Site Characterization, Remediation and Health and Safety Plan

For

Former
CLEVITE CORPORATION SITE
East 105 Street, Cleveland, Ohio

Submitted To:

GOULD INC.
Eastlake, Ohio

Submitted By:

SEVENSON ENVIRONMENTAL SERVICES, INC.
2749 Lockport Road
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Revised November 27, 1996

Former CLEVITE CORPORATION Site

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1.0. INTRODUCTION

The intent of this plan is to present the methods and general sequencing of the activities Sevenson Environmental Services, Inc. proposes to employ in order to remediate the former Clevite Corporation Facility at East 105th Street.

The primary objective of this plan is to provide a site characterization plan, termination survey plan and remediation plan for NRC approval. Once the characterization plan is approved by the NRC, the sequencing of subsequent operations is as follows:

a. Performance of the site characterization survey;

b. Submittal of the site characterization survey report for NRC approval;

c. Submittal of a revised remedial plan for NRC approval, if amendment of this Plan is required;

d. Site remediation;

e. Submittal of a final survey report;

f. Performance of a confirmatory survey by the NRC; and

g. Release of the site when confirmatory survey verifies that release requirements have been satisfied.

The remedial action will be performed in a safe, efficient, and economical manner to minimize the potential of human contact with potentially contaminated material by removing this material and transporting it to a Low Level Radioactive Disposal Facility. Upon completion of this remediation, Sevenson will perform a termination survey employing the protocols of NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination", to show that the site meets the criteria for release for unrestricted use.

It is Sevenson's intent to have the termination survey approved before starting the characterization survey so that information obtained during the characterization survey may be used for release and to prevent duplication of survey efforts. Sevenson realizes that data from the characterization survey can be used in the termination survey report only if the area remains undisturbed.

Approval of the characterization and remediation plan by the NRC will operate in lieu of obtaining NRC permits for the remedial work.

2.0. SITE DESCRIPTION/BACKGROUND

The former Clevite Corporation Facility is located at 540 East 105th Street, Cleveland, Ohio. This site is presently owned by Neighborhood Progress, Inc.

Clevite Corporation was a manufacturer of nuclear fuel under an Atomic Energy Commission license, including high-enriched uranium fuel for the U.S. Navy and AEC research reactors, as well as Thorium products. The company ceased fuel manufacturing in the 1960's. A closeout radiation survey by the licensee was accepted by the AEC, and the license was terminated. The 160,000 square foot building was sold in 1991 to Neighborhood Progress, Inc., and has been divided into smaller sections for lease.

On May 27, 1993, a Region III (Chicago) radiation specialist performed a radiation survey at the site which had been identified as a potentially contaminated site in an Oak Ridge National Laboratory review of former AEC and NRC licenses.

The survey identified low-level radioactive contamination in some cracks and crevices in the concrete floor of one portion of the building now occupied by a machine shop.

The machine shop area was surveyed because blueprints in the AEC license file identified it as a fuel manufacturing area. Other areas of the building were surveyed on a

sampling basis, and no contamination was identified. Selected areas outside the building were also surveyed, and no contamination was identified.

The area of thorium use was never identified. As a consequence all areas of the building and environs will have to be assumed to be contaminated with natural thorium. All areas where thorium is present will be decontaminated to thorium guidelines and all other areas will be decontaminated to uranium guideline values.

Based upon its May 27, 1993 survey, the NRC concluded that the first floor machine shop and a few assembly areas were not decontaminated to a residual radiation level consistent with NRC Guidelines. However, the NRC also concluded these radiation levels do not constitute an immediate health and safety problem. Although the NRC believes there is no immediate danger, the NRC believes its measurements exceed NRC limits for unrestricted use.

3.0. CHARACTERIZATION/TERMINATION SURVEY PLAN

3.1 Survey Objectives

The purpose of the final status survey is to demonstrate that the radiological conditions at the former Clevite Site satisfy the NRC guidelines and that the plant site can be released for unrestricted use. The specific objectives of the survey are to show that:

A. **Surface Activity of Buildings & Structures**

1. Average surface contamination levels are within the allowed levels.

2. Small areas of residual activity, known as "hot spots" do not exceed three times the average value. The "hot spot" limit applies to areas up to 100 cm^2. The average activity level within the 1 m^2 area containing a "hot spot" must be within the guidelines.

3. Reasonable efforts have been made to clean up removable activity and the removable activity does not exceed 20% of the average surface activity guidelines.

4. Exposure rates in occupiable locations are less than 5 μR/hr above background. Exposure levels are measured at 1 m from floor and lower wall surfaces and are averaged over floor areas of 10 m^2.

B. **Volume Activity of Soil & Building Materials**

1. Average radionuclide concentrations are within the authorized value. Averaging is based on a 100 m^2 grid area.

2. Reasonable efforts will be made to identify and remove "hot spots" that exceed the average guideline by greater than a factor of the square root of (100/A) where A is the area of the hot spot in m squared.

3. Exposure rates do not exceed 5 μR/hr above background at one meter from the surface. Exposure rates may be averaged over 100m^2 grid areas. Maximum exposure rates over any discrete area of < 100 m^2 may not exceed 10 μR/hr above background.

The above conditions will be demonstrated at a 95% confidence level for each survey unit as a whole. The survey data will be used to calculate the total inventory of isotopes on the site.

3.2. Identity of Contaminates

Based on known licensed operations at the site the isotopes have been identified to be:

U-234
U-235
U-238
Th-Nat or Th-232

Based on the mixture of isotopes that may be present, the following guideline values will be used:

3.2.a. If Thorium is present,

average: 1000 dpm/100 cm^2 averaged over 1 m^2

maximum: 3000 dpm/100 cm^2 applied to < 100 cm^2

removable: 200 dpm/100 cm^2

soil contamination 10pCi/gm

3.2.b. If Uranium only is present:

average: 5000 dpm/100 cm^2 averaged over 1 m^2

maximum: 15,000 dpm/100 cm^2 applied to area < 100 cm^2

removable: 1000 dpm/100 cm^2

soil contamination guidelines for Enriched uranium is 30 pCi/gm and for natural Uranium is 10 pCi/gm

Alpha spectroscopy will be used to determine the isotopic ratios for U-234/U-235/U-238.

The thorium limits will be used as the guideline limits for this project. If it is determined through isotopic analysis that no thorium exists in a given survey area then the uranium limits will be used.

3.3. Organization and Responsibilities

The survey will be performed by a qualified team of Sevenson Environmental employees.

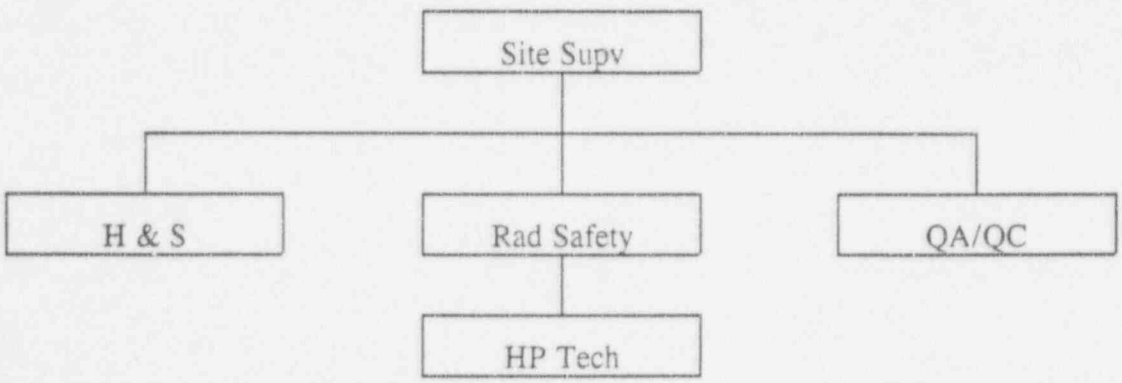
- **Mr. Anthony Certo, Site Superintendent.**
  His duties are overall responsibility for work operations.

- **Mr. Rory Grube, Radiological Safety Officer/Health Physicist.**
  His duties are to supervise and perform radiological monitoring and analysis, review and evaluate radiological surveys, prepare reports.

- **Mr. Scott Wasmer, Health Physics Technician.**
  His duties are to perform radiological monitoring, collect environmental samples, assist in report preparation, enforce site safety and health plan.

- **Mr. Paul Hitcho, CIH, Health and Safety Officer.**
  His duties are to develop implement and update as appropriate, and enforce the site specific safety health and emergency response plan.

- **Mr. John Davis, CHP, QA/QC.**
  His duties will be to coordinate all interface requirements during the survey process, ensure that all aspects of the QA is adhered to. In performance of his QA/QC duties, Mr. Davis will be completely independent of other site duties.



3.4. Training Requirements

The primary purpose of maintaining training requirements is to ensure that all personnel know and understand radiological controls and that all personnel working on the site are aware of their responsibilities in the area of radiation protection to ensure the safe operation of the site and general safety of the public. The best protective measure available to the site is a highly trained and capable work force that employs proper radiological controls in their work environment. Training will meet or exceed all requirements of 10 CFR 19. Specific details of the training requirements are presented in Section 10 of the Health and Safety Plan. All provided training will be documented by Sevenson and certified by recipient.

3.5 Laboratories

Analytical services for smears and air work zone air samples will be performed on site by Sevenson. Soil samples and environmental air samples will be analyzed by Controls for Environmental Pollution, Inc., Santa Fe, NM. The QA coordinator will monitor in-house and contractors laboratory services.

3.6 General Survey Plan

This survey plan consists of systematic processes and procedures that have been deemed acceptable by industry standards and the NRC. Table 1 provides a breakdown of activities.

3.7. Tentative Schedule

Upon receipt of notice to proceed, Sevenson shall initiate on-site mobilization, training, etc., as aforementioned. Approximate times for completion are as follows:

- Mobilization - 2 days.
- Training - all workers will be trained prior to arriving on site with the exception of site specifics. This will take approximately 1 week.
- Radiological surveys for site characterization/termination survey - 3 weeks.
- Site remediation - 2 months
- Final survey report - 3 weeks
- Demobilization - 2 days

3.8. Survey Report

A report describing the survey procedures and findings will be prepared and submitted to the NRC. The report format and content will follow the recommendations contained in NUREG/CR 5849.

Appendix E contains the survey data summaries and statistical analysis of the data, tables E-1 through E-9 and F-1 and F-2.

TABLE 1
OVERVIEW OF MAJOR TASKS AND ACTIVITIES

Evaluate contamination potential

1. Review operating history with respect to facility use, spills, releases etc.
2. Identify radionuclides of concern and determine guidelines.
3. Classify areas as to "affected" and "unaffected".

Establish grid reference system

1. Install grids.
2. Prepare facility survey maps.

Determine background levels

1. Measure indoor exposure rates and ambient beta-gamma levels.
2. Measure outdoor exposure rates.
3. Collect background soil samples.

Perform direct measurements

1. Conduct surface scans.
2. Determine frequency and locations of measurements to meet criteria.
3. Conduct surface activity measurements.
4. Measure exposure rates.

Collect Samples

1. Determine frequency and locations of sampling to meet criteria.
2. Collect systematic and special samples.

Analyze Samples

1. Count smears and swabs.
2. Analyze soil, paint, residue and other solid samples for uranium/thorium activity.

Interpret data

1. Convert data to standard units.
2. Calculate average levels.
3. Compare data with criteria.
4. Compute total residue activity inventory.

Prepare report

1. Construct data tables.
2. Develop graphics.
3. Prepare text.
4. Submit report to NRC.

4.0 SURVEY PLAN & PROCEDURE

4.1 General

Due to the nature of operations conducted at the site, the entire building and surrounding area must be surveyed including the roof of the building. The number of samples taken will be determined by the use and previous assessment. The data for areas not disturbed as a result of this survey will be used to support the termination survey of the site.

4.2 Instrumentation

Table 2 lists the instrumentation to be used for the survey activities, along with typical parameters and detection sensitivities for the instrumentation and survey technique. The combination of instrumentation and technique were chosen to provide a detection sensitivity of 25% or less of the guideline levels.

Sensitivities for scanning techniques are based on movement of the detector over the surface at 1 detector width per second and use of audible indicators to sense changes in instrument count rate. Experience demonstrates that qualified surveyors can detect the levels listed in Table 2 with a 90% confidence level. All instruments will be calibrated a minimum of once every 6 months, using NIST-traceable standards. Calibration will be for the specific uranium radiation energies expected to be present at the site. Operational and

background checks will be performed at least once each 4 hours on instrument use. The check source will be Tc99 for Beta and Th-230 for Alpha.

The basic equations for determining field instrument detection limits are:

Surface Activity Measurement for an integrated measurement over a preset time

$$MDA = \frac{2.71 + 4.65\sqrt{B \cdot t}}{t \cdot E \cdot \left(\frac{A}{100}\right)}$$ (1) MDA	MDA = Activity level in dpm/100 cm2 B = Background cpm t = count time in minutes A = Active probe area in cm^2 E = Detector efficiency

Surface Activity Measurement of a Ratemeter Instrument

$$MDA = \frac{4.65\sqrt{\frac{B}{2t_c}}}{E \cdot \left(\frac{A}{100}\right)}$$ (2) MDA	MDA = Activity level in dpm/100 cm^2 B = Background cpm t_c = meter time constant A = Active probe area in cm^2 E = Detector efficiency

Scanning MDA

$MDA = \frac{3 \bullet Br}{E \bullet A/100}$ **(3) MDA Scanning**	MDA = Activity level in dpm/100 cm^2 Br = Background rate E = Detector efficiency A = Area of probe

Laboratory Analysis of Wipes

$MDA = \frac{2.71 + 4.65\sqrt{B_g \cdot t}}{(t) \cdot (E)}$ **(4) MDA**	MDA = Activity level in dpm/100 cm^2 Bg = Background cpm t = count time in minutes E = Detector efficiency

Table 2

INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

Type of Measurement	Detector	Meter	Background	4π Eff	Detector Sensitivity
Surface Activity alpha	Ludlum 43-68 100 cm² Window Gas Proportional	Ludlum 2221	4 - 5 cpm	20%	100 dpm
Surface Activity Beta	Ludlum 43-68 100 cm² Window Gas Proportional	Ludlum 2221	150 cpm	48%	Scan 1250 dpm Direct 165 dpm
Surface Scan Alpha	Ludlum 43-65 50 cm² Window Scintillation	Ludlum 3 Ludlum 4	1 - 2 cpm	15%	80 dpm
Surface Scan Beta/Gamma	Ludlum 44-9 15.5 cm² Window Pancake	Ludlum 3 Ludlum 4	20 - 40 cpm	19%	2000-4000 dpm
Surface Activity Alpha	Ludlum 43-65 50 cm² Window Scintillatior	Ludlum 3 Ludlum 4	1 - 2 cpm	15%	200 dpm
Surface Activity Beta/Gamma	Ludlum 44-9 15.5 cm² Window Pancake	Ludlum 3 Ludlum 4	20 - 40 cpm	19%	400-800 dpm
Surface Activity Alpha/Beta/Gamma	43-1-1	Ludlum 2224-1	0.2 - 2 cpm α 140 - 160 cpm βγ	27%α 47%βγ	14 - 26 dpm α 163 - 175 dpm βγ
Surface Scan Alpha/Beta/Gamma	43-1-1	Ludlum 2224-1	0.2 - 2 cpm α 140 - 160 cpm βγ	27%α 47%βγ	2 - 17 dpm α 1191 - 1361 dpm βγ
Surface Scan Gamma	1 X 1 NaI	Ludlum 3-97	7 - 10 μR	N/A	4μR

Table 2

INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

Exposure Rates	1 X 1 Organic Crystal	W.B. Johnson Model GSM160 μR Meter	4 - 5 μR	N/A	3μR

DETECTOR SENSITIVITY COMPUTATIONS

Surface Scan Alpha B = 2 cpm E = 0.15 A = 50

$$MDA = \frac{3 \times 2}{0.15 \times 50/100} = 80 \text{ dpm}$$

Static Surface Alpha: B = 2 E = 0.15 $t_c = 0.16$

$$MDA = \frac{4.65 \times \sqrt{2/2 \times 0.16}}{0.15 \times 0.5} = \mathbf{155} \text{ dpm}$$

Surface Scan Beta B = 300 E = 0.19 A = 100

$$MDA = \frac{3 \times 300}{0.19 \times 100/100} = 4736.84 \text{ dpm}$$

Static Surface Activity Beta:

$$MDA = \frac{4.65 \times \sqrt{300/2 \times 0.016}}{0.19 \times 100/100} = 749.35 \text{ dpm}$$

Surface Activity Integrated Time: B = 300 t = 1

$$MDA = \frac{2.71 + 4.65\sqrt{300 \times 1}}{1 \times 0.19 \times 100/100} = 438 \text{ dpm}$$

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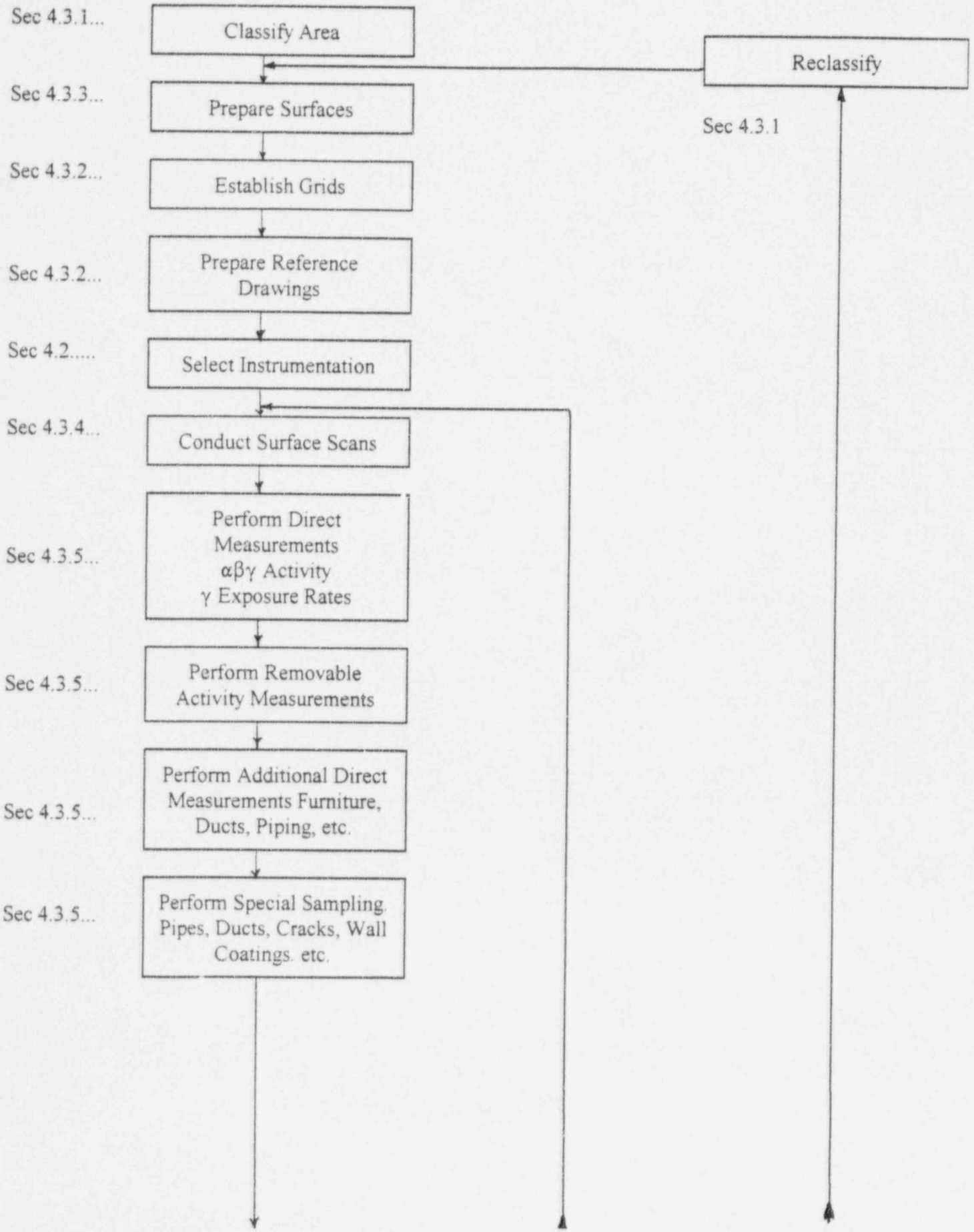
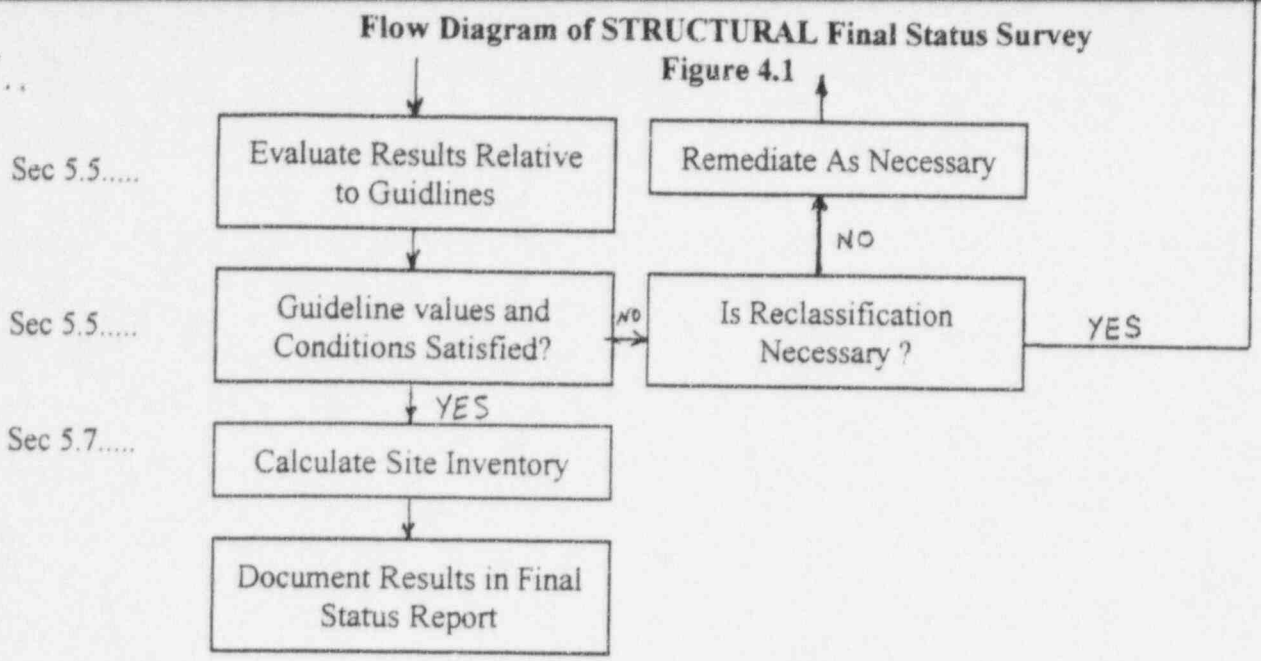
Flow Diagram of STRUCTURAL Final Status Survey
Figure 4.1

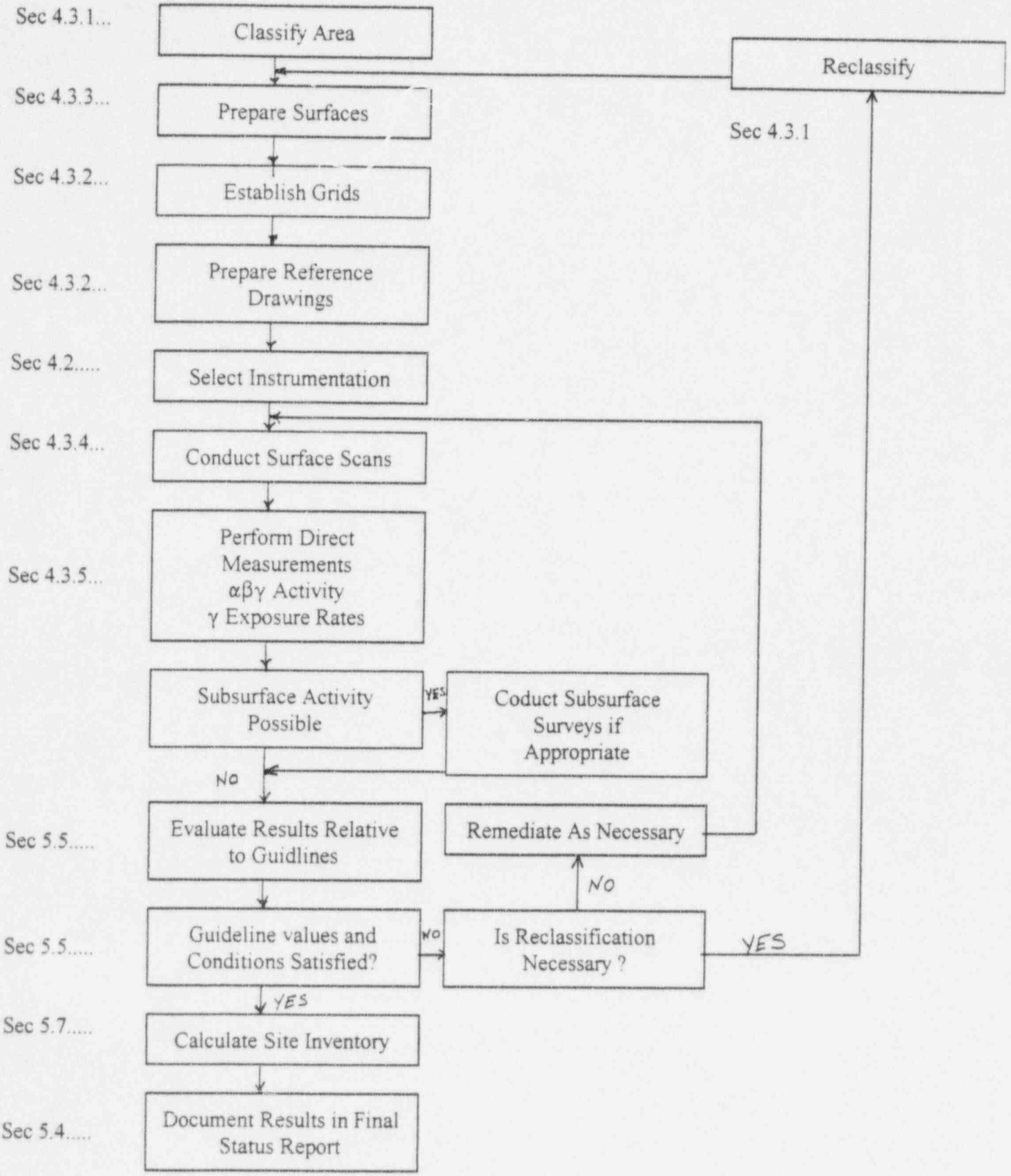


Flow Diagram of STRUCTURAL Final Status Survey

Figure 4.1



Flow Diagram of Site Grounds Final Status Survey
Figure 4.2



4.3.1 Classification By Contamination Potential

(Refer to Figure 4.1 & 4.2)

All areas will not have the same potential for contamination and will not require the same degree of attention to achieve an acceptable degree of confidence that the site satisfies the established release criteria. The two classifications used are affected and unaffected. Classification will be accomplished by examining records of building use. In general, affected areas will include areas where radioactive material was used or stored or where records indicate spills or other unusual events took place. Included in this classification are adjacent areas to the area of use. A preliminary analysis based on prior surveys indicate that the machine shop, including the upper walls and ceiling and hallway adjacent to the machine shop, are affected areas, and all other areas will be unaffected.

Areas identified by scans or direct measurements as exceeding guidelines will be reclassified as affected areas and gridded and resurveyed accordingly. Refer to figures 4.1 and 4.2 for the decision making process. Those areas where the elevated activity is due to fluctuations in background levels will not be reclassified. These areas are identified room by room in section 5. This decision was based on the type of material and the fact that no alpha

contamination existed. It should be noted that both uranium and thorium are alpha emitters.

4.3.2. Gridding and Survey Unit Designation

Affected areas will be divided into 100 m^2 survey units. The floor surfaces and wall surfaces up to 2m in height will be marked off in 1m grids. If it is believed that contamination > 25% of the guideline value exists, then upper walls and ceiling will be gridded.

Unaffected areas will be divided into larger survey units. Due to the complexity of the physical layout of the interior of the building, an on-site determination will have to be made as to size. It is planned to limit the survey units to a maximum of 1000 m2. Thirty survey points will be established in each unit.

If necessary, a grid system will be established to facilitate the identification of survey points.

Land areas around the building will be gridded at 10m intervals.

4.3.3. Surface Preparation

The radiations from Th-232 are predominately alpha and beta radiations. Tile and carpet on the floor can shield out all the alpha and a majority of the beta. If a floor covering has been installed since operations utilizing radioactive material ceased, the tile at the survey point will have to be removed or the carpet lifted in order to conduct a valid survey. In some cases, grease or paint may have to be removed in order to meet the objectives of the survey.

4.3.4. Surface Scanning of Structures

100% of the floor, wall, and ceilings in affected areas will be scanned for alpha, beta, and gamma radiations, including the upper surfaces of exposed duct work and piping. Activity levels will be recorded on prepared diagrams or maps. Scanning speeds will be 1 detector width per second for alpha and beta detection and .5m per second for gamma detection. Residual alpha and beta activity in excess of 3x the guideline value or external radiation in excess of 2x the guideline value above background at 1 meter from the surface will be remediated.

In unaffected areas, 10% of the floor and lower wall surfaces will be scanned and results logged in a prepared diagram or survey map. Scanning speeds will be 1 detector width per second for alpha and beta detection and .5m per second for gamma detection. Grid lines or permanent fixtures will be used for locations. If residual activity in excess of 25% of the guideline values is detected, the unit will be recategorized as affected.

Scans will be made of outdoor areas at 1m above the surface. Ten meter grids will be established for affected areas and 100% of the area will be scanned. Areas of suspected elevated activity will be sampled and analyzed, and the activity compared with the guideline values. This area will be remediated as required.

4.3.5. Surface Activity Measurements

Since our instruments cannot go below 25% of the guideline value for beta, systematic measurements will be made at a spacing of 1m for alpha and beta radiation, and 2 m for gamma radiation. A one minute reading will be taken and recorded in the field log book. A smear for removable activity will be taken at each direct reading location. Q-tips will be used for cracks and holes in the floor for smear tests. If a survey point is determined to have residual activity in excess of the guideline values, five additional direct radiation measurements will be made around the original high reading so as to cover an area of $1m^2$. If the weighted average, as described in Sec. 8.5. of NUREG/CR-5849 is greater than the guideline values, the area will be marked for remediation and resurveyed. Cores of the concrete floor and sub soil will be cut and analyzed if indications show activity going through cracks in the floor. After all survey points in a survey unit are less than the guideline values, a statistical analysis will be performed to insure that sufficient survey points were included in the unit.

Unaffected areas will have a minimum of 30 survey points in each unit, direct readings will be made for fixed and removable radiation. These points will be on all building surfaces, including upper surfaces of exposed duct work and pipes. If residual activity in excess of 25% of the guideline values is measured, the survey unit will be made an affected area. When the survey of

the unit is completed, a statistical evaluation will be performed to insure sufficient data exists.

In affected outdoor areas, when scanning has indicated that guideline values have been met, systematic sampling at 4 equidistant locations between the center and each grid block corner will be performed. A minimum of 30 data points will be used. For paved surfaces, a measurement similar to that used indoors will be used. If indications point out that the activity is below the surface, then cores of the paving and subsoil will have to be taken.

In unaffected outdoor areas, 30 random sample points will be selected for soil sampling and analysis. For pavement, 30 randomly selected locations will be analyzed for surface activity.

4.4. Background Measurements

Interior background measurements will be made inside the buildings of the Clevite site, having no history of radionuclide use. A series of 8 to 10 readings will be made on each meter/detector used. The average and 95% confidence level will be determined for each instrument. Also, a minimum of 10 locations for area background measurement and sampling will be selected within a 0.5 to 10 km radius of the site. Exposure rate measurements will be performed using a micro R meter. A background soil sample will be collected.

This Section describes methods for converting survey data to appropriate units for comparison with guideline values and evaluating data, relative to conditions, established for termination of the license.

5.1. Data Conversion

Radiological survey data is obtained in units, such as counts per unit time, which have no intrinsic meaning relative to the guideline values. Therefore, the survey data from field and laboratory measurements are converted to units which will enable comparisons. Standard units used for expressing final status survey findings are:

- Surface Contamination — $\frac{\text{dpm}}{100\ \text{cm}^2}$ (disintegrations per minute per 100 cm^2)
- Soil Radionuclide Concentration — pCi/g (picocuries per gram)
- Exposure Rate — μR/h (microroentgens per hour)

In performing the conversions, it is necessary to know several factors; these are:

c	total integrated counts recorded by the measurement
c/m	total countrate from an analog (rate) instrument
t	time period (minutes) over which the count was recorded
B	count during recording period, due only to background levels of radiation
B/m	background count rate on an analog instrument
E	detection efficiency of instrument in counts per disintegration
A	active surface area of the detector in cm^2
M	mass of sample analyzed in grams
2.22	factor to convert a disintegration rate to activity units of picocuries, i.e. dpm/pCi.

These factors are used in the equations in the remainder of Section 5.1.

5.1.1. Surface Activity

A measurement for surface activity is performed over an area, represented by the sensitive surface area of the detector. If the instrument display is in count rate, i.e. counts per minute, the conversion to dpm/100 cm^2 is performed by:

$$\frac{\text{dpm}}{100\ cm^2} = \frac{(c/m - B/m)}{E}\left(\frac{100}{A}\right) \qquad (5\text{-}1)$$

For a technique using an integrated count on a digital instrument, the conversion is:

$$\frac{\text{dpm}}{100\ cm^2} = \frac{(c - B)}{t \bullet E}\left(\frac{100}{A}\right) \qquad (5\text{-}2)$$

The level of removable activity collected by a smear is calculated in the same manner, except, the detector area correction factor, $\frac{100}{A}$, is dropped from the equation because the smear is performed over a 100 cm^2 area and the detector area correction is usually considered when determining the efficiency, leaving:

$$\frac{\text{dpm}}{100\ cm^2} = \frac{(c - B)}{t \bullet E} \qquad (5\text{-}3)$$

5.1.2 Soil Radionuclide Concentration

To determine the radionuclide concentration in soil in units of pCi/g, the calculation performed is:

$$pCi/g = \frac{(c-B)}{t \bullet E \bullet 2.22 \bullet M} \qquad (5\text{-}4)$$

If the analytical procedure includes a wet chemistry separation, it will also be necessary to correct for the fractional recovery (R), determined by a spike or tracer added to the sample.

$$pCi/g = \frac{(c-B)}{t \bullet E \bullet 2.22 \bullet M \bullet R} \qquad (5\text{-}5)$$

5.1.3. Exposure Rate

If an instrument such as a pressurized ionization chamber or a "micro-R" meter is used for measuring exposure rate, the instrument reading will be directly in the desired exposure rate units of μR/h. A gamma scintillation or GM detector with a count rate or digital scaling instrument provides data in units of counts per minute or per some preset time, respectively. Conversion to μR/h is accomplished, using calibration factors developed for the specific instrument and survey site. The background exposure rate is then subtracted from the total to determine the net level, attributed to residual activity from licensed operations. This net level is compared with the guideline value.

$$\mu R/h = \frac{c/m}{\left[\frac{c/m}{\mu R/h}\right]} \quad \text{or} \quad \frac{c}{\left[\frac{c/m}{\mu R/h}\right]^*} \qquad (5\text{-}6)$$

* Site Specific Calibration Factor for Detector

5.2. Measurement Uncertainty

Each reported value will include an assessment of its uncertainty. The rate of radioactive decay is not constant with time and is therefore described by a Poission probability distribution. Based on such a distribution, the best estimate of the standard deviation(s) on a number of counts (c) is the square root of the counts, i.e.

$$s = \sqrt{c} \tag{5-7}$$

and the standard deviation in a count rate over time (t) is therefore:

$$s_r = \frac{\sqrt{c}}{t} \tag{5-8}$$

For the majority of measurements conducted during a final status survey, the number of counts due only to background will be a significant portion of the total count. The background also has an uncertainty associated with it which is taken into consideration by:

$$s_r = \sqrt{\frac{c}{t^2} + \frac{B}{t^{2B}}} \tag{5-9}$$

where

t_B is the time period over which the background count was determined.

The standard deviation or uncertainty in the count or count rate will be converted to the same standard units used to express the measurement value by use of the equations provided in Section 5.1. The uncertainty will be given at the 95% confidence level which requires multiplying the standard deviation value by a factor of 1.96.

5.3. Minimum Detectable Activity

Less than or equal to minimum detectable activity (MDA) levels will be reported but will only be used for averaging site activity levels when the value for (MDA) $< 10\%$ of the guideline value. For all other calculations, actual values will be used.

5.4. Data Presentation Format

All final status survey data will be presented in the format of NUREG/CR-5849 APPENDIX D.

5.5. Comparison with Guideline Values

5.5.1 Removable Activity

Data for removable activity levels will be compared directly to the guideline values. The limit for removable activity is 20% of the guideline value for total surface activity. If that level is exceeded, remediation and resurvey will be necessary.

5.5.2. Elevated Areas of Activity

Levels of residual activity, i.e. elevated areas, which exceed the guideline value, are initially compared directly with the guideline.

- Buildings or Structures

  The limit for maximum activity on a building or structure surface is three times the guideline value, when averaged over an area of 100 cm^2 or less. Residual activity exceeding this limit will be remediated and follow-up surveys performed. Areas of elevated activity between one and three times the guideline value will be tested to assure that the average surface activity level within a contiguous 1 m^2 area containing the elevated area is less than the guideline value.

  To evaluate whether this averaging condition is satisfied, additional measurements will be performed, and the activity level and areal extent of the elevated area will be determined. The average (weighted average) in the 1 m^2 area will then calculated, taking into consideration the relative fraction of the 1 m^2 occupied by the elevated area(s), using the relationship:

$$\bar{x}_w = \frac{1}{n_s} \sum_{i=1}^{n_s} x_i \left[1 - \sum_{k=1}^{n_k} A_k \right] + \sum_{k=1}^{n_k} y_k A_k \qquad (5\text{-}10)$$

where

$\bar{x}_w$ = weighted mean including elevated area(s)

x_i = systematic and random measurements at point i

n_s = number of systematic and random measurements

y_k = elevated area activity in area k

A_k = fraction of 1 m^2 occupied by elevated area k

n_k = number of elevated areas.

- soil

  The limit for soil activity at any location is three times the average guideline value. Residual activity exceeding this level will be remediated and follow-up survey performed. Areas of elevated activity between one and three times the guideline value will be tested to assure that the average concentration is less that $(100/A)^{1/2}$ times the guideline value, where A is the area of the elevated activity in m^2. Levels exceeding this limit will be remediated. If this condition is satisfied, the average activity in the 100 m^2 contiguous area containing the region of elevated activity will then be determined to assure that it is within the guideline value. Equation 5-10 is also used for this calculation, substituting 100 m^2 for the 1 m^2, used when calculating average surface activity.

5.5.3 Exposure Rates

Exposure rate levels are compared directly with the guideline value. The maximum exposure rate may not exceed two times the guideline value, above background. If the level is above that value, the area will be remediated and resurveyed.

5.5.4. Calculating Average Levels

General surface activity, soil activity, and exposure rate guideline values are average values, above background, established for areas of survey unit surfaces (surface activity), 100 m^2 (soil activity and open land exposure rates), and 10 m^2 (indoor exposure rates). To enable comparison of the survey data with those guidelines, the mean (x) of measurements in each of the survey units is calculated using all measurements (n_s) within that area:

(5-11)

5.5.5 Comparisons

Average levels, calculated following the procedures in Section 5.5.4, are compared with the guideline values and conditions. If the averages exceed the applicable guideline values and/or conditions, further remediation is required and follow-up measurements will be performed to verify the effectiveness of the actions. After the averages satisfy the guideline values and conditions, the results will be further evaluated to determine whether the data each survey unit (i.e. group of contiguous grids or regions with the same classification of contamination potential), provides a 95% confidence level that the true mean activity level meets the guidelines.

The test is performed by calculating the average (equation 5-11) and standard deviation of the data for a particular radiological parameter in each survey unit using all measurement locations; the standard deviation is calculated by:

(5-12)

If there are areas of elevated activity in the survey unit, the weighted mean x (equation 5-10) for each 1 m^2 of building surface, or 100 m^2 of land, containing an elevated area, will be used as one of the x_i's in equations 5-11 and 5-12.

(5-13)

where

$t_{1-a, df}$ = is the 95% confidence level obtained from NUREG/CR-5849 Appendix B. Table B-1: df (degrees of freedom) is n-1. α is the false positive probability, i.e. the probability that μ_α is less than the guideline value if the true mean activity level is equal to the guideline value.

$\bar{x}$ = is the calculated mean from equation 5-11

s_x = is the standard deviation from equation (5-12)

n = is the number of individual data points used to determine $\bar{x}$ and s_x.

The value of μ_α is compared to the guideline value; if μ_α is less than the guideline, the area being tested meets the guideline at a 95% confidence level. This means that the probability is less than 5% that μ_α will pass the test, when the true mean activity level exceeds the guideline value.

5.6. Identifying Additional Measurement/Sampling Needs

If μ_α calculated in the previous section is greater than C_G (NRC guideline value), there are two possibilities. If $\bar{x} \geq C_G$, a cleanup is required. However, if $\bar{x} < C_G$, a larger sample might be able to demonstrate compliance. The sample mean ($\bar{x}$) and standard deviation(s) for a given sample size were calculated in the previous Section using equations 5-11 and 5-12. Using these parameters, the total number of data points (n_1) which would be required to demonstrate that the activity level satisfies the guideline value at the desired level of confidence, is determined by:

(5-14)

where

n_1	=	number of data points required
C_G	=	guideline value
$\bar{x}$	=	mean
S_x	=	sample standard deviation
$Z_{1-\alpha}$, $Z_{1-\beta}$	=	standard normal variables: α is the false positive probability, i.e. that $\mu_\alpha < C_G$, if the true mean activity is equal to C_G, and β is the false negative probability, i.e. that $\mu_\alpha > C_G$, if the true mean activity is equal to C_G.

NUREG/CR-5849 Table B-2 (Appendix B) has been provided for ease of estimating the total number of data-points required to demonstrate meeting guidelines at a false positive level of 5% and a false negative level of 10%. Subtracting the number of data points already collected (n) from this total calculated number (n_1), determines the

number of additional measurements or samples which will be required to demonstrate the desired confidence of the data. If this calculation indicates that additional data are needed from a survey unit to demonstrate meeting the guideline, it is recommended that they be collected uniformly over the area, using the same sampling methodology as that used for the first samples. To demonstrate compliance, μ_a is based on all data points; thus additional data are combined with the original data and the acceptance testing repeated. The process of determining additional samples to try to meet the guideline can only be done one time. If the additional samples do not bring μ_a below the guideline, additional remediation will be required.

5.7. Calculating Site Inventory

The total residual activity is calculated for each radionuclide by determining the mean activity for each survey unit, multiplying that mean level by the total surface area or soil volume of the unit. The total activity of the site will be determined by summing all survey unit activities.

5.8. Results by Room

a. Basement

i. *Boiler Room/Entrance* - 32 grids greater than or equal to 25% of the guideline value of which 7 are greater than or equal to 1000 dpm/100cm² (direct). Elevated readings due to naturally occurring radioactive material in structural material. 6 of the seven readings greater than 1000 dpm/100cm² were on brick walls in close areas. These readings are due to the natural fluctuations in background. The seventh reading greater than 1000 dpm/100cm² was on a twelve inch tile drain pipe. Tile drain pipe has naturally occurring radioactive in it as on site sampling has indicated.

b. South East Wing, 1st Floor

i. *Room # 1* - 118 grids greater than or equal to 25% of the guideline value of which 2 are greater than or equal to 1000 dpm/100cm² (direct). 2 grids greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 200 dpm/100cm² (smearable). This room was surveyed as an affected area. This room contained four anchor bolt holes. The contamination was from a single source and in a limited area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

ii. *Room # 2* - 219 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). 1 grid greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). This room was surveyed as an affected area.

iii. *Room # 7* - 75 grids greater than or equal to 25% of the guideline value of which 13 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). 3 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The contamination was under the wall between room # 7 and room # 18. The contamination was from a single source and in a limited area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

iv. *Room # 8* - 15 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). This is the room where the Dew Pointer was found, 20 mrem/hr @ contact with source, 2 mrem/hr contact with case. This room was surveyed as an affected area. The elevated activity readings are attributed to naturally occurring radioactive material in the structural material. A clay tile pipe contributed to the elevated activity at the drain. The Dew Pointer was removed. No further remediation is required.

v. *Room # 9* - 41 grids greater than or equal to 25% of the guideline value of which 11 are greater than or equal to 1000 dpm/100cm² (direct). 41 grids greater than or equal to 25% of the guideline value of which 36 are greater than or equal to 200 dpm/100cm² (smearable). 1 grid was greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The contamination in this room was a continuation from the hallway. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

vi. *Room # 10* - 7 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

vii. *Room # 11* - 94 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). This room was surveyed as an affected area. The contamination was found under the sliding pocket door from the hallway. The other elevated activity readings are attributed to naturally occurring radioactive material found in the structural material. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

viii. *Room # 12* - 24 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material. This room was surveyed as an affected area.

ix. *Room # 13* - 47 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid was greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

x. *Room # 14* - 69 grids greater than or equal to 25% of the guideline value of which 2 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid was greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xi. *Room # 15* - 1 grid greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xii. *Room # 18* - 72 grids greater than or equal to 25% of the guideline value of which 28 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 200 dpm/100cm² (smearable). 7 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The contamination in this room was isolated to under the wall adjoining room # 7. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xiii. *Sections (A, B, C, etc.)* - 60 grids greater than or equal to 25% of the guideline value of which 15 are greater than or equal to 1000 dpm/100cm² (direct). 5 grids greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). 9 grids were greater than or equal to 3000 dpm/100cm² (direct). The hallway, where it joins the west wing, was identified as contaminated above the guideline value and was reclassified as affected. The rest of the areas remained unaffected and the elevated activity is attributed to naturally occurring activity in structural material. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xiv. *Test Cell* - 26 grids greater than or equal to 25% of the guideline value of which 14 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). 7 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. This room contained contaminated sand. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one

adjacent 1 meter grid square.

c. South East Wing, 2nd Floor

i. *Roof* - 52 grids greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 1000 dpm/100cm² (direct). All of the roof areas exhibited elevated activity levels. Samples from the roof, counted on site for informational purposes only, indicated no thorium or uranium contamination. A sample sent for uranium and thorium activity determination indicated no uranium and thorium. It is therefore believed that the roof area as a whole is either contaminated with naturally occurring radioactive material or from fall out from nuclear testing and is beyond the scope of the survey guidelines.

d. West Wing, 1st Floor

i. *Weld Shop* - 117 grids greater than or equal to 25% of the guideline value of which 8 are greater than or equal to 1000 dpm/100cm² (direct). 3 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. This room is being used for welding with thoriated tungsten rods. This room will be surveyed last after clean-up to minimize the time between remediation and final status survey. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

ii. *Elevator Entrance* - 29 grids greater than or equal to 25% of the guideline value of which 8 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

iii. *Inside Dock Area* - 61 grids greater than or equal to 25% of the guideline value of which 26 are greater than or equal to 1000 dpm/100cm² (direct). 1 grid greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). 21 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

iv. *Tin Shed (Outside West Wing)* - Found a glass jar of thorium oxide. This room was surveyed as an affected area. The jar was removed from the area. No further remediation required.

v. *Hallway* - 415 grids greater than or equal to 25% of the guideline value of which 82 are greater than or equal to 1000 dpm/100cm² (direct). 11 grids greater than or equal to 25% of the guideline value of which 4 are greater than or equal to 200 dpm/100cm² (smearable). 45 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was

surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

vi. *Stairwell* - 84 grids greater than or equal to 25% of the guideline value of which 9 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

vii. *Room # 1* - 28 grids greater than or equal to 25% of the guideline value of which 8 are greater than or equal to 1000 dpm/100cm² (direct). 6 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

viii. *Room # 2* - 46 grids greater than or equal to 25% of the guideline value of which 16 are greater than or equal to 1000 dpm/100cm² (direct). 12 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

ix. *Room # 3* - 175 grids greater than or equal to 25% of the guideline value of which 7 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

x. *Room # 4* - 65 grids greater than or equal to 25% of the guideline value of which 8 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xi. *Room # 5* - 30 grids greater than or equal to 25% of the guideline value of which 27 are greater than or equal to 1000 dpm/100cm² (direct). 4 grids greater than or equal to 25% of the guideline value of 200 dpm/100cm² (smearable). 23 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xii. *Room # 6* - 124 grids greater than or equal to 25% of the guideline value of which 14 are greater than or equal to 1000 dpm/100cm² (direct). 6 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xiii. *Room # 7* - 140 grids greater than or equal to 25% of the guideline value of which 25 are greater than or equal to 1000 dpm/100cm² (direct). 3 grids were greater than or equal to 3000 dpm/100cm² (direct). This

room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xiv. *Room # 8* - 162 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xv. *Room # 9* - 14 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xvi. *Room # 10* - 39 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xvii. *Room # 11* - 134 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xviii. *Room # 12* - 25 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xix. *Room # 13* - 43 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xx. *Room # 14* - 134 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xxi. *Room # 15* - 164 grids greater than or equal to 25% of the guideline value of which 61 are greater than or equal to 1000 dpm/100cm² (direct). 27 grids were greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xxii. *Room # 16* - 577 grids greater than or equal to 25% of the guideline value of which 182 are greater than or equal to 1000 dpm/100cm² (direct). 28 grids greater than or equal to 25% of the guideline value of which 16 are greater than or equal to 200 dpm/100cm² (smearable). 93 grids were greater than or equal to 3000 dpm/100cm² (direct). Furnace

in room was used for smelting depleted uranium. This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xxiii. *Room # 17* - 61 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xxiv. *Room # 18* - 37 grids greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 1000 dpm/100cm² (direct). 1 grid was greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

xxv. *Room # 19* - 23 grids greater than or equal to 25% of the guideline value of which 2 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

xxvi. *Room # 20* - 100 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

e. West Wing 2nd Floor

i. *Sections (A, B, C, etc.)* - 36 grids greater than or equal to 25% of the guideline value of which 2 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

f. West Wing 3rd Floor

i. *Sections (A, B, C, etc.)* - 32 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material. Areas of particular interest were the bathrooms. Drain pipes in the bathrooms are made of tile pipe. The drains are contained in brick walls of which one is covered by glazed tile (glazed tile had the highest background).

g. West Wing 4th Floor

i. *Roof* - 115 grids greater than or equal to 25% of the guideline value of which 6 are greater than or equal to 1000 dpm/100cm² (direct). 2 grids greater than or equal to 25% of the guideline value of which 1 is greater

than or equal to 200 dpm/100cm² (smearable). 2 grids were greater than or equal to 3000 dpm/100cm² (direct). All of the roof areas exhibited elevated activity levels. Samples from the roof, counted on site for informational purposes only, indicated no thorium or uranium contamination. A sample sent for uranium and thorium activity determination indicated no uranium and thorium. It is therefore believed that the roof area as a whole is either contaminated with naturally occurring radioactive material or from fall out from nuclear testing and is beyond the scope of the survey guidelines. The exhaust duct fan was located on the 4th floor roof and was the source of contamination on the roof. The location where the fan had been was surveyed as affected.

ii. *Sections (A, B, C, etc.)* - 15 grids greater than or equal to 25% of the guideline value of which 3 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

h. North East Wing 1st Floor

i. *CAMPS Room* - 41 grids indicate greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material. It should be noted that the CAMPS area was constructed in the mid sixties. Background fluctuations on construction material were similar to those found through out the rest of the facility supporting the argument that many of the areas with elevated readings are due to naturally occurring radioactive material found in the structural material.

ii. *Sections (A, B, C, etc.)* - 74 grids greater than or equal to 25% of the guideline value of which 5 are greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

i. North East Wing 2nd Floor

i. *Grid Seal storage area*. Owner opened a sealed glass case containing uranium powder spilling the contents. He then used a standard vacuum cleaner to cleanup the spilled powder. Sevenson was requested by the owner to survey the area. 1 grid was greater than or equal to 3000 dpm/100cm² (direct). This room was surveyed as an affected area. The areas above the guideline values will be remediated. The remediated areas will be surveyed as well as one adjacent 1 meter grid square.

ii. *CAMPS Room* - 27 grids greater than or equal to 25% of the guideline value of 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

iii. *Roof* - 62 grids greater than or equal to 25% of the guideline value of which 7 are greater than or equal to 1000 dpm/100cm² (direct). All of the roof areas exhibited elevated activity levels. Samples from the roof, counted on site for informational purposes only, indicated no thorium or uranium contamination. A sample sent for uranium and thorium activity determination indicated no uranium and thorium. It is therefore believed that the roof area as a whole is either contaminated with naturally occurring radioactive material or from fall out from nuclear testing and is beyond the scope of the survey guidelines.

iv. *Sections (A, B, C, etc.)* - 66 grids greater than or equal to 25% of the guideline value of which 2 are greater than or equal to 1000 dpm/100cm² (direct). 2 grids greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 200 dpm/100cm² (smearable). These areas were primarily in the grid seal room. The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

j. North West Wing 1st Floor

i. *Corner* - 18 grids greater than or equal to 25% of the guideline value of which 1 is greater than or equal to 1000 dpm/100cm² (direct). The elevated activity levels are attributed to naturally occurring radioactive material found in the structural material.

ii. *Roof* - 30 grids greater than or equal to 25% of the guideline value of which 5 are greater than or equal to 1000 dpm/100cm² (direct). All of the roof areas exhibited elevated activity levels. Samples from the roof, counted on site for informational purposes only, indicated no thorium or uranium contamination. A sample sent for uranium and thorium activity determination indicated no uranium and thorium. It is therefore believed that the roof area as a whole is either contaminated with naturally occurring radioactive material or from fall out from nuclear testing and is beyond the scope of the survey guidelines.

5.9. Characterization/Final Status Survey Results

Characterization survey information will be used with final status survey information to complete a Final Status Survey. Characterization survey results from areas that were not remediated and were not treated as affected will be added to survey results from areas that were treated as affected and remediated. Areas that were treated as affected but contained no activity above the guideline values due to other than naturally occurring radioactive material will be added to the final status survey information. Areas where the averaging survey proved no activity above the guideline values will be added to the final status survey. Where the final survey data overlaps the characterization survey data the final survey data taken after remediation will be used,

however, all of the data will be presented. The Characterization Survey Data will be resubmitted with the Final Status Survey taken after remediation to complete one document that shows all areas of the site are remediated below the guideline values. The same format as used in the Characterization Report will be used for statistical interpretation and evaluation. This information was submitted in the format suggested NUREG/CR-5849.

5.10. QC/QA

See Appendix F for the procedures used to ensure the validity of the characterization and final survey data.

5.11. Determining Number of Background Data Points

For the purposes of this manual, if the average of air background is $< 10\%$ of the guideline value, then background will be considered to be insignificant relative to the guideline. If the average is $> 10\%$ of the guideline values, then additional measurements will have to be made to insure that the average value is representative. The number of measurement required is calculated in the following manner:

(5-15)

where

n_B = number of background measurements required
x_B = mean of initial background measurements
s_x = Standard deviation of initial background measurements
t_{11}
$_{95.5\%,df}$ = t statistic for 95.5% confidence at df=n-1 degrees of freedom, where n is the number of initial background data points.

NUREG/CR-5849, Table B-1 (Appendix B) contains a list of values for the $t_{95.5}$ statistic at various degrees of freedom. Subtracting the number of data points already collected (n) from this total calculated number (n_B) determines the number of additional measurements or samples which will be required to demonstrate the desired confidence of the data. If this calculation indicates that additional background data are needed, the measurements will be collected uniformly over the area, using the same sampling methodology as that used for the initial samples. The average background is then recalculated using all data points.

If the value of the upper bound is $<10\%$ of the guideline value, it can be assumed that variations in background will be insignificant. If this value is greater than 10%, then additional samples for background will have to be taken to insure that the average mean represents the true mean value within $\pm$ 20% at the 95% confidence level. The number of samples needed to demonstrate acceptance will be determined using sec. 8.7 of NUREG/CR-5849.

4.5 Sample Analysis

Smears and swabs for removable contamination will be analyzed for gross alpha, gross beta activity. Soil, sediment, gravel, roofing material, and other large volume samples will be analyzed for Thorium/Uranium by Alpha spectroscopy; total thorium will be calculated on the basis of previously determined (Section 3.2) isotopic activity ratios for this site. Activity will be calculated for each specific isotope. Samples of paint, residue, and other samples of small volume will be analyzed for Thorium/Uranium by wet chemical separation and alpha spectroscopy.

Laboratory chain-of-custody procedures will be observed for all sample analyses.

5.0 INTERPRETATION OF SURVEY RESULTS

6.0 REPORT

A report characterizing the site will be submitted to the NRC before remediation work commences. This report will summarize all data in tables. Measurement and sample locations will be shown on scaled drawings. Detailed remediation plans will be submitted based on the characterization survey.

A report, describing the procedures and finding of the final status survey will be prepared and submitted to the NRC. Data will be summarized in tables. Measurement and sampling locations will be shown on scale drawings.

7.0 REMEDIATION PLAN

7.1. Premobilization

Prior to mobilization, the characterization and remediation plans presented herein will require approval by the NRC. Once approval is granted, Sevenson will commence mobilization activities.

7.2. Mobilization

Upon receipt of the Notice to Proceed, Sevenson will mobilize to the site. Site mobilization includes moving men and equipment to the site in preparation of performing the characterization surveys. All workmen who will perform remedial activities will have undergone baseline physicals and OSHA and site-specific training.

7.3. Site Remediation

After authorization to proceed has been given by NRC the remediation phase of the contract will begin.

Work will consist of "hand" excavation/chipping methods. Identified areas will be chipped using hammers, chisels, small electrically operated chipping guns or walk behind floor scabblers. Reasonable effort will be made to identify, evaluate, and remove areas of residual activity exceeding the guideline values. Reasonable efforts will be made to clean up removable activity and removable activity in any 100 cm^2 area will not exceed 20% of the average surface activity guideline value. During all chipping operations, HEPA vacuums will be utilized to collect all dust and particles. The Health Physicist Technician will be present during all remedial activities to insure dust migration does not occur as

well as determining remedial limits by radiological survey. Contaminated materials collected in the HEPA vacuum will be placed in DOT-approved 55-gallon drums in preparation for transport to a licensed disposal facility. Remediation will occur after normal working hours (e.g. second shift) so that normal plant operation will not be affected. When remediation is completed and the NRC has performed a confirmatory survey, site restoration will commence. Remediated areas will be cleaned, then restored to their original condition. Restoration will primarily consist of applying "flash patch" concrete to disturbed floor areas and paint "touch-up". Equipment and materials that can be decontaminated will be. Decontamination water will be placed in properly labeled 55-gallon drums for proper filtering or disposal. Personnel and equipment decontamination procedures are discussed in the *Health and Safety Plan*. Sevenson acknowledges that the NRC reserves comments on this section.

7.4. ALARA

a. Man-Rem Estimates

1. Mobilization - 0.000 man-rem
2. Training - 0.000 man-rem
3. Characterization/Averaging Survey - 0.030 man-rem
4. Site Remediation - 0.040 man-rem
5. Final Survey - 0.000 man-rem
6. Demobilization - 0.000 man-rem

b. Administrative Controls will be implemented via radiation work permits,

dosimetry program, air sampling program, radiation surveys, pre job briefings, and man-rem estimates. Additional controls may be implemented if exposure estimates are exceeded.

c. Engineering Controls will consist of but are not limited to HEPA ventilation, containment enclosures with HEPA ventilation, protective clothing, and postings. Containment enclosures will be seal, inspected and negative pressure tested prior to commencing any work within the enclosure. Additional controls may be implemented.

7.5. Transportation and Disposal

Sevenson anticipates approximately two (2) 55-gallon drums of material may be collected (15 Cubic Feet ±) from the remedial activities dependent upon results of the site characterization surveys. The controlled material will be placed in DOT-approved containers (drums) in preparation of transportation and disposal. A licensed hauler will be utilized to transport this material to a facility permitted to accept this material.

Wastes shipped to the Low-Level Radioactive Waste Disposal Facility (LLWDF) will meet all of the waste acceptance criteria (WAC) established to achieve conformance with the license of the facility. Sevenson will determine in advance how to package, mark, store, manifest and ship the wastes. Wastes being shipped will meet or exceed federal regulations and requirements.

The waste will be properly manifested, then shipped to the disposal facility. The selected disposal facility will be submitted to Gould Inc. prior to disposal.

7.6. Demobilization

Once all remedial activities are complete, Sevenson will demobilize. All men and equipment will be removed from the site. The site will be left in its original, or better, condition.

APPENDIX F
QC/QA PROCEDURES

BACKGROUND AND SOURCE CHECKS

1. Initial background levels will be established before work commences per section 5.8 of the manual.

2. A daily background reading should be made. This reading should fall with in the limits established for background. If it is higher there is a possibility the detector may be contaminated or meter is not functioning properly.

3. The detection efficiency of the detector should be established initially by taking a series of ten counts and determining the average and the standard deviation at the 95% confidence level.

4. A daily source check should be made of the instrument. The value should fall within the established limits. If it doesn't, check counting gas, high voltage. Compare against similar detector. If comparison fails, send off for repair.

BUILDING SCAN SURVEY

1. Select the proper instrument from those listed in Table 2.

2. Obtain the proper data sheets.

3. Fill in the heading on the data sheet.

4. A. Affected Areas

   Scan 100% of the floor and lower walls in affected areas. If it is believed that contamination levels on the upper walls and ceilings are less than 25% of the guideline a minimum of 30 measurement locations on each surface should be selected. If contamination levels are greater than 25% of the guideline value all surfaces shall receive a 100% survey. Record elevated locations of radioactivity.

   B. Unaffected Areas

   Scan 10% of the floor and lower wall surfaces of unaffected areas using a grid system.

5. Scan speeds will be one detector width per second for beta and alpha particles and 0.5m/sec for gamma radiation. The detector should be no more than 2 cm off the floor for beta detection and no more than 1 cm for alpha detection. The gamma probe will be held at the waist.

6. Locations of elevated radiation will be noted for further investigation.

AVERAGING SURVEY

1. Select the proper instruments from the [illegible] in Table 2. Ensure that the background and source checks have been done.

2. Obtain the proper survey sheets.

3. Fill in the data sheet heading.

4. Determine the area of the elevated reading and record the average activity contained in the area. Take five direct readings in the one meter area that contains the elevated reading and record on the form.

5. Repeat for each elevated reading in the survey unit.

6. Turn in the forms to the survey coordinator.

BUILDING DIRECT MEASUREMENT AND REMOVABLE CONTAMINATION SURVEY

1. Select the proper instruments from those listed in table 2. Check to see if backgrounds and source checks have been done.

2. Obtain the proper survey data sheets.

3. Complete the survey information at the top of the form.

4. A. Affected Area

   Since the meter used for the beta scanning survey has an MDA greater than 25% of the guide line the survey will be done at one meter intervals on the floor and lower wall surfaces and at all locations determined to have elevated levels of activity from the scan survey. A direct measurement on ceilings and upper wall surfaces should be made for each 20 m^2 of surface area. A scan of each selected location should be made to identify any locations of elevated activity.

   B. Unaffected Area

   Thirty or 1 per 50 m^2 direct measurement points, which ever is greater, should be selected in the unaffected area. All surfaces in the survey unit should be included in the total area.

5. Take a one minute count at each location and record the reading.

6. Take a 100 cm^2 wipe at each location of the direct survey using moderate pressure. Place the wipe in an envelope labeled with the proper location. If cracks or bolt holes are present use a Q-Tip to obtain a wipe.

7. Insure that the forms have been completed and turn them and the wipes in to the survey coordinator.

DATA EVALUATION, AFFECTED AREAS

For each survey unit file fill out the attached data summary sheet and insert it into the front of the file when it is completed.

CHECK affected Area Surveys for:

1. Completeness of data.

2. Do elevated areas of activity exceed 3 x guideline ? If so tag file with red tag indicating remediations is needed.

3. If elevated areas of activity fall between one and three guideline values tag the file with a blue tag indicating an averaging survey is required.

4 If external gamma readings are greater than b2 x guidelines tag file with red flag for remediation.

5. If removable contamination levels are 0.2 x guideline tag with a red tag for remediation

6 If all the survey points meet the guideline criteria determine the average activity for the survey unit using eq.5.11 from the manual.

7. Compare the calculated average value to the guideline using eqs. 5.12 & 5.13.

8. If the value for μ is less than the guideline value the survey unit being tested meets the guideline criteria at a 95% C.L. The file will be tagged with a green flag.

9. If μ is greater than the guideline and the average activity level for the survey unit is greater than the guideline tag the file with a red tag.

10. If the average activity of the survey unit is less than the guideline a larger sample may demonstrate compliance. If a larger sample is required the number of samples to be taken may be determined by eq. 5.14. Tag the file with a yellow flag to indicate additional sampling is required. If after sampling the activity levels cannot meet the guideline criteria tag the file with a red tag for remediation.

12. If the survey unit meets the criteria in step 8 above calculate the radioactive inventory for the survey unit.

DATA EVALUATION, UNAFFECTED AREAS

For each survey unit file fill out the attached data summary sheet and insert it into the front of the file when it is completed.

CHECK unaffected Area Surveys for:

1. Completeness of data.

2. Do elevated area of activity exceed 0.25 x guideline ? If so reclassify unit as affected.

3. If all the survey points meet the guideline criteria determine the average activity for the survey unit using eq.5.11 from the manual.

4. Compare the calculated average value to the guideline using eqs. 5.12 & 5.13.

5. If the value for μ is less than the guideline value the survey unit being tested meets the guideline criteria at a 95% C.L. The file will be tagged with a green flag.

6. If μ is greater than the guideline a larger sample may demonstrate compliance. If a larger sample is needed the number of samples needed can be calculated using eq.5.14. Tag the file with a yellow flag to indicate additional sampling.

7. If upon additional sampling μ is still greater than the guideline reclassify the survey unit as affected.

DATA SUMMARY SHEET

1. DATE_____

2. SURVEY UNIT_____

3. INITIAL CLASSIFICATION_____

4. NUMBER OF SURVEY POINTS > GUIDELINES
   A. SCANS_____
   B. DIRECT SURVEYS_____
   C. EXTERNAL RADIATION_____
   D. REMOVABLE CONTAMINATION_____

5. NUMBER OF SURVEY POINTS >1 AND <3X GUIDELINES_____

6. ARE ALL DATA POINTS LESS THAN THE GUIDELINE VALUES_____

IF THE ANSWER TO 6 IS YES

7. WHAT IS THE AVERAGE LEVEL OF CONTAMINATION FOR THE SURVEY UNIT_____.

8. STANDARD DEVIATION FOR SURVEY UNIT_____.

9. μ = _____

10. μ > GUIDELINE_____

11. IS THE AVERAGE VALUE > THAN THE GUIDELINE _____(REMEDIATE).

12. IS THE AVERAGE VALUE < THAN GUIDELINE_____(TAKE MORE SAMPLES).

13. HOW MANY MORE SAMPLES MUST BE TAKEN_____.