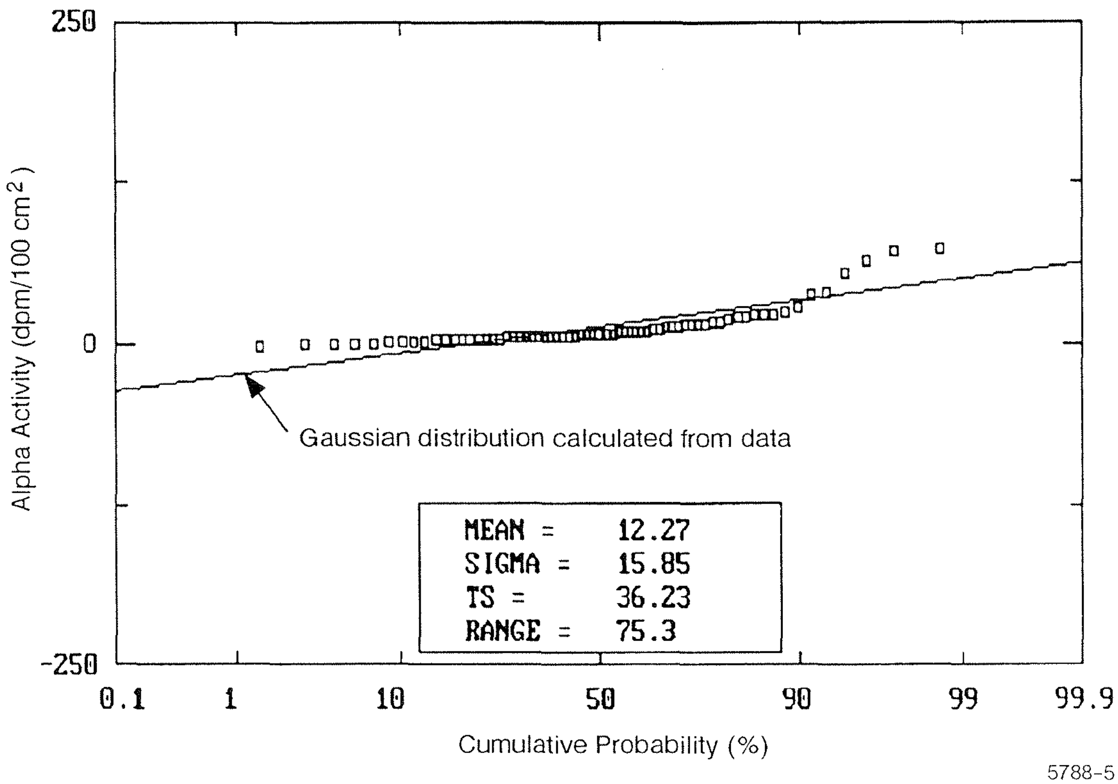

Figure 9. Total Alpha Activity in T028 Survey Grids

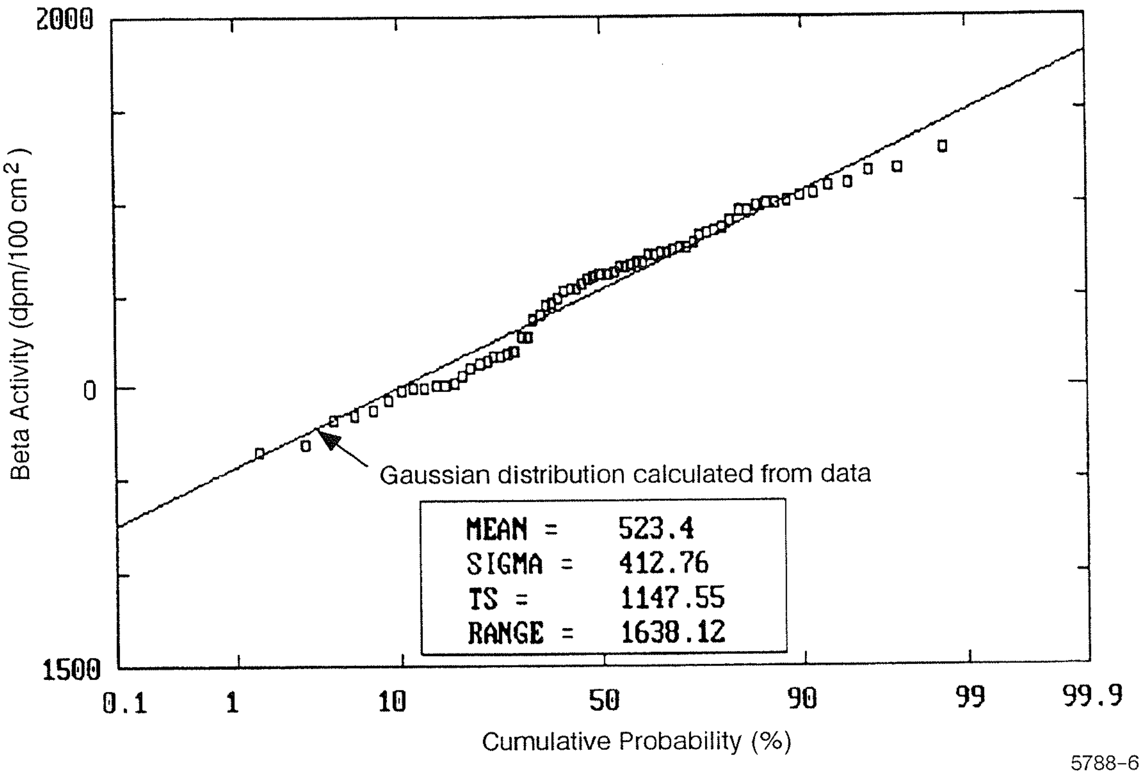

Figure 10. Total Beta Activity in T028 Survey Grids

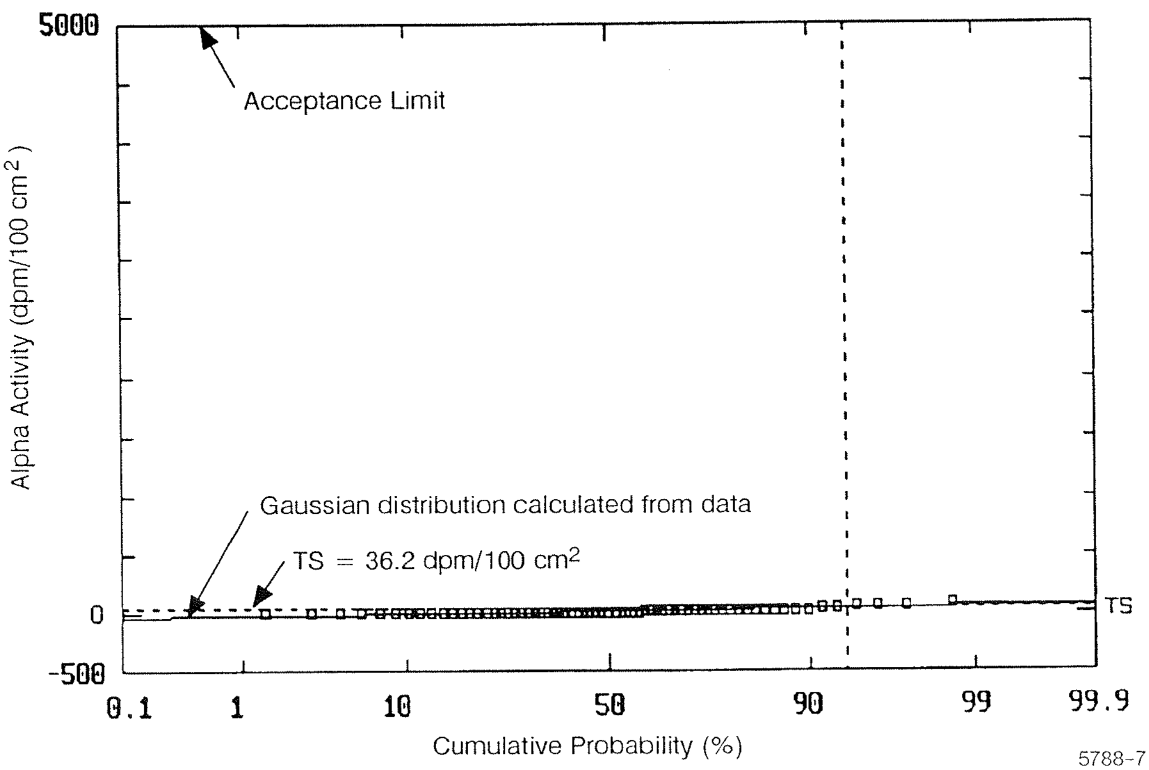

Figure 11. Total Alpha Activity in T028 Survey Grids–Reduced Scale

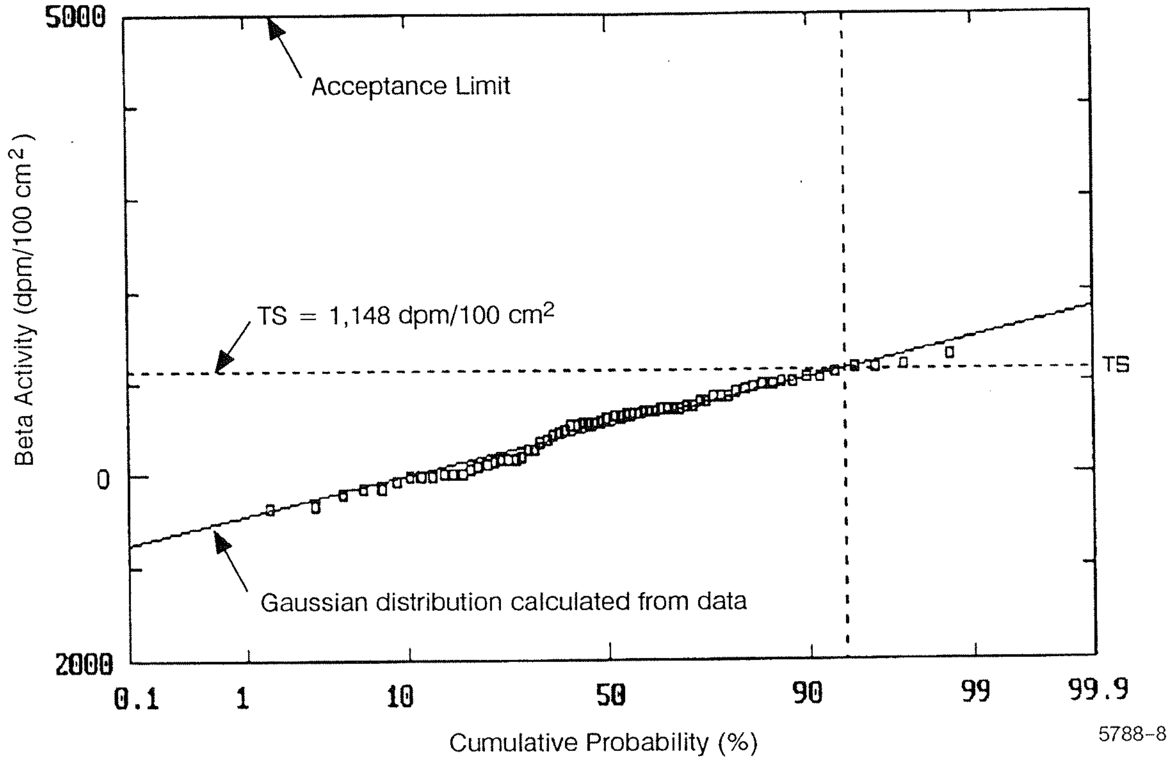

Figure 12. Total Beta Activity in T028 Survey Grids–Reduced Scale

indicate no need for further action. The reduced–scale plot of the data in Figure 11 clearly show that the few potential alpha outliers indicated in Figure 9 are of no regulatory concern.

6.2.2 Removable Alpha/Beta Activity

Removable (smear) alpha/beta measurements were also conducted in all 67 survey grid locations. These data are shown plotted vs the cumulative probability in Figures 13 and 14. As was the case in Figure 9, there is some deviation from a Gaussian distribution in both data sets, with several outliers.

The removable alpha and beta data sets are shown on reduced scales in Figures 15 and 16. Here, the appropriate acceptance limit of 1,000 dpm/100 cm^2 is shown as the top limit of each graph. Again, both data sets show TS values well below the acceptance limit, and indicate no need for further action. The few potential outliers, indicated in Figures 13 and 14, are far below levels that are of regulatory concern.

6.3 AMBIENT GAMMA EXPOSURE MEASUREMENTS

Ambient gamma exposure rate measurements were made in 29 grid locations, including 16 locations in Rooms 102 and 102A, and 13 locations in Room B101. Because of expected differences in natural background gamma exposure rates in the above–grade vs

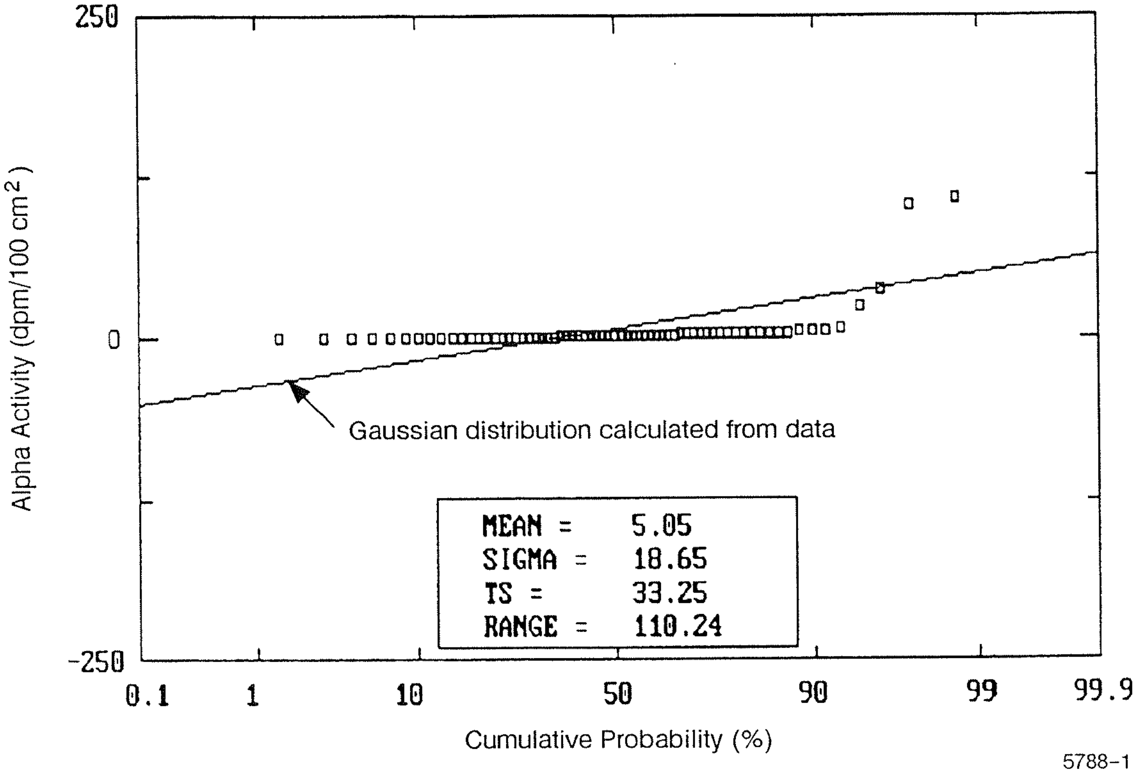

Figure 13. Removable Alpha Activity for T028 Survey Grids

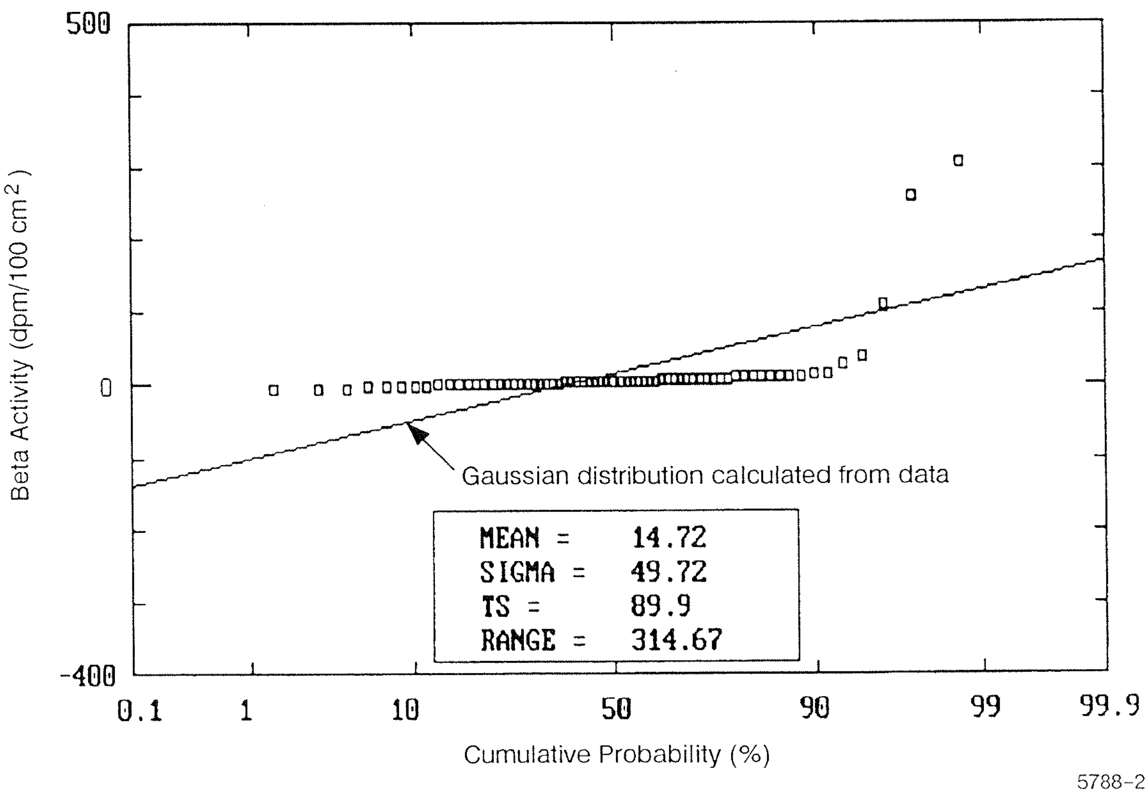

Figure 14. Removal Beta Activity for T028 Survey Grids

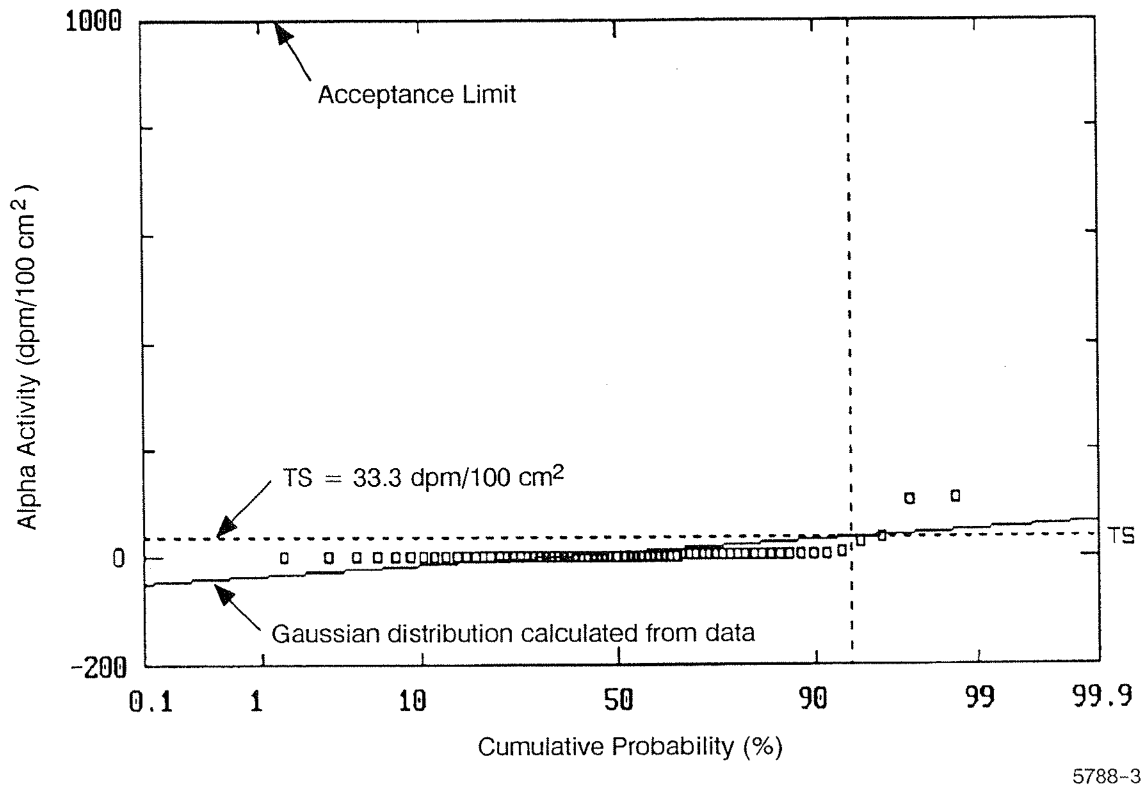

Figure 15. Removable Alpha Activity in T028 Survey Grids – Reduced Scale

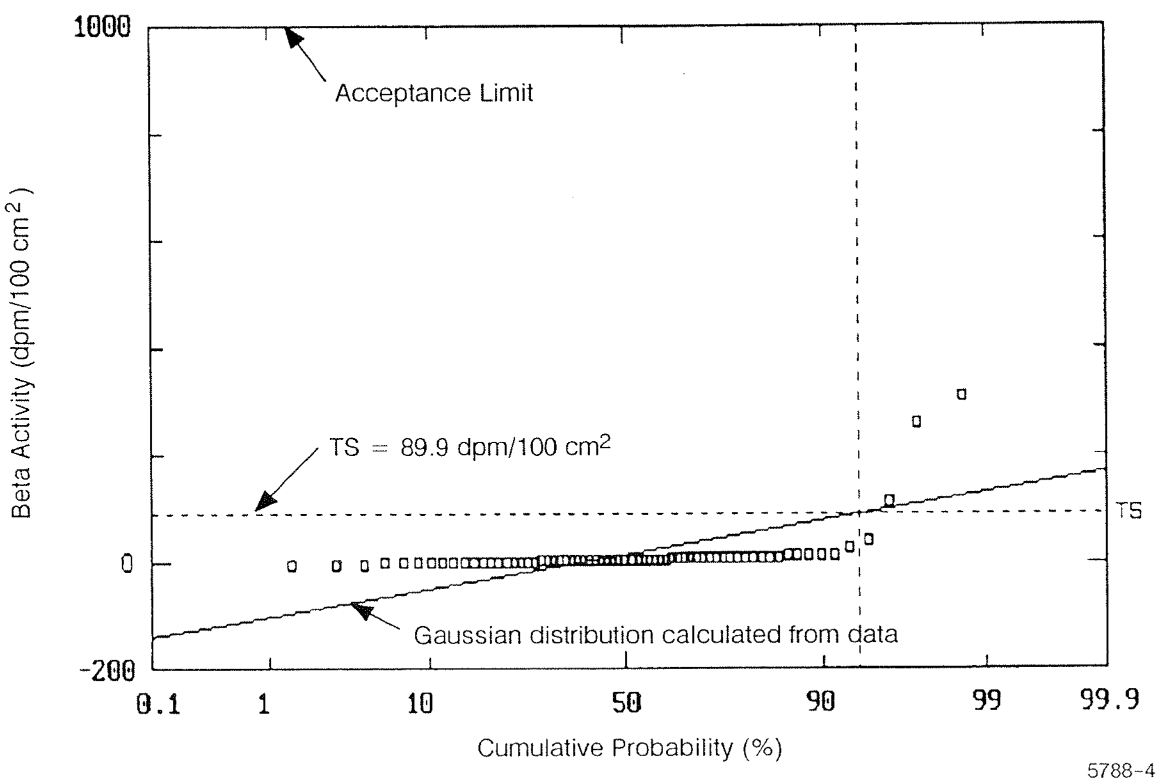

Figure 16. Removable Beta Activity in T028 Survey Grids – Reduced Scale

the basement area, the two areas were treated as separate data sets for statistical analysis. Treatment of the data and determination of gamma background levels appropriate to each data set are discussed below.

6.3.1 Background Gamma Exposure Rate at the SSFL

Because the variability in the background gamma exposure rate at the SSFL approaches 3 to 4 μR/h, the choice of a suitable value to use for the background exposure rate is critically important. Ideally, the best approach is to choose an area whose characteristics (geographic, location, etc.) are identical to the area under study. For the present survey, where the two areas of interest included a bare concrete slab floor and a concrete vault, no genuinely suitable "background" area was readily available. Therefore, the approach that was taken here was to average the available background gamma exposure rate data from a variety of areas at the SSFL. The five areas considered and summary data for each are listed in Table 3. All five area data sets have been used in previous radiological surveys at the SSFL and are outdoor areas where no radioactive materials have ever been used, stored, or disposed of.

The first three data sets were from areas specifically chosen based on their known history of use at the SSFL, which effectively precluded the possibility of there ever having been radioactive materials present at the sites. The latter two data sets, on the other hand, were established and used separately during the final radiological surveys of the Old Conservation Yard (a portion of the old Rocketdyne Barrel Storage Yard) (Ref. 11) and the Building T064 Sideyard (Ref. 12). Each of these latter data sets were subsets of gamma survey data taken in 1988 in the immediate vicinity of these two SSFL sites. The data points included in the subsets were taken from a single contiguous area within each

Table 3. Background Gamma Exposure Rates (μR/h) at the SSFL

Location	Data Points	Average Value	Range	Standard Deviation (1σ)
Bldg 309 Area	36	15.6	3.4	0.8
Well No. 13 Road	43	16.2	2.2	0.5
Incinerator Road	35	14.0	1.4	0.4
Old Conservation Yard	75	13.1	4.2	0.8
T064 Side Yard	24	15.5	3.0	0.8
	Average:	14.9	2.8	0.7
	± 1σ	1.3	1.1	0.2

D635-0172

of the larger data sets, where it could be reasonably ascertained that no previous use of radioactive materials had ever taken place.

The combined data in Table 3 give an average outdoor gamma exposure rate background at the SSFL of 14.9 ± 1.3 μR/h (1σ). The range (maximum minus minimum) of measured data from the five data sets varied from 1.4 for the Incinerator Road, to 4.2 for the area east and adjacent to Building T064.

6.3.2 Gamma Exposure Rates for Rooms 102 and 102A

Ambient gamma exposure rates measured in the 16 floor grid locations in Rooms 102 and 102A are presented in Figure 17. The data are plotted vs the cumulative Gaussian probability. The mean measured gamma exposure rate is 11.4 μR/h, with a range of 2.7 μR/h. Comparison with the data in Table 3 shows that this average value is significantly lower than generally observed at the SSFL, although individual data values in the 9 to 10 μR/h range have been observed.

Following the procedure guidelines given in Section 5.7.3, therefore, the median of the data set (11.2 μR/h) was used for a representative (unbiased) background estimate. The resulting background-subtracted gamma exposure rates above-grade in T028 are shown in Figure 18, compared against the appropriate acceptance limit of 5 μR/h shown

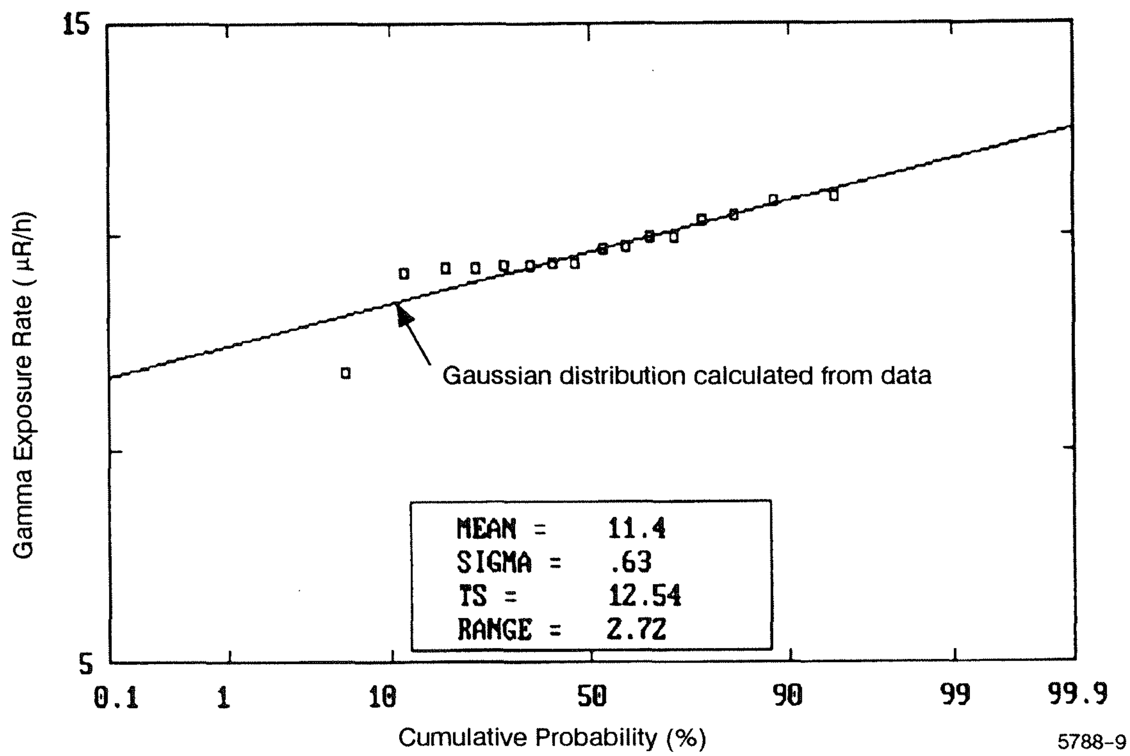

Figure 17. Gamma Exposure Rates for T028 Survey Grids (Rooms 102 and 102A)

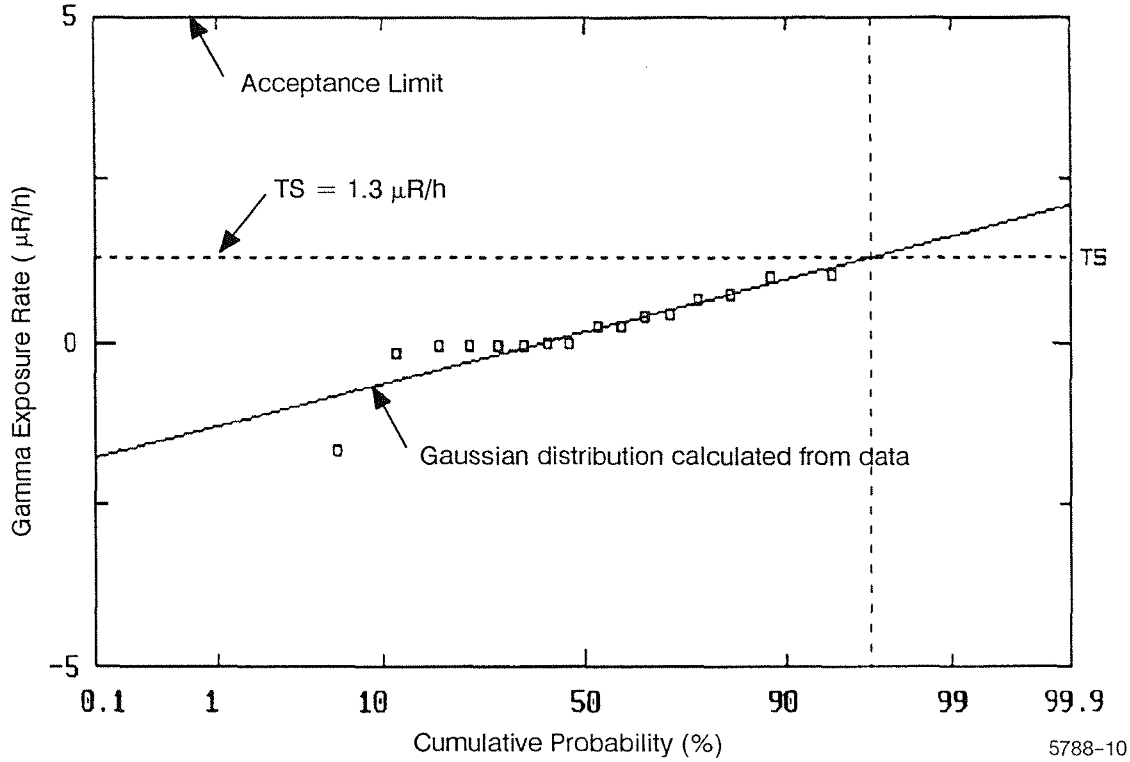

Figure 18. Gamma Exposure Rates for T028 Survey Grids (Rooms 102 and 102A)–Reduced Scale

at the top of the graph. The test statistic for the distribution is 1.3 μR/h, well below the acceptance limit.

6.3.3 Gamma Exposure Rates for Room B101

The second set of gamma exposure rates measured, that for the basement of Building T028, is shown in Figure 19. As expected for a concrete vault, the data set shows values higher than observed above grade. For this distribution, it was appropriate to use an adjusted background level following the method described earlier in Section 3.1.1. This method specifies adding 3 μR/h to the natural ambient gamma exposure rate for the SSFL of 14.9 μR/h, resulting in a background gamma exposure rate of 17.9 μR/h. The method also specifies using the higher acceptance limit of 10 μR/h given in Table 1. The resulting background–subtracted Room B101 data is shown in Figure 20. The test statistic for the distribution is 3.4 μR/h, which is well below the applicable 10 μR/h acceptance limit. Correlation of the measured gamma data with corresponding survey location, however, does indicate a gradient across the room of ~4.7 μR/h. This result is also below the 10 μR/h limit, but, as expected, does indicate some remaining low–level residual activation in the concrete wall section that was adjacent to the previously decommissioned STIR reactor.

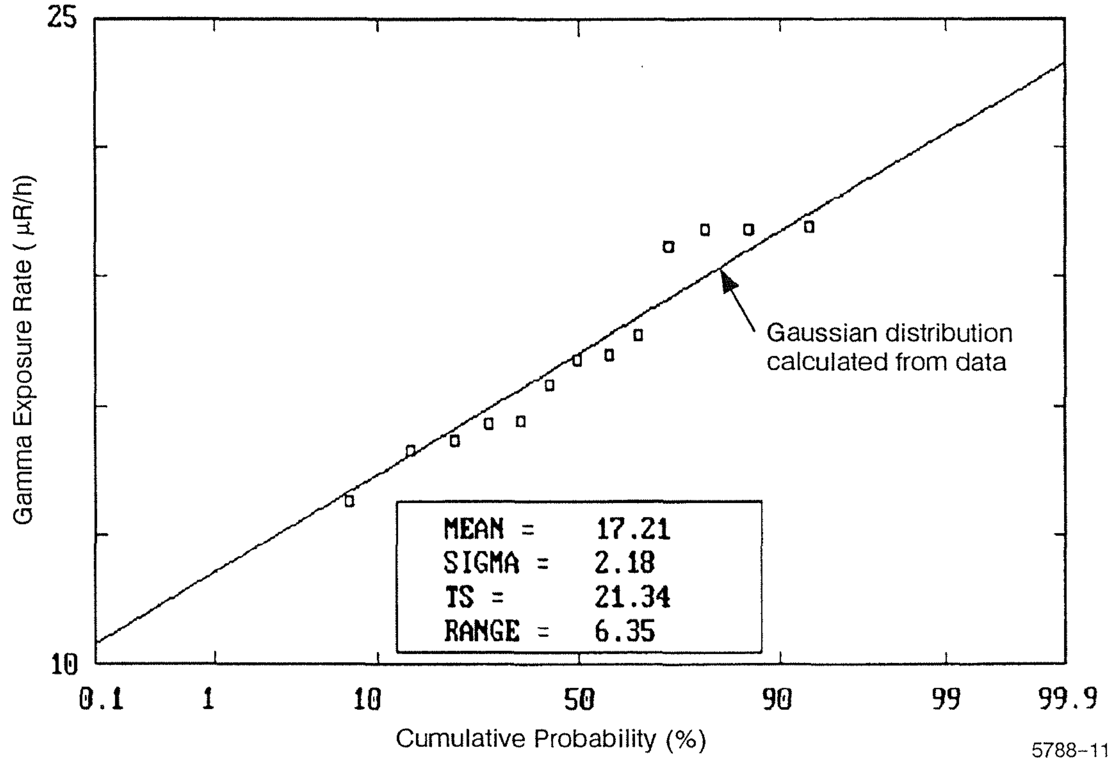

Figure 19. Gamma Exposure Rates for T028 Survey Grids (Room B101)

6.4 ADDITIONAL SURVEYS

Several additional nongridded areas of T028 were surveyed as part of the final radiological release survey. These data are discussed below.

6.4.1 Room B101

Removable alpha/beta surveys were conducted on several special structural surfaces in Room B101. These included the 7–1/2 ton bridge crane and rails (20 smears, 90% survey), and the ceiling light fixtures (10 locations). Results of the smear surveys are shown in Figures 21 and 22 plotted vs the cumulative Gaussian probability and are listed in Appendix C. Figures 23 and 24 show the same data plotted on a reduced scale for comparison with the acceptance limit of 1,000 dpm/100 cm^2. Test statistic values for both data sets are well below the acceptance limit.

6.4.2 HEPA Filter Plenum Foundation

Ground–level surveys were conducted on the concrete foundation beneath the R/A exhaust HEPA filter plenum after removal of the plenum. The survey encompassed 17 grid locations. Survey results were reported as NDA for total alpha/beta, and as <20 and <50 dpm/100 cm^2 for removable alpha/beta, indicating no observable residual radionuclide activity. These results are well below the acceptance limits of 5,000 and 1,000

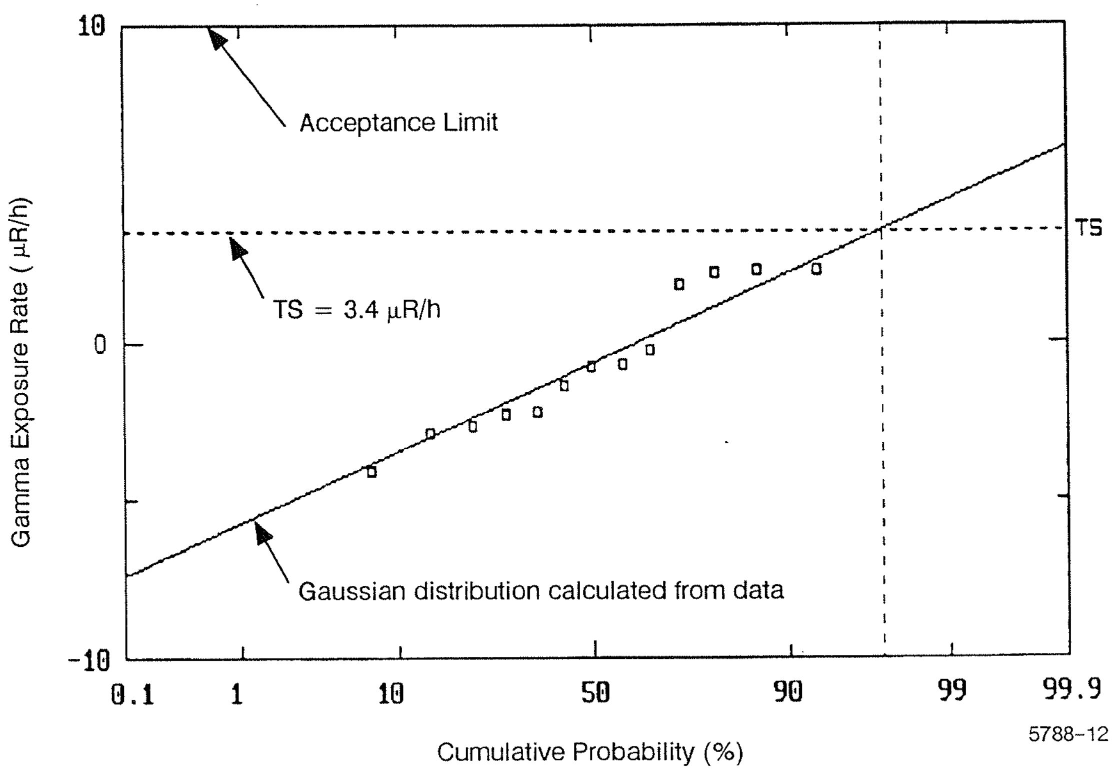

Figure 20. Gamma Exposure Rates for T028 Survey Grids (Room B101)–Reduced Scale

dpm/100 cm^2, respectively, and therefore, no further statistical analysis of these data was performed.

6.5 STATUS OF BUILDING

The above-grade concrete slab floor and the test vault (Room B101) are the only remaining features of T028 still intact. The basement room is currently inactive.

A decommissioning file for Building T028 has been established and is currently archived at Rockwell's SSFL Building T100. Appendix D contains a list of items archived in this file.

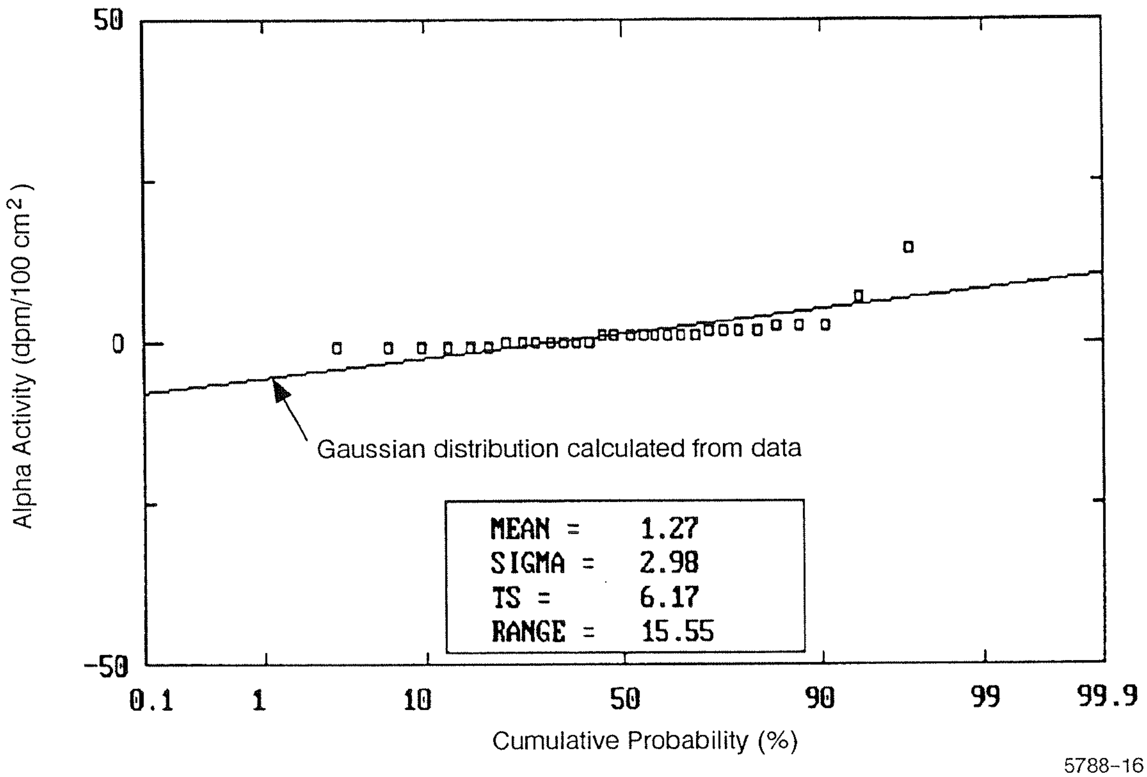

Figure 21. Removable Alpha Activity for B101 Structures

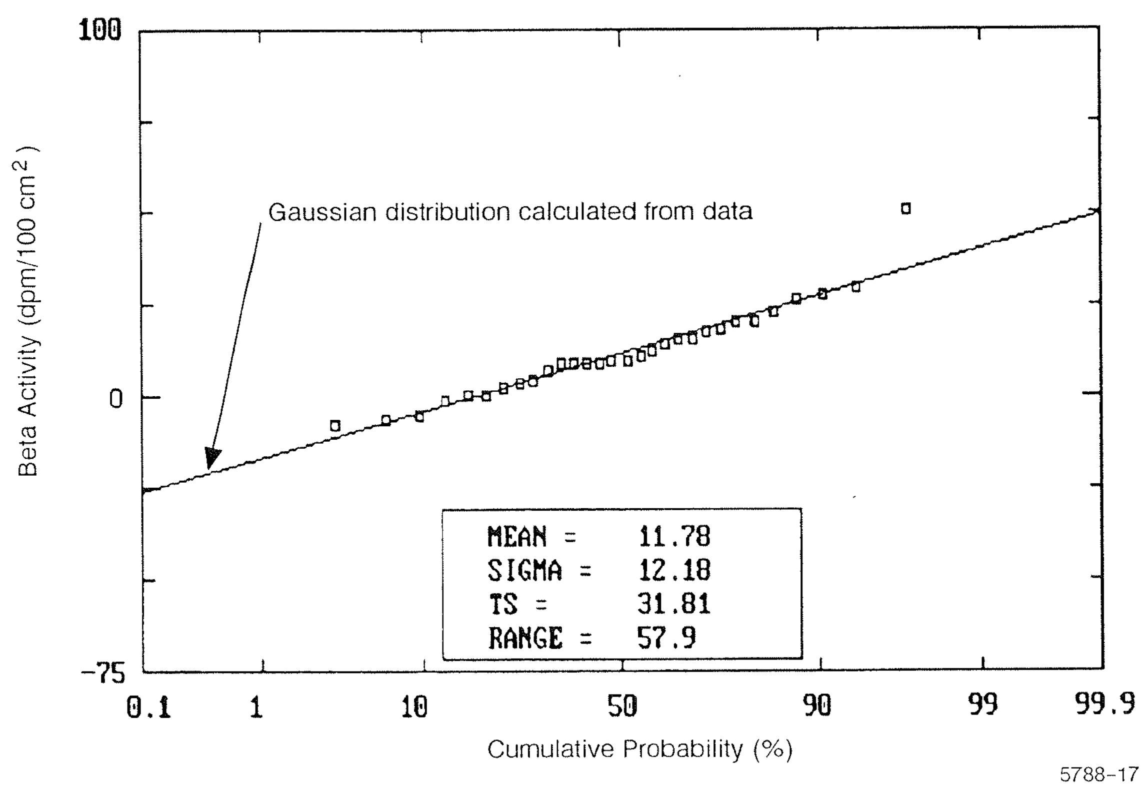

Figure 22. Removable Beta Activity for B101 Structures

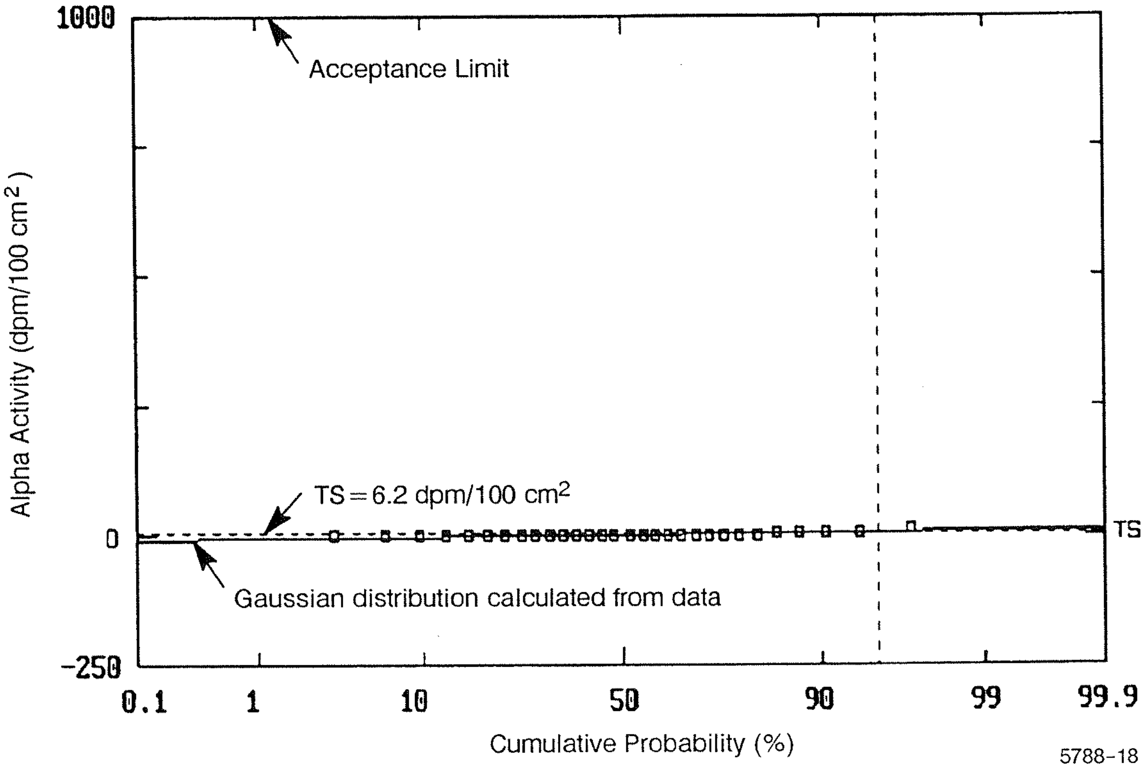

Figure 23. Removable Alpha Activity for B101 Structures–Reduced Scale

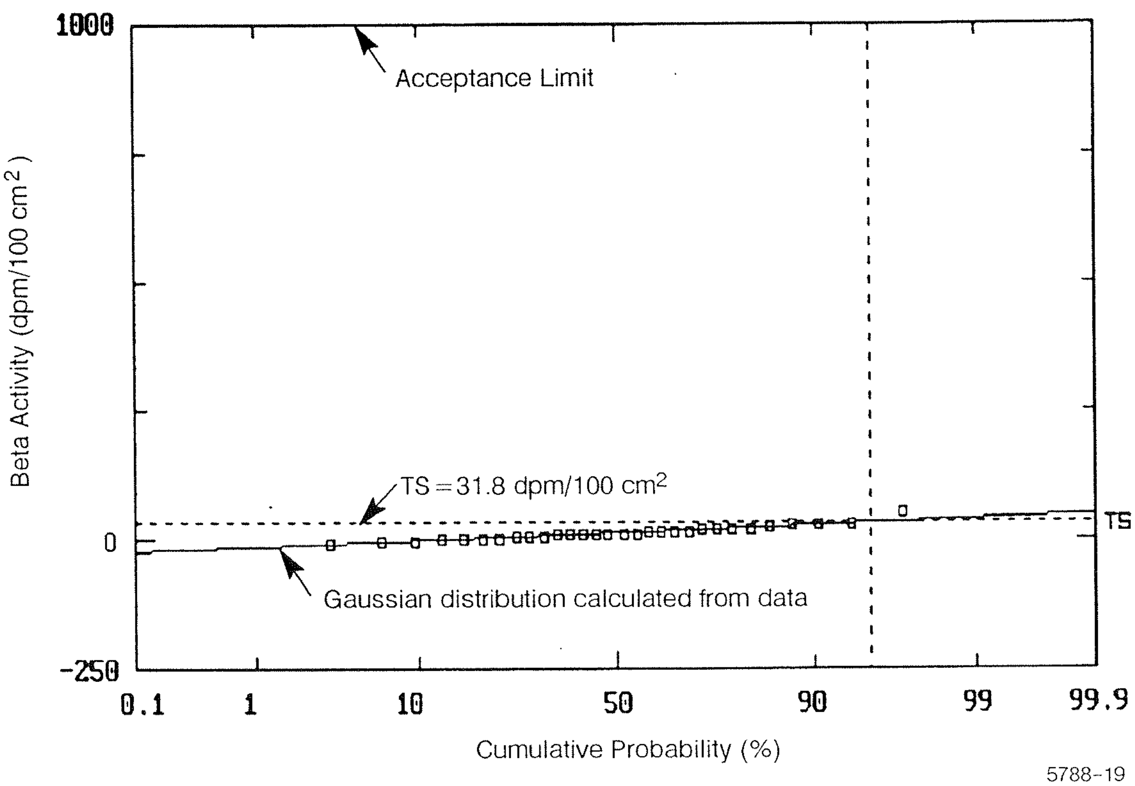

Figure 24. Removable Beta Activity for B101 Structures–Reduced Scale

7.0 CONCLUSIONS

Specific and overall conclusions relating to the current radiological status of T028 are given below.

7.1 SPECIFIC CONCLUSIONS

1. Indication–only radiological survey data on nongridded areas of T028 indicated no detectable residual radioactivity.

2. Total alpha/beta measurements made in 67 grid locations in T028 Rooms 102, 102A, and B101 showed test statistic (TS) values of 36.2 and 1,148 dpm/ 100 cm^2, respectively. Both values are well below the acceptance limit for surface contamination of 5,000 dpm/100 cm^2.

3. Removable alpha/beta measurements made in the same 67 grid locations showed TS values of 33.3 and 89.9 dpm/100 cm^2, respectively. Removable alpha/beta measurements on various remaining structures located at the facility showed TS values of 6.2 and 31.8 dpm/100 cm^2. All values are well below the acceptance limit for removable contamination of 1,000 dpm/100 cm^2.

4. Background–subtracted ambient gamma exposure rate measurements made in 16 grid locations in Rooms 102 and 102A, and 13 grid locations in B101, showed TS values of 1.3 and 3.4 μR/h, both below the applicable acceptance limits of 5 and 10 μR/h, respectively. Some slight residual gamma activity, less than the 10 μR/h limit, was observed near the north wall of B101, presumably from residual activation from the previously removed STIR reactor.

7.2 OVERALL CONCLUSIONS

1. Based on the results of the final radiological survey reported here, the remaining structures at SSFL Building T028 may be released for use without radiological restrictions.

8.0 REFERENCES

1. B. F. Ureda, "STIR Facility, Decontamination and Disposition, Final Report," Rockwell International Report AI-ERDA 13168, August 26, 1976.

2. A. Klein, "Building T028 Decontamination and Demolition Final Report," Rockwell International Supporting Document N001TI000322, June 6, 1990.

3. R. J. Tuttle, "Radiological Status of T028," Rockwell International Internal Letter 495 Il.rjt, April 17, 1989.

4. "Radiation Protection for Occupational Workers," DOE Order 5480.11, Attachment 2, July 20, 1989.

5. "Guidelines for Residual Radioactivity at FUSRAP and Remote SFMP Sites," U.S. Department of Energy Report, February 1985.

6. "Order Authorizing Dismantling of Facility and Disposition of Component Parts," U.S. Nuclear Regulatory Commission, Docket 50–375, February 22, 1983.

7. "Sampling Procedures and Tables for Inspection by Variables for Percent Defect," MIL–STD–414, June 11, 1957.

8. V. A. Swanson, "Building T020 Radiological Survey Procedure," Rockwell International Supporting Document 173DWP000021, May 24, 1988.

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

10. V. A. Swanson, "Building T028 Radiological Survey Plan," Rockwell International Supporting Document N704DWP990095, February 1991.

11. G. Subbaraman and B. M. Oliver, "Final Decontamination and Radiological Survey of the Old Conservation Yard," Rockwell International Supporting Document N704SRR990030, August 16, 1990.

12. G. Subbaraman and B. M. Oliver, "Final Decontamination and Radiological Survey of the Building T064 Side Yard," Rockwell International Supporting Document N704SRR990031, October 30, 1990.

APPENDIX A

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF HEALTH SERVICES

714 P Street
Sacramento, CA 95814
(916) 445-0931

February 7, 1986

RE: 1. Radioactive Materials License No.

2. "Initial Radiological Survey and Analysis - Facility", dated September 12, 1985.

3. "Final Radiological Survey, ", dated December 6, 1985.

Dear :

Upon review of the above referenced information, the Department is unable to concur with the conclusions made in the "Final Radiological Survey, ".

Your Plan describes your: (a) removal of interior activated concrete to a level of approximately 133 pCi/gm and your intent to (b) rubblize this 133 pCi/gm material with other concrete to reduce the concrete average concentration to 13.3 pCi/gm, and then (c) bury this aggregate mixture at 1 to 1.5 meters below the surface at a sanitary landfill.

The staff believes an appropriate method to evaluate the gamma emitting activation products in concrete and rebar for unrestricted release is specified in NUREG-2082 and NUREG-0613c (copy enclosed). Your facility presently exceeds the recommended criteria of 5 uR/hr at one meter from any surface. Because of your facility's interior configuration we estimate that 10 uR/hr at one meter above background inside the structure is a reasonable equivalent to the slab criteria.

Our information shows that interior background levels within concrete normally exceed comparative unconfined background levels by approximately 1-4 uR/hr. The problem of determining background levels may be accomplished by monitoring a similar confinement made of similar material with similar mass.

If no similar structure and material mass can be found, then nearby outside environmentally representative measurement should be taken and modified to reflect the interior concrete mass contribution such that: Measured exterior background + corrective number (~3 uR/hr) = estimated interior background.

A method to evaluate dose rate would be a Reuter Stokes Environmental Radiation Monitor.

If you believe the 10 uR/hr above background contributions is too conservative for measuring radioactivity in a total enclosure to reflect 5 uR/hr contribution from any one surface at 1 meter, then please comment with supporting references and calculations. Likewise, if you believe the 3 uR/hr addition to exterior background levels is in error, please submit your corrective number with supporting documentation.

Sincerely,

Don D. Honey, Chief
Radiation Standards Section
Radiologic Health Branch

Enclosure

APPENDIX B
TOTAL AND REMOVABLE ALPHA/BETA MEASUREMENTS IN T028 GRIDS

RADIOLOGICAL SURVEY DATA

T028 total and removable alpha/beta measurements

		ALPHA (DPM/100CM2)						BETA (DPM/100CM2)						GAMMA (uR/h)	
SAMPLE NAME	GRID NAME	TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	TOTAL	STD DEV	MAX	STD DEV	REM	STD DEV	TOTAL	STD DEV
102	C-1	15.42	5.78			0.38	0.93	-131	93			9.38	5.61		
102	C-2	4.20	4.20			-0.38	0.53	0	95			0.00	4.66		
102	E-1	5.61	4.43			1.89	1.41	-317	89			-1.04	4.54		
102	E-2	4.20	4.20			-0.38	0.53	-154	92			-2.08	4.42		
102	F-1	8.41	4.86			0.38	0.93	732	107			-2.08	4.42		
102	F-2	8.41	4.86			1.13	1.20	540	104			-2.08	4.42		
102	F-3	8.41	4.86			0.38	0.93	356	101			1.04	4.78		
102	F-4	5.61	4.43			1.89	1.41	59	96			8.34	5.51		
102	N-1	14.02	5.61			0.38	0.93	-347	89			7.29	5.41		
102	N-2	2.80	3.96			-0.38	0.53	-7	95			4.17	5.10		
102	S-1	1.40	3.71			-0.38	0.53	20	95			7.29	5.41		
102	S-2	-2.80	2.80			2.65	1.60	-183	92			6.25	5.31		
102	W-1	0.00	3.43			-0.38	0.53	-72	94			0.00	4.66		
102	W-2	4.20	4.20			0.38	0.93	-26	95			5.21	5.21		
102A	C-1	8.16	3.84			1.13	1.20	123	99			1.04	4.78		
102A	E-1	1.36	2.35			0.38	0.93	133	99			3.13	5.00		
102A	E-2	2.72	2.72			-0.38	0.53	7	97			-7.29	3.76		
102A	F-1	6.80	3.60			0.38	0.93	564	106			7.29	5.41		
102A	F-2	10.87	4.30			-0.38	0.53	728	109			7.29	5.41		
102A	F-3	4.08	3.04			-0.38	0.53	1183	116			4.17	5.10		
102A	F-4	6.80	3.60			-0.38	0.53	980	113			3.13	5.00		
102A	F-5	9.51	4.08			-0.38	0.53	1169	116			0.00	4.66		
102A	F-6	12.23	4.51			0.38	0.93	1012	113			0.00	4.66		
102A	F-7	13.59	4.71			-0.38	0.53	721	109			9.38	5.61		
102A	N-1	-1.36	1.36			-0.38	0.53	161	99			3.13	5.00		
102A	N-2	5.44	3.33			0.38	0.93	179	100			-6.25	3.90		

102A	S-1	-1.36	1.36			-0.38	0.53	-14	96			1.04	4.78		
102A	S-2	2.72	2.72			1.13	1.20	98	98			2.08	4.89		
102A	W-1	2.72	2.72			1.13	1.20	189	100			3.13	5.00		
102A	W-2	2.72	2.72			3.40	1.77	161	99			3.13	5.00		
B-101	C-1	2.63	3.22			1.06	1.84	720	119			0.94	4.31		
B-101	C-2	11.83	4.74			2.12	2.12	1002	123			9.40	5.15		
B-101	C-3	2.63	3.22			1.06	1.84	748	119			-0.94	4.10		
B-101	C-4	6.57	3.94			2.12	2.12	952	122			0.00	4.20		
B-101	C-5	6.57	3.94			0.00	1.50	870	121			2.82	4.51		
B-101	C-6	3.94	3.48			3.18	2.37	820	121			10.34	5.23		
B-101	E-1	21.03	5.88			37.10	6.45	601	117			110.92	11.04		
B-101	E-2	3.94	3.48			3.18	2.37	584	117			6.58	4.88		
B-101	E-3	62.31	9.69			109.18	10.86	653	114			257.56	16.12		
B-101	E-4	38.77	7.83			0.00	1.50	755	115			27.26	6.58		
B-101	E-5	72.50	9.90			102.82	10.55	784	117			307.38	17.51		
B-101	F-1	54.53	8.65			2.12	2.12	998	121			1.88	4.41		
B-101	F-10	27.59	6.35			2.12	2.12	525	114			7.52	4.97		
B-101	F-2	69.93	9.73			4.24	2.60	1292	125			11.28	5.32		
B-101	F-3	23.74	5.95			4.24	2.60	1103	122			8.46	5.06		
B-101	F-4	36.57	7.20			4.24	2.60	676	116			5.64	4.79		
B-101	F-5	19.89	5.52			0.00	1.50	900	119			7.52	4.97		
B-101	F-6	21.17	5.67			1.06	1.84	952	120			9.40	5.15		
B-101	F-7	17.32	5.21			0.00	1.50	1043	121			4.70	4.70		
B-101	F-8	14.76	4.89			0.00	1.50	676	116			7.52	4.97		
B-101	F-9	22.45	5.81			0.00	1.50	837	118			5.64	4.79		
B-101	N-1	13.85	5.18			1.06	1.84	265	107			13.16	5.48		
B-101	N-2	4.15	3.66			2.12	2.12	671	114			15.04	5.64		
B-101	N-3	16.62	5.54			24.38	5.30	854	117			38.54	7.34		
B-101	S-1	5.54	3.92			6.36	3.00	755	115			12.22	5.40		
B-101	S-2	2.77	3.39			1.06	1.84	530	112			1.88	4.41		
B-101	S-3	4.15	3.66			3.18	2.37	438	110			4.70	4.70		
B-101	W-1	13.20	4.94			0.00	1.50	388	114			1.88	4.41		
B-101	W-2	7.92	4.17			0.00	1.50	459	115			11.28	5.32		
B-101	W-3	2.64	3.23			1.06	1.84	477	115			-4.70	3.64		
B-101	W-4	7.92	4.17			1.06	1.84	607	117			4.70	4.70		

B-101PIT	E-2	7.13	4.28			0.00	1.50	265	113			-2.82	3.88		
B-101PIT	F-5	19.98	6.05			2.12	2.12	1085	125			1.88	4.41		
B-101PIT	F-6	1.43	3.19			2.12	2.12	649	119			1.88	4.41		
B-101PIT	N-1	1.43	3.19			0.00	1.50	609	118			4.70	4.70		
B-101PIT	S-3	7.13	4.28			-1.06	1.06	629	119			-0.94	4.10		
B-101PIT	W-4	-1.43	2.47			2.12	2.12	1037	124			4.70	4.70		
Maximum:		72.50				109.18		1291.50				307.38			
Minimum:		-2.80				-1.06		-346.62				-7.29			
Average:		12.27				5.05		523.40				14.72			
SD:		15.85				18.65		412.76				49.72			

APPENDIX C
AMBIENT GAMMA EXPOSURE RATE MEASUREMENTS IN T028 GRIDS

RADIOLOGICAL SURVEY DATA

T028 gamma survey data

		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
102	F-1													9.55	0.09
102	F-2													11.23	0.10
102	F-3													11.17	0.10
102	F-4													11.08	0.10
102	F-5													11.66	0.10
102	F-6													11.97	0.11
102	F-7													11.16	0.10
102	F-8													11.63	0.10
102	F-9													11.48	0.10
102A	F-1													11.18	0.10
102A	F-2													11.90	0.11
102A	F-3													12.22	0.11
102A	F-4													11.17	0.10
102A	F-5													11.46	0.10
102A	F-6													11.23	0.10
102A	F-7													12.27	0.11
B101	F-1													15.63	0.12
B101	F-10													20.05	0.14
B101	F-11													20.09	0.14
B101	F-12													19.67	0.14
B101	F-13													20.15	0.14
B101	F-2													14.97	0.12
B101	F-3													15.23	0.12
B101	F-4													15.68	0.12
B101	F-5													13.79	0.11
B101	F-6													16.52	0.12

B101	F-7													17.67	0.13
B101	F-8													17.10	0.13
B101	F-9													17.18	0.13
Maximum:														20.15	
Minimum:														9.55	
Average:														14.00	
SD:														3.30	

APPENDIX D
REMOVABLE ALPHA/BETA MEASUREMENTS ON T028 STRUCTURAL COMPONENTS

RADIOLOGICAL SURVEY DATA

T028 structure surveys (removable alpha/beta)

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
B101CRANE	G-1					1.73	1.73					-7.52	11.40		
B101CRANE	G-2					0.00	1.22					-6.02	11.45		
B101CRANE	G-3					0.00	1.22					6.77	11.87		
B101CRANE	G-4					0.00	1.22					-5.26	11.48		
B101CRANE	G-5					6.91	2.73					9.02	11.94		
B101CRANE	G-6					-0.86	0.86					26.32	12.47		
B101CRANE	G-7					0.86	1.50					2.26	11.72		
B101CRANE	G-8					-0.86	0.86					10.53	11.98		
B101CRANE	G-9					-0.86	0.86					15.79	12.15		
B101LITFX	LF-1					1.73	1.73					50.38	13.18		
B101LITFX	LF-10					2.59	1.93					22.56	12.36		
B101LITFX	LF-2					1.73	1.73					3.76	11.77		
B101LITFX	LF-3					-0.86	0.86					14.29	12.10		
B101LITFX	LF-4					0.00	1.22					9.78	11.96		
B101LITFX	LF-5					0.86	1.50					0.00	11.65		
B101LITFX	LF-6					-0.86	0.86					15.79	12.15		
B101LITFX	LF-7					0.00	1.22					18.05	12.22		
B101LITFX	LF-8					-0.86	0.86					9.02	11.94		
B101LITFX	LF-9					14.69	3.77					0.00	11.65		
B101RAILS	R-1					2.59	1.93					20.30	12.29		
B101RAILS	R-10					0.00	1.22					-0.75	11.63		
B101RAILS	R-11					0.86	1.50					20.30	12.29		
B101RAILS	R-2					0.86	1.50					29.33	12.56		
B101RAILS	R-3					0.86	1.50					4.51	11.79		
B101RAILS	R-4					2.59	1.93					9.02	11.94		
B101RAILS	R-5					1.73	1.73					9.02	11.94		

B101RAILS	R-6					0.00	1.22					17.30	12.20		
B101RAILS	R-7					0.86	1.50					27.07	12.49		
B101RAILS	R-8					0.86	1.50					12.03	12.03		
B101RAILS	R-9					0.86	1.50					9.78	11.96		
Maximum:						14.69						50.38			
Minimum:						-0.86						-7.52			
Average:						1.27						11.78			
SD:						2.98						12.18			

APPENDIX E

LIST OF ITEMS IN THE BUILDING T028 DECOMMISSIONING FILE

The following is a list of the documents on the decommissioning of SSFL Building T028. The documents are archived in SSFL Building T100.

1. V. A. Swanson, "Building T028 Radiological Survey Plan," Rockwell International Supporting Document N704DWP990095, to be released in 1991.

2. A. Klein, "Building T028 Decontamination and Demolition Final Report," Rockwell International Supporting Document N001TI000322, June 6, 1990.

3. Building T028 radiological survey and other supporting data, including Instrument Qualification Reports, survey location maps and diagrams, and Health and Safety Analysis Reports.

4. Spreadsheet data on measurements of total and removable alpha/beta activity, and ambient gamma exposure rate data, measured at T028 as part of the final radiological survey.

5. B. M. Oliver, "Final Decontamination and Radiological Survey of Building T028," Rockwell International Supporting Document N704SRR990033, February 1990.