SURVEY PROCEDURES MANUAL
FOR THE
ENERGY/ENVIRONMENT SYSTEMS DIVISION
ENVIRONMENTAL SURVEY AND SITE ASSESSMENT PROGRAM

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Survey Procedures Manual

For The

E/ESD
Environmental Survey and
Site Assessment Program

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

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Project Manager

SECTION 1.0

INTRODUCTION

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education (ORISE) conducts radiological survey activities for the Department of Energy under contract DE-AC05-76OR00033 and for the Nuclear Regulatory Commission under several interagency agreements. ORISE is managed and operated by Oak Ridge Associated Universities for the U.S. Department of Energy.

:s surveyed under this program are primarily those where residual contamination from prev. .rations may pose a potential risk to the environment of the site or the health and safety of those occupying the site presently or in the future. Other activities include monitoring of radioactive effluents from currently operating facilities and miscellaneous technical assistance to the funding agencies.

The purpose this Procedures Manual is to provide a standardized set of procedures that document activities rogram in an auditable manner. These procedures are applicable to both the DOE and NRC ..ions. Procedures presented here are limited to those associated with site radiological survey activities; procedures related to laboratory and analytical functions are presented in a separate document. A separate manual detailing the quality assurance program has also been prepared. Detailed operating procedures for various program equipment are not provided here; the reader is referred to manufacturers instructional manuals for such information.

This manual was produced through the combined effort of many ESSAP staff members, both past and present. r contributions are greatly appreciated.

SECTION 2.0

ORGANIZATION AND RESPONSIBILITIES

Because of frequent changes in staff it is impractical to present a current organizational chart in this document. Instead, Figure 2-1 indicates the generic organizational structure of the ORISE Environmental Survey and Site Assessment Program. Detailed responsibilities for various staff positions are documented in position description forms, which have been developed for all employees. Additional information is included in the Quality Assurance Manual. With respect to the field survey activities, it is the general responsibility of the site coordinator to assure that these procedures are followed by all personnel performing radiological surveys and to continually evaluate results for accuracy and precision. Site coordinator is a generic title which applies to any individual designated as ORISE's representative and on site supervisor. It is the responsibility of each individual conducting surveys to abide by all aspects and details presented in this manual and to report deviations or abnormal results to the responsible supervisor.

The Project Manager is responsible for development and periodic revision of procedures related to field survey activities. In addition to an annual review and revision cycle for this procedures manual, procedures may be developed, reviewed, and/or revised at any time as may be determined necessary by the Project Manager. Field survey procedures require approval by the Project Manager; they are concurred with and implemented for the ESSAP by the Program Director (or in his absence the Assistant Program Director). The Health and Safety/Quality Assurance Coordinator is responsible for distribution and control of procedures. The authority for interpretations of procedures resides with the Project Manager but may be delegated to the level of the field site coordinator.

Environmental Survey and Site Assessment Program

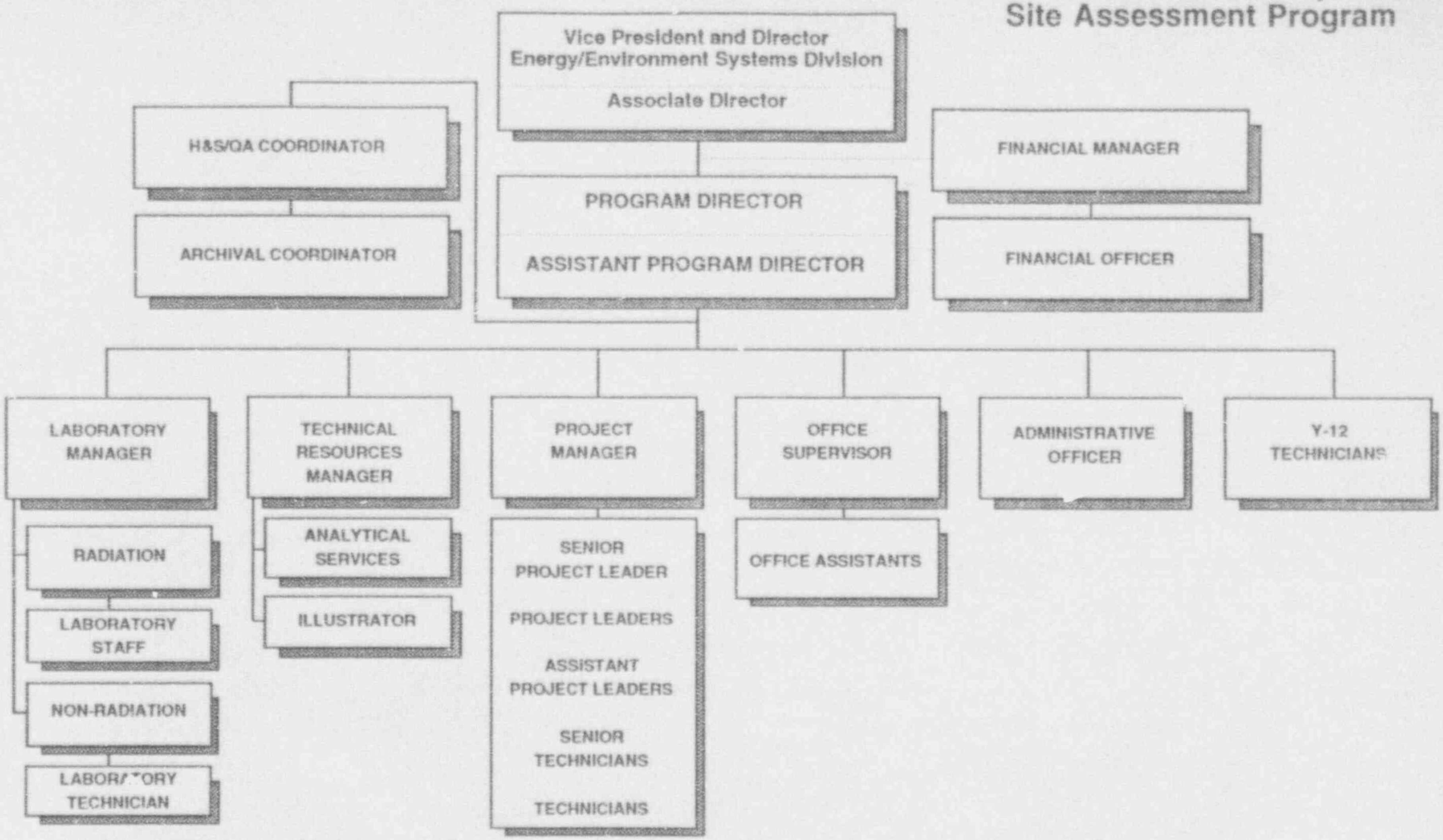

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Figure 2-1

SECTION 3.0

SUMMARY OF ACTIVITIES

Within its operations, the ORISE/ESSAP conducts the following major categories of radiological surveys.

1. Preliminary (designation, screening, or inclusion) survey: Limited investigation to determine if radiological conditions warrant in-depth evaluation.

2. Characterization (comprehensive) survey: Thorough measurement and sampling to determine the extent and levels of site contamination. This survey is used to establish requirements for remedial action.

3. Operational Monitoring: Measurements to evaluate the adequacy and accuracy of routine monitoring and control and/or to determine compliance with regulations.

4. Remedial Action Support: Surveys during cleanup operations to guide the extent of such operations.

5. Post-Remedial Action Survey: Comprehensive radiological evaluation following site cleanup.

6. Verification (confirmatory) Survey: Measurements over limited site areas to verify the results of other survey findings.

Assignments are received from the NRC or DOE funding agencies. These agencies provide background information concerning the site history, type of survey desired, and scheduling requirements. The funding agency also provides names of site contacts and obtains site access consent when necessary.

A scoping visit is performed by one or more of the following to gather additional details concerning the site: Program Director, Assistant Program Director, Project Manager, an experienced individual designated by the Project Manager. Such details include area, building description, site accessibility for gridding and surveying, special equipment requirements, security arrangements, site contacts, recommended local accommodations, area maps and photographs. Other pertinent information is obtained through reviews of records and reports of the regulatory agencies.

A proposed survey plan is prepared for submission to the funding agency. Due to differences in sites, each plan is site specific. Factors considered in the plan include the type of survey, site size and complexity, operational history, potential radionuclides present, and available manpower and equipment resources. The survey plan may require modification based on findings as the survey progresses. The plan is written to allow for such field changes. It is the responsibility of the cognizant site coordinator to make appropriate changes in the plan at the field location. All such changes must be documented in the site log or on the appropriate field survey forms.

Subcontracts and purchase requisitions for specialized services and equipment are initiated.

When the survey plan has been approved and the schedule finalized, the Project Leader and Project Manager select personnel for the survey and the site coordinator prepares a listing of supplies and instruments required. Travel arrangements are also initiated.

The survey is performed in accordance with the survey plan. All data and samples collected at the site are returned to the ESSAP laboratories in Oak Ridge for analysis and interpretation. A draft report of the survey results is provided and, following review and revision, a final report is issued.

SECTION 4.0

RECORDS AND REPORTS

A site specific survey plan is developed prior to the start of on-site activities. Changes in the survey plan are often necessary due to unanticipated findings as the survey progresses. Changes may also be made at the request of the funding agency. The designated site coordinator has the authority to make appropriate changes to the plan. Modifications not directly requested by the funding agency must have a defendable technical basis and a change of any kind must be documented in the site logbook. The site coordinator is responsible for reviewing data for accuracy and completeness before on-site activities are concluded.

All data, notes, measurements, calibrations, and other information pertinent to a survey site must be recorded and maintained. Records must conform with the following basic requirements:

1. Marked with date of entry.
2. Signed (or initialed) by the author of the entry.
3. Written or printed, in pen, in a legible manner.
4. Contain all pertinent information in a concise, accurate entry.

Records may be in several forms. These include: maps, standard record forms for specific survey measurements, and the field data logbook, which is the daily diary and notebook of the site coordinator.

Column headings or requested information on record data forms may be inappropriate or incorrect for specific site situations. If so, appropriate handwritten changes must be made on the forms. When certain information requested on the presented form is not required, the space or columns should be crossed through or marked "NA" (not applicable) as an indication that such information was not required, rather than having possibly been forgotten.

If data corrections are necessary a single line will be drawn across the entry. New data, initials of the surveyor and date of correction will be recorded. Data will not be obliterated by erasing or use of white-out.

Original drawings and maps may first be drawn in pencil but must be made permanent by tracing in ink or producing a photocopy prior to the addition of data to the page.

All records relative to a specific site are reviewed and retained by the site coordinator or their designee until the report has been prepared. Records must be protected from loss, damage, tampering, or unauthorized access by keeping them under surveillance or in a secured storage location. Following acceptance of the final report by the funding agency all records, background information, and other information relative to the site are archived for permanent storage according to the requirements established in the Quality Assurance Manual.

The results of surveys are documented in reports. The complexity and style of the report and its distribution are determined based on the type of survey and the requirements established by NRC, DOE or other funding agency. These reports are provided only to the funding agencies; they are responsible for the distribution of all information concerning the surveys.

SECTION 5.0

INSTRUMENT CALIBRATION

AND

OPERATIONAL CHECK-OUT

SECTION 5.1

GENERAL INFORMATION

1.0 PURPOSE

To describe the general approach to calibration and operational check-out of survey instruments

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Calibration

3.1.1 Instruments to be used for quantitative measurements are source calibrated, and the initial check-out performed, prior to each specific site survey to determine necessary correction factors and to establish operating parameters and acceptable operating criteria.

Exception: The Pressurized Ionization Chamber is calibrated by the manufacturer.

3.1.2 Calibration is to be performed, when possible, with standards traceable to the National Institute of Standards and Technologies (NIST) or other industry recognized standards organizations.

3.1.3 Originals of calibration records are to be maintained at the Oak Ridge facilities; however, copies must accompany instruments to the survey location.

3.1.4 Instruments used only for qualitative scanning or screening purposes are to have an operational check-out performed prior to each specific site survey.

3.1.5 Instruments are calibrated and/or checked out as an instrument/detector combination and are to be used in that combination for survey activities.

3.1.6 Threshold values are determined based on manufacturer specifications and/or determination of specific characteristics and response. The values listed apply only to the instrument/detector combination referenced.

3.1.7 All equipment associated with instrument and detector operations (e.g., gas tubing, flow meters, regulators, etc.) shall be checked to assure proper working order of the complete survey system. Audio output is to be checked for consistent response with associated headphones and any necessary adapters in place.

3.2 Operational Check-Out

3.2.1 Equipment

3.2.1.1 Detectors

3.2.1.2 Portable ratemeter-scaler

3.2.1.3 Cable

3.2.1.4 Record forms

3.2.1.5 Check sources

3.2.2 Procedure

3.2.2.1 This procedure applies to all field survey instruments.

3.2.2.2 Operational check-out is to be performed daily prior to the use of a survey instrument, and at any time the performance of the instrument is questionable. Check-out is also performed as a quality control function according to requirements as described in Section 7 of the ESSAP Quality Assurance Manual.

3.2.2.3 Attach the detector to the instrument.

3.2.2.4 Turn the instrument on and check batteries, replace if necessary.

3.2.2.5 Adjust the threshold and high voltage settings to predetermined values.

3.2.2.6 Place the appropriate check source in contact with the designated location on the detector.

3.2.2.7 Determine and record the count rate on the Instrument Operational Check-Out Form (Figure B-1, or equivalent).

3.2.2.8 Turn the audible output on to assure its operation.

3.2.2.9 Remove the source and determine and record the background count rate.

3.2.2.10 Compare source and background levels to previous checks.

3.2.2.11 Changes in source responses or background rate, exceeding established acceptable limits must be reconciled before the instrument can be used.

SECTION 5.2

ELECTRONIC CALIBRATION OF RATEMETERS

1.0 PURPOSE

To describe the procedure for calibration of ratemeters

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter: Model PRM-6, Eberline Instrument Corporation; Model 2221, Ludlum Instrument Co.; or equivalent.

3.1.2 Pulse generator: Model 500, Ludlum Instrument Co.; or equivalent.

Note: The pulse generators are calibrated when new and annually thereafter by the manufacturer.

3.1.3 Cable: MHV-C; or other connectors, as applicable.

3.1.4 Record forms.

3.2 Procedure

3.2.1 Turn ratemeter on and check batteries; replace if necessary.

3.2.2 Turn the ratemeter off and connect to the pulse generator.

3.2.3 Turn the pulse generator on.

3.2.4 Set the pulse amplitude to 50 mV and the amplitude adjustment knob to 5 on the analog scale.

3.2.5 Turn the ratemeter onto HV setting. Check instrument voltage reading and pulser voltage reading. (If a difference of 50 V or greater is noted, remove the instrument from service) Record both readings on the Electronic Calibration Record Form (Figure B-2, or equivalent).

3.2.6 Set the multiplier knob to the 1K scale.

3.2.7 Set pulse rate to 400,000 pulses/min. using the multiplier adjustment knobs.

3.2.8 Set ratemeter to x 1,000 (1K) scale. Record reading.

3.2.9 If necessary, adjust the 1K potentiometer (pot) inside the ratemeter to bring reading to 400,000 cpm. Record adjusted response.

3.2.10 Decrease the pulse rate to 40,000 pulses/min. by setting the multiplier knob to the 100 scale.

3.2.11 Set ratemeter to the x 100 scale. Record reading.

3.2.12 If necessary, adjust the x 100 pot inside the ratemeter to bring reading to 40,000 cpm. Record adjusted response.

3.2.13 Decrease the pulse rate to 4,000 pulses/min. by setting the multiplier knob to the 10 scale.

3.2.14 Decrease the pulse rate to 4,000 pulses/min. by setting the multiplier knob to the 10 scale.

3.2.15 Set the ratemeter to the x 10 scale.

3.2.16 If necessary, adjust the x 10 pot inside the ratemeter to bring reading to 4,000 cpm. Record adjusted response.

3.2.17 Decrease the pulse rate to 400 pulses/min. by setting the multiplier knob to the 1 scale.

3.2.18 Set the ratemeter to the x 1 scale. Record reading.

3.2.19 If necessary, adjust the x 1 pot inside the ratemeter, to bring reading to 400 cpm. Record adjusted response.

3.2.20 Set ratemeter to x 1,000 (1K) scale.

3.2.21 Set the multiplier knob to the 1K scale.

3.2.22 Set pulse rate to 200,000 pulses/min. using the multiplier knobs. Record reading.

3.2.23 If necessary, adjust the x 1,000 (1K) pot, inside the ratemeter, to bring readings to 200,000 cpm. Record adjusted response.

3.2.24 Repeat steps 3.2.10 thru 3.2.19 for 20,000 pulses/min., 2,000 pulses/min. and 200 pulses/min Decrease the pulse rate scale first, followed by the ratemeter scale.

3.2.25 Verify the initial ratemeter readings for 400,000 pulses/min. thru 400 pulses/min. to insure calibration stability. If stability is not achieved, remove the instrument from service.

3.2.26 Turn off ratemeter and pulse generator and disconnect the cables.

SECTION 5.3

GAMMA SCINTILLATION DETECTOR CHECK-OUT AND CROSS CALIBRATION

1.0 PURPOSE

To describe the procedures for cross calibration and operational check-out of gamma scintillation detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter: Model PRM-6, Eberline Instrument Corporation; or equivalent.

3.1.2 Sodium iodide detector: Model 489-55, Victoreen Instrument Co.; Model SPA-3 or Model PG-2, Eberline Instrument Corporation; or equivalent.

3.1.3 Pressurized Ionization Chamber (PIC), Model RSS-111 or Model RSS-1011, Reuter Stokes Co.

3.1.4 Cable: MHV-MHV; or other connectors, as applicable.

3.1.5 Record forms.

3.1.6 Calibration source.

3.1.7 Check source.

3.2 Procedure

3.2.1 Turn ratemeter on, check batteries, and replace if necessary.

3.2.2 Adjust the high voltage to approximately 900 V.

3.2.3 Turn ratemeter off. Attach scintillation detector and turn ratemeter back on.

3.2.4 Determine the background count average with the ratemeter set to slow response. Record the average count rate on the first data line of the Instrument Operational Check-Out Form (Figure B-1, or equivalent).

3.2.5 Determine the acceptable background response limits by setting the ratemeter to fast response. Record the actual lowest and highest values observed.

NOTE: If the site background is not consistent with the predetermined background response range, a new range shall be established and noted on the form.

3.2.6 Choose a check source with a gamma energy distribution representative of the radioactive material of concern at the survey site.

3.2.7 Determine the check source count rate by placing a gamma check source (e.g., Co-60, Cs-137) on the front of the detector. Record the count rate on the first data line of the record form. Also, determine and record the $\pm$ 10% variation of the check source count rate as the source response limits.

NOTE: The form and check source are to accompany the instrument to the field survey site.

3.2.8 Perform cross-calibration.

3.2.8.1 Assemble PIC, turn on, check batteries, and allow to stabilize approximately 5 minutes.

3.2.8.2 Place the PIC at a location of measurable activity. If no such areas are present perform the calibration at 6 to 10 locations on the site. Adjust the tripod to position the center of the PIC chamber at 1 meter above the surface.

3.2.8.3 Determine the exposure rate (see Section 7.3). Record on Cross Calibration Form (Figure B-3, or equivalent).

3.2.8.4 Remove the PIC and measure the scintillation detector count rate at 1 meter above the surface. Record this value on the Cross Calibration Form (Figure B-3, or equivalent).

3.2.8.5 Repeat steps 3.2.6.2 to 3.2.6.4 for locations of different radiation intensities. If possible, obtain calibration points throughout the entire range of radiation levels noted on the site. In this case a minimum of 5 different measurements in each of the ranges - <20 μR/h, 20 to 100 μR/h, and 100 to 500 μR/h is recommended.

3.2.8.6 Prepare a calibration curve of detector count rate versus exposure rate. There is a computer program which will generate a table of these values.

NOTE: Calibration curves determined using cable lengths of 3 meters or less are not necessarily applicable to instrument/detector combinations using cables greater than 3 meters long.

3.2.9 Consistent Instrument Display

For sites where several instrument/detector units will be used in the same area, units may be adjusted to display similar responses.

3.2.9.1 Obtain a gamma radiation source with an activity great enough to be distinguished at a distance of 1 meter.

3.2.9.2 Place each of the detectors at a prescribed distance from the source and check readings. The distance should be a minimum of 3 feet, chosen to give a detector/instrument response >10,000 cpm.

3.2.9.3 If all units do not respond within 10% of each other, adjust the high voltages to obtain the same meter response. The voltage should be between 750 and 950 volts; if outside this range, do not attempt to use the detector for this purpose.

3.2.9.4 If voltage adjustments were necessary, perform items 3.2.4 through 3.2.7 again.

3.2.9.5 Record operational voltage on the Instrument Operational Check-Out Form (Figure B-1, or equivalent). If the voltage has been set to a value other than 900 V, indicate in the Comments section that the Operating Voltage was adjusted to allow for consistent response between instruments at this site.

SECTION 5.4

ALPHA SCINTILLATION DETECTOR CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedures for calibration and operational check-out of alpha scintillation detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2220 or 2221 Ludlum Instrument Corporation; or equivalent.

3.1.2 Alpha detector: Model AC3-7, Eberline Instrument Corporation; or equivalent.

3.1.3 Cable: CP1-CP1; C-CP1; or other connectors, as applicable.

3.1.4 Record forms.

3.1.5 Calibration sources.

3.1.6 Check source.

3.2 Procedure

3.2.1 Attach the alpha detector to a portable ratemeter-scaler.

3.2.2 Turn the instrument to the HV position. Note condition of battery as indicated by digital display. Press the "LIGHT" switch. If the "BATT OK" legend does not remain displayed, battery power is marginal and batteries should be replaced.

3.2.3 Adjust the threshold setting accordingly for the following instrument/detector combinations.

PRS-1/AC3-7	2.0(20mv)
Ludlum 2221/AC3-7	200(20mv)

3.2.4 Turn on instrument audio and direct detector face to a source of light to check for "light leaks". Repair or replace detector face as necessary.

3.2.5 Construct a Plateau Curve.

The operating voltage is determined based on the characteristics of a plateau curve. Curves are constructed once a year, after major repairs to a detector, and when a new detector is received. These curves are kept on file in the instrument room.

3.2.5.1 Place the detector on one of the alpha calibration sources having a disintegration rate greater than 50,000 dpm.

3.2.5.2 Turn the high voltage down, then gradually increase voltage until the meter begins to register counts.

3.2.5.3 The speaker unit may now be turned off.

3.2.5.4 Accumulate counts for 0.5 minute.

3.2.5.5 Record voltage setting and count rate.

3.2.5.6 Increase voltage to next higher even multiple of 50 V.

3.2.5.7 Accumulate counts for 0.5 minute and record voltage and count rate.

3.2.5.8 Repeat 3.2.5.6 and 3.2.5.7 until the count rate begins to increase rapidly with increased voltage. Do not increase the voltage into the continuous discharge range as damage to the instrument/detector may result.

3.2.5.9 Prepare a graph of count rate vs. voltage. This graph should consist of a relatively flat section where there is little increase in count rate over a voltage range of up to several hundred volts. This voltage range is called the plateau region of the detector.

3.2.5.10 Select a voltage at the midpoint of the plateau region as the operating voltage and indicate the value on the graph. Adjust the instrument voltage tc this setting. (This operating voltage typically ranges between 950 and 1250 volts.)

3.2.6 Record the predetermined operating voltage and threshold on the Calibration Form (Figure B-4, or equivalent).

3.2.7 Determine the detector background count for 5 minutes. If the count rate is zero or exceeds 3 cpm repeat the count. If it falls out of this range again, the unit should be removed from service until repairs can be made. Calculate and record the count rate per minute on the Calibration Form (Figure B-4, or equivalent).

3.2.8 Select a count time which will provide an accumulation of 10,000 gross counts with an alpha calibration source.

3.2.9 Set the detector on the source and accumulate the count. Record the scurce identification number and the source count.

3.2.10 Reverse the detector position and repeat the count.

3.2.11 Subtract the background count rate from the calibration source counts.

3.2.12 Calculate the response efficiency for both detector/source arrangements. Determine the operating efficiency by averaging the efficiencies obtained from the two measurements and rounding the result to two significant figures. Record all information. (The counting efficiency for an AC3-7 typically ranges from 13-20%.)

3.2.13 Calculate the minimum detectable activity (MDA) using the following formula:

$$MDA = \frac{2.71 + (4.66\sqrt{B})}{T \times E \times G}$$

MDA = activity level in disintegrations/minute/100 cm^2
B = background (total counts)
T = count time (min) to be used for field measurements
E = operating efficiency $\left(\frac{\text{counts}}{\text{disintegration}}\right)$
G = geometry $\left(\frac{\text{detector area cm}^2}{100}\right)$

This formula calculates the activity level in dpm/100 cm^2 which can be detected with 95% confidence of having neither a false positive nor a false negative result.

Compare this value to the site guidelines to determine adequate sensitivity of the instrumentation. An MDA that is less than 50% of the applicable criteria is desirable.

3.2.14 Position an alpha check source at the front portion of the detector. Accumulate the count for one minute. Record the source position, count rate and time. Remove the detector from the source. Reposition the detector and source and repeat the count. Repeat 10 times. Calculate the average value and the 3 sigma deviation. The 3 sigma value should be ≤ 10% of the mean. If it is not, the instrument/detector combination must be removed from service until repairs can be made. Record all information.

NOTE: This same check source is to accompany the calibrated instrument to the field survey site.

3.2.15 Prepare an Instrument Operational Check-Out Form (Figure B-1, or equivalent). Enter the average check source count rate, the average background count rate and the count times on the first data line. Also enter acceptable range limits for the check source. The background range should be established as 0-3 cpm.

NOTE: This form accompanies the instrument to the survey site.

3.2.16 Daily instrument operational check-out is performed according to Section 5.1.

SECTION 5.5

GM DETECTOR CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedures for calibration and operational check-out of GM detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2220 or 2221 Ludlum Instrument Corporation; or equivalent.

3.1.2 GM detector: Model HP-260 (GM "Pancake"), or equivalent.

NOTE: The HP-260 detector face may be covered with a thin layer of tracing paper to provide a total thickness of 7 mg/cm^2 which will increase the degree of protection of the detector face from accidental puncture and contamination and shield out alpha particle contributions. If a shield is to be used, all calibration and operational check-out procedures should be performed with the shield in place.

3.1.3 Cable: CP1-BNC; C-BNC; or other connectors, as applicable.

3.1.4 Record forms.

3.1.5 Calibration sources.

3.1.6 Check source.

3.2 Procedure

3.2.1 Attach the GM detector to a portable ratemeter-scaler.

3.2.2 Turn instrument to HV. Note condition of battery as indicated by digital display. Press the "LIGHT" switch. If the "BATT OK" legend does not remain displayed, battery power is marginal and batteries should be replaced.

3.2.3 Set the threshold display accordingly for the following combinations.

PRS-1/HP260	5.0	(50mv)
Ludlum 2220/HP260	500	(50mv)
Ludlum 2221/HP260	500	(50mv)

3.2.4 Adjust the high voltage to 900 volts.

3.2.5 Determine the detector background for 1 minute. Repeat 10 times. Calculate the average value, the 3 sigma deviation and the allowable range. Record the information on the Calibration Form (Figure B-4, or equivalent).

3.2.6 Select count time which will provide an accumulation of 10,000 gross counts with an appropriate beta calibration source.

3.2.7 Place the detector on the source and accumulate the count. Record the source identification number and the source count.

3.2.8 Subtract the background count rate from the calibration source counts.

3.2.9 Calculate the detector efficiency and round the result to two significant figures. Record the operating efficiency. (The counting efficiency typically ranges from 15-18%).

3.2.10 Calculate the minimum detectable activity (MDA) using the following formula:

$$MDA = \frac{2.71 + (4.66\sqrt{B})}{T \times E \times G}$$

MDA = activity level in disintegrations/minute/100 cm^2
B = background (total counts)
T = count time (min) to be used for field measurements
E = operating efficiency $\left(\frac{\text{counts}}{\text{disintegration}}\right)$
G = geometry $\left(\frac{\text{detector area } cm^2}{100}\right)$

This formula calculates the activity level in dpm/100 cm^2 which can be detected with 95% confidence of having neither a false positive nor a false negative result.

Compare this value to the site guidelines to determine adequate sensitivity of the instrumentation. An MDA that is less than 50% of the applicable criteria is desirable.

3.2.11 Position a beta-gamma check source (e.g., Co-60, Sr-90) on the detector. Accumulate the count for one minute. Record the count rate and time. Remove the detector from the source. Reposition the detector and source and repeat the count. Repeat 10 times. Calculate average value and the 3 sigma deviation. The 3 sigma value should be $\leq$ 10% of the mean. If it is not, the detector must be removed from service until repairs can be made. Record all information.

NOTE: This same check source is to accompany the calibrated instrument to the field survey site.

3.2.12 Prepare a daily Instrument Operational Check-Out Form (Figure B-1, or equivalent). Enter the average check source count rate, the average background count rate and the count times on the first data line. Enter acceptable range limits for check source and background response.

NOTE: This form accompanies the instrument to the survey site.

3.2.13 Daily instrument operational check-out is performed according to Section 5.1.

SECTION 5.6

PROPORTIONAL DETECTOR CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedures for calibration and operational check-out of proportional detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model 2220 or 2221 Ludlum Instrument Corporation; or equivalent.

3.1.2 Proportional detector: Model 43-68 Ludlum Instrument Corporation; or equivalent.

3.1.3 Cable: C-C; or other connectors, as applicable.

3.1.4 Record forms.

3.1.5 Calibration sources.

3.1.6 Check source.

3.2 Procedure

3.2.1 Purge detector

3.2.1.1 Attached P-10 gas supply and detector outlet hoses to flow meters. Refer to operating manual.

3.2.1.2 Turn on main bottle valve and adjust flow rate to approximately 100 cc/min. Allow to purge for 5 minutes. Reduce flow to approximately 40 cc/min and continue purging for 20 minutes.

3.2.1.3 Attach the detector to a portable ratemeter-scaler.

3.2.1.4 Check the condition of the batteries. The instrument is fully charged at 6 volts. Models 2220 and 2221 are inoperable at 4.4 volts or less. Replace batteries if necessary.

3.2.1.5 Adjust the threshold setting to 50 (5.0mV). (This value applies to both the alpha and the alpha-beta modes.)

3.2.1.6 Set high voltage to approximately 1100 V. Note source count rate.

3.2.1.7 Note source count rate two (2) minutes later. If the count rate varies by greater than ± 10%, continue purging and checking until the rate is stabilized. If the second count is within ± 10% of first count, unit is adequately purged and ready for use. Record purge check values on the Calibration Form (Figure B-4, or equivalent).

3.2.1.8 Disconnect the out flow line and replace with a tubeless coupling to allow for continuous venting of the system. Continuous flow is required during calibration.

NOTE: Unit may be used in the static mode if a good seal can be established. The length of time a static purge can be maintained varies for individual detectors. To operate in static mode disconnect both hoses from the detector. Begin checking source response as soon as the background count rate begins to drop off. If a decline of approximately 10% or more is noted, the system must be repurged.

3.2.2 Construct a Plateau Curve

The operating voltage is determined based on the characteristics of a plateau curve. Curves are constructed once a year, after major repairs to a detector, and when a new detector is received. These curves are kept on file in the instrument room.

3.2.2.1 Place the detector on one of the alpha calibration sources having a disintegration rate greater than 50,000 dpm.

3.2.2.2 Turn the high voltage down, then gradually increase voltage until the meter begins to register counts.

3.2.2.3 The speaker unit may now be turned off.

3.2.2.4 Accumulate counts for 0.5 minute.

3.2.2.5 Record voltage setting and count rate.

3.2.2.6 Increase voltage to next higher even multiple of 50 V.

3.2.2.7 Accumulate counts for 0.5 minute and record voltage and count rate.

3.2.2.8 Repeat 3.2.5.6 and 3.2.5.7 until the count rate begins to increase rapidly with increased voltage.

3.2.2.9 Prepare a graph of count rate vs. voltage. This graph should consist of a relatively flat section where there is little increase in count rate over a voltage range of up to several hundred volts. This voltage range is called the plateau region for the detector.

3.2.2.10 Select an alpha operating voltage at the midpoint of the plateau region and indicate the value on the graph. (This operating voltage typically ranges between 1000 and 1300 volts.)

3.2.2.11 If detection of beta is also required, place the detector on a beta calibration source having a disintegration rate greater than 50,000 dpm. Continue accumulating and recording 0.5 minute counts at 50 V increments to obtain the alpha-beta plateau. This region will not be as "flat" as the alpha operating region but should still be distinguishable. Do not increase the voltage into the continuous discharge range as damage to the instrument/detector may result.

3.2.2.12 Select the alpha-beta operating voltage slightly above the "knee" at least 75 V below the level of continuous discharge. Indicate the operating voltage on the graph. (This operating voltage typically ranges between 1,500 to 1,750 volts).

NOTE: If the plateau region is not distinguishable, adjust voltage and accumulate 0.5 minute counts at each 25 V increment in the region where the plateau is expected to occur.

3.2.3 Adjust the instrument setting to the predetermined alpha operating voltage and record the value on the Calibration Form (Figure B-4, or equivalent).

3.2.4 Determine the detector background counts for 5 minutes. If the count rate is zero or exceeds 3 cpm, repeat the count. If it falls out of this range again, the unit should be removed from service until repairs can be made. Calculate and record the count rate per minute.

3.2.5 Select count time which will provide an accumulation of 10,000 gross counts with an alpha calibration source.

3.2.6 Position the alpha calibration source at the approximate center of the detector and accumulate the count. Record the source identification number and the source count.

3.2.7 Calculate the detector efficiency and round the result to two significant figures. (Typical efficiencies range from 18 to 21%). Record the operating efficiency.

3.2.8 Calculate the minimum detectable activity (MDA) using the following formula:

$$MDA = \frac{2.71 + (4.66\sqrt{B})}{T \times E \times G}$$

MDA = activity level in disintegrations/minute/100 cm^2
B = background (total counts)
T = count time (min) to be used for field measurements
E = operating efficiency $\left(\frac{counts}{disintegration}\right)$
G = geometry $\left(\frac{detector\ area\ cm^2}{100}\right)$

This formula calculates the activity level in dpm/100 cm^2 which can be detected with 95% confidence of having neither a false positive nor a false negative result.

Compare this value to the site guidelines to determine adequate sensitivity of the instrumentation. An MDA that is less than 50% of the applicable criteria is desirable.

3.2.9 Position an alpha check source at the approximate center of the detector and accumulate the count for one minute. Record the source position, count rate and time. Remove the detection from the source. Reposition the detector and source and repeat the count. Repeat 10 times. Calculate the average value and the 3 sigma deviation of these numbers.

The 3 sigma value should be ≤ 10% of the mean. If it is not, the instrument/detector combination must be removed from service until repairs can be made. Record all information.

NOTE: This same check source is to accompany the calibrated instrument to the field survey site.

3.2.10 Prepare a daily Instrument Operational Check-Out Form (Figure B-1, or equivalent). Enter the average check source count rate, the average background count rate and the count times on the first data line. Enter acceptable range limits for background and check source response.

NOTE: This form accompanies the instrument to the survey site.

3.2.11 Daily instrument operational check-out is performed according to Section 5.1.

3.2.12 Adjust the voltage to the specified alpha-beta operating voltage and record the value on the Calibration Form (Figure B-4, or equivalent).

3.2.13 Determine the alpha-beta background for 1 minute. Repeat 10 times. Calculate the average value, the 3 sigma deviation, and the range. Record the information on the back of the form.

3.2.14 Repeat steps 3.2.5 through 3.2.10 using beta calibration sources of an energy applicable to the survey site. (Typical efficiencies range from 20-23%.)

NOTE: Problems have been noted when using proportional detectors in high altitude areas. It may be necessary to establish the operating voltage and perform calibration on-site. Special arrangements must be made through the Technical Resource Manager to remove the calibration sources from the laboratory.

SECTION 5.7

PRESSURIZED IONIZATION CHAMBER CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedure for operational check-out of the pressurized ionization chamber

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 The pressurized ionization chamber is used as a secondary standard for cross calibration of other gamma measuring instruments. Calibration of this equipment is therefore performed by the manufacturer. Recalibration is to be performed biennially or at any time repairs of the instrument are required.

3.2 Immediately following calibration by the manufacturer the initial operational check-out is to be performed on the PIC.

3.2.1 Assemble PIC, turn on, check rechargeable and 300 V batteries. Recharge and/or replace batteries if necessary. Allow to stabilize for approximately 5 minutes.

3.2.2 Determine the background and the gross and net check source exposure rates and record the information on the PIC Tracking Form (Figure B-5, or equivalent).

3.2.3 Record the acceptable range for the response to the check source as ± 10% of the net value.

NOTE: This form is kept in the instrument room files.

3.3 Prior to transport to a survey site, an operational check-out is to be performed on the PIC.

3.3.1 Assemble PIC, turn on, check batteries and allow to stabilize for approximately 5 minutes.

3.3.2 Transfer the acceptable net check source (See 3.2.3) response limits from the PIC Tracking Form to the PIC Field Check-Out Form (Figure B-6, or equivalent).

3.3.3 Determine and record the background, and the gross and net check source exposure rates.

3.3.4 Compare the net check source exposure rate to the acceptable net check source response limits. If the response is within the limits, record the information for the background measurement and the gross and net check source measurements on the first line of the PIC Field Check-out Form, (the line marked "ORAU DATA") and on the next available line of the PIC Tracking Form. If the net exposure rate does not fall within the acceptable range limits, remove the PIC from service until repairs can be made.

NOTE: The PIC Field Check Form accompanies the instrument to the field survey site.

SECTION 5.8

COMPENSATED GM DETECTOR CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedures for calibration and operational check-out of energy compensated GM detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; or equivalent.

3.1.2 Energy compensated GM detector: Model HP-270, Eberline Instrument Corporation; or equivalent.

3.1.3 Cable: CP1-BNC; or other connectors, as applicable.

3.1.4 Record forms.

3.1.5 Calibration source.

3.1.6 Check source.

3.2 Procedure

3.2.1 Attach the detector (shield closed) to a portable scaler.

3.2.2 Turn on, check batteries, and replace if necessary.

3.2.3 Adjust high voltage to 900 V and threshold to 5 (50 mV).

3.2.4 Determine background for 5 minutes and calculate background count rate. Record the value.

3.2.5 Cross-calibration can be performed; as for gamma scintillation detectors, see Section 5.3, items 3.2.9.1 to 3.2.9.6. Calibration for exposure rates at levels exceeding the capability of the PIC can be performed under the direction of staff health physicists and the ORISE Office of Safety and Environmental Assurance. Record information on the Cross Calibration Form (Figure B-3, or equivalent) or the Exposure Rate Calibration Data Form (Figure B-20, or equivalent)

3.2.6 Determine check source reproducibility by positioning a gamma check source (Co-60 or Cs-137) on the side of the detector and determine and record the count rate on the Calibration Form, (Figure B-4, or equivalent). Repeat 10 times and calculate average and 3 sigma deviation. Record check source range.

NOTE: This same source is to accompany the calibrated instrument to the field survey site.

3.2.7 Prepare an Instrument Operational Check-Out Form (Figure B-1, or equivalent) entering the background and average check source counting rates on the first data line.
NOTE: This form accompanies the instrument to the survey site.

3.2.8 Daily instrument operational check-out is performed according to Section 5.1.

SECTION 5.9

FLOOR MONITOR CHECK-OUT

1.0 PURPOSE

To describe the procedure for operational check-out of floor monitors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent.

3.1.2 Proportional detector: Model 43-37, Ludlum Instrument Company; or equivalent.

3.1.3 Floor monitor cart: model 239-1, Ludlum Instrument Company; or equivalent.

3.1.4 Cable: C-C; or other connectors, as applicable.

3.1.5 Record forms.

3.1.6 Check source.

NOTE: The floor monitor is used only for qualitative determinations and locating areas of surface contamination. It is not used as a measuring device.

3.2 Procedure for Operation in the Alpha Mode

3.2.1 Attach the detector to the ratemeter-scaler.

3.2.2 Turn on, check batteries, and replace if necessary.

3.2.3 Set threshold to 100 (10.0 Mv).

3.2.4 Operating voltage is determined based on plateau curves that are prepared once a year. Files are kept in the instrument room. The voltage will usually be about 1250 V (see Section 5.6).

3.2.5 Attach P-10 gas supply and detector outlet hoses to flow meters. Refer to operating manual.

3.2.6 Turn on main bottle valve and adjust flow rate to approximately 100 cc/min. Allow to purge for 10 minutes.

3.2.7 Decrease flow rate to 40-60 cc/min and purge for at least 20 minutes.

3.2.8 Place a source beneath the detector. Note source count rate.

3.2.9 Note source count rate 2 minutes later. If count rate varies by greater than ± 10% continue purging and checking until the rate is stabilized. If second count is within ± 10% of first count, unit is adequately purged and ready for use. Record purge check values on the Calibration Data Form (Figure B-4, or equivalent).

3.2.10 If operation in "static" mode is necessary, disconnect hoses from the detector and turn off main gas valve. If continuous flow is to be used, the flow rate may remain at approximately 40 cc/min.

3.2.11 Remove source and record background count rate.

3.2.12 Turn on speaker unit and check audible response, with and without headphones connected.

3.2.13 Place the alpha check source beneath the detector. Determine if the floor monitor is responding to the alpha check source. If it is, proceed to next step; if not, consult the site coordinator.

3.2.14 Recheck source response about every 15 minutes while operating in static mode. Unit should maintain a purge for approximately two (2) hours following purging. If count rate drops by more than 25%, repurge detector.

3.3 Procedure for Operation in the Alpha-Beta Mode

3.3.1 Attach the detector to the ratemeter.

3.3.2 Turn on, check batteries, and replace if necessary.

3.3.3 Operating voltage is determined based on plateau curves that are prepared once a year. Files are kept in the instrument room. The voltage will usually be about 1750 V (see Section 5.6, item 3.2.2).

3.3.4 Attach P-10 gas supply and detector outlet hoses to flow meters. Refer to operating manual for specific instructions.

3.3.5 Turn on main bottle valve and adjust flow rates to approximately 100 cc/min. Allow to purge for 10 minutes.

3.3.6 Decrease flow rate to 40-60 cc/min. and purge for at least 20 minutes.

3.3.7 Place the source beneath the detector. Note source count rate.

3.3.8 Note source count rate 2 minutes later. If count rate varies by greater than ± 10% continue purging and checking until the rate is stabilized. If second count is within ± 10% of first count, unit is adequately purged and ready for use. Record purge check values on the Calibration Data Form (Figure B-4, or equivalent).

3.3.9 If operation in "static" mode is necessary, disconnect hoses from the detector and turn off main gas valve. If a continuous flow is to be used, the flow rate may remain at approximately 40 cc/min.

3.3.10 Remove source and record background count rate.

3.3.11 Turn on speaker unit and check audible response with and without headphones attached.

3.3.12 Unit should maintain a purge for approximately two (2) hours following purging. Recheck source response about every 15 minutes. If count rate drops by more than 25%, repurge detector.

NOTE: Remove the gas tank and detector head from floor monitor before transporting. Appropriate shipping papers must accompany the P-10 gas during transport, (see Section 10.0).

SECTION 5.10

IONIZATION SURVEY METER CALIBRATION AND CHECK-OUT

1.0 PURPOSE

To describe the procedures for calibration and operational check-out of ionization survey meters

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Calibration of the higher range ionization instruments is to be performed under direction of staff health physicists and the ORISE Office of Safety and Environmental Assurance, using standard procedures developed for that operation. Record appropriate information on the Exposure Rate Calibration Data Form (Figure B-20, or equivalent). Copies of the calibration record forms are to be maintained in ESSAP files.

3.2 Prepare a daily Instrument Operational Check-Out Form (Figure B-1, or equivalent) entering the background and average check source counting rates on the first data line.

NOTE: This form accompanies the instrument to the survey site.

3.3 Daily instrument operational check-out is performed according to Section 5.1.

SECTION 5.11

COLLIMATED GAMMA SCINTILLATION DETECTOR CHECK-OUT

1.0 PURPOSE

To describe the procedure for performing the operational check-out of collimated gamma scintillation detectors

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model 2200, Ludlum Instrument Co.; or equivalent.

3.1.2 Scintillation detector: Model 489-55, Victoreen Instrument Co.; or equivalent.

3.1.3 Lead collimator for scintillation detector, approximately 1 cm thick with four 2.5 cm x 7 mm slots at the detector midpoint, ORISE design.

3.1.4 Cable: C-MHV; or other connectors, as applicable.

3.1.5 Record forms.

3.1.6 Check source.

3.2 Procedure

3.2.1 Assemble the scintillation detector/collimator and attach to the ratemeter-scaler.

3.2.2 Turn on, check batteries, and replace if necessary.

3.2.3 Adjust the high voltage to 900V and the threshold to 10 mV.

3.2.4 Prepare a daily Instrument Operational Check-Out Form (Figure B-1, or equivalent). Determine and record the instrument background count rate on the first data line.

3.2.4.1 Position a gamma check source over one of the slots on the collimator. Determine the check source response count rate and ± 10% variation of the check source response.

3.2.4.2 Record the check source response count rate on the first data line. Also enter the acceptable range limits for the check source.

NOTE: This form accompanies the instrument to the survey site.

SECTION 5.12

FIELD MEASURING TAPE CALIBRATION

1.0 PURPOSE

To describe the procedure for maintaining a standardized measuring tape and calibrating field survey tapes

2.0 RESPONSIBILITIES

2.1 Technical Resources Manager is responsible for assuring that this procedure is implemented, and for maintaining custody of the standards reference tape.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 General

3.1.1 Tapes used for field survey measurements are to be calibrated upon receipt from the manufacturer and if damage or discrepancies are identified or suspected.

3.1.2 Tapes are calibrated by comparing them with the INVAR Standard Tape. This tape remains in the custody of the program's Laboratory Manager and is used only for calibration purposes.

3.1.3 Each field measuring tape is assigned a unique identification number.

3.1.4 Tapes should be in agreement with the INVAR Standard to within 1.0% (e.g., 1.0 m per 100 m), at each calibration point. If not, the tape is to be removed from service until the differences can be resolved.

3.1.5 Originals of calibration records are maintained for each field measuring tape. A copy may be taken to the field, if necessary.

3.1.6 Tapes should be visually inspected for damage prior to initial use and before and after each use.

3.2 Equipment

3.2.1 INVAR standard measuring tape

3.2.2 Field survey tape

3.2.3 Tape calibration form

3.2.4 Survey stake, chaining pin, or other appropriate anchor point

3.3 Calibration

3.3.1 Obtain the INVAR Standard Tape from the Technical Resources Manager.

3.3.2 Determine the section of the field measuring tape to be calibrated. Although the entire tape will usually be calibrated, the procedure may also be used to calibrate sections of tape.

3.3.3 Attach the two tapes to a common anchor point, such that the starting point on the field measuring tape is aligned with the zero point on the INVAR Standard Tape.

3.3.4 Using moderate pressure (that which would be used during typical field measurements) stretch the field measuring tape and hold it adjacent to the INVAR Standard Tape.

3.3.5 Using the Tape Calibration Form (Figure B-7, or equivalent), record the distance intervals for the field measuring tape and INVAR Standard Tape at the starting or zero point and at 1%, 5%, 10%, 25%, 50%, 75%, and 100% of the full tape length being calibrated. For example, if a 30 m length is being calibrated, measurements should be noted at 0, 0.3 m, 1.5 m, 3 m, 15 m, 22.5 m, and 30 m.

3.3.6 Compare the field survey tape and the INVAR Standard Tape to assure that all points satisfy the $\pm$ 1.0% criteria.

3.3.7 If the tape satisfies the criterion, file the form and return the tape to the equipment and supply inventory. If not, mark the tape as unacceptable and initiate actions to determine the reason for discrepancies.

3.3.8 Clean the INVAR Standard Tape (if appropriate) and return it to the Technical Resources Manager.

SECTION 5.13

ROTAMETER CALIBRATION

1.0 PURPOSE

To describe the procedure for the calibration of rotameters, used for air sampling

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 General

3.1.1 A calibration curve shall be made upon initial receipt of a rotameter, following repairs or disassembly for cleaning, if malfunctions are suspected, or within six months of intended use.

3.1.2 Rotameters are to be checked at 25% and 75% of their scale prior to each survey.

3.1.3 Calibration is to be performed using a wet test or dry gas meter.

3.1.4 Originals of calibration records are to be maintained at the Oak Ridge facilities; copies should accompany personnel to the survey location.

3.2 Preparation for Calibration of Rotameters

3.2.1 Equipment

3.2.1.1 Rotameter

3.2.1.2 West Test or Dry Gas Meter

3.2.1.3 Stopwatch

3.2.1.4 Ring Stand or other suitable holding device

3.2.1.5 Air Adjusting Valve

3.2.1.6 Vacuum Pump

3.2.1.7 Record Forms

3.2.1.8 Thermometer

3.2.2 Procedure for Set-Up of Wet Test Meter

3.2.2.1 Level meter using bubble level on top in conjunction with leveling screws on bottom of legs.

3.2.2.2 Fill meter with distilled water by opening valve under funnel and fill until water is level with top of needle in sight tube. Any over-fill can be drained by opening valve on bottom of sight tube.

3.2.2.3 With distilled water in manometer, adjust to zero by sliding graduated scale up or down.

3.2.2.4 Mount the rotameter in a vertical position using a ring stand or other similar device (see Figure 5.14-1).

3.2.2.5 Run 3/8" tubing from the top barbed connector (outlet) of the wet test meter to the lower barbed connector (inlet) of the rotameter.

3.2.2.6 Attach a 3/8" tube from the top barbed connector of the rotameter to the air adjusting valve on the suction side of the pump. If rotameter has a built-in valve, open fully.

3.2.2.7 Close the air adjusting valve and turn on pump. Open valve slowly to keep water from surging into system.

3.2.2.8 Adjust the vacuum relief valve on the pump along with the air adjusting valve to obtain a high rate of air flow (<u>not exceeding 60 cfh or 28 lpm</u>). <u>Do not exceed 5 inches of mercury vacuum on inlet gauge</u>.

3.2.2.9 Aerate the system for approximately one hour before attempting calibrations. Proceed to step 3.3.

3.2.2 Procedure for Set-Up of Dry Gas Meter

3.2.3.1 Mount the rotameter in a vertical position using a ring stand or other similar device (see Figure 5.14-1).

3.2.3.2 Run 3/8" tubing from the outlet side of the dry gas meter to the lower barbed connector (inlet) of the rotameter.

3.2.3.3 Attach a 3/8" tube from the top barbed connector of the rotameter to the air adjusting valve on the suction side of the pump. If rotameter has a built-in valve, open fully.

3.2.3.4 Close the air adjusting valve and turn on pump. Open valve slowly to keep the sight ball of the rotameter from striking the roof of the unit causing possible damage. Proceed to Step 3.3.

3.3 Rotameter Calibration

3.3.1 Adjust rotameter to a low setting representing about 25% of full scale.

3.3.2 Using a stop watch, measure the time required to draw the appropriate volume of air through the meter. Record temperature, time and pressure differential on pump and meter, as appropriate on the Rotameter Calibration Form (Figure B-8, or equivalent).

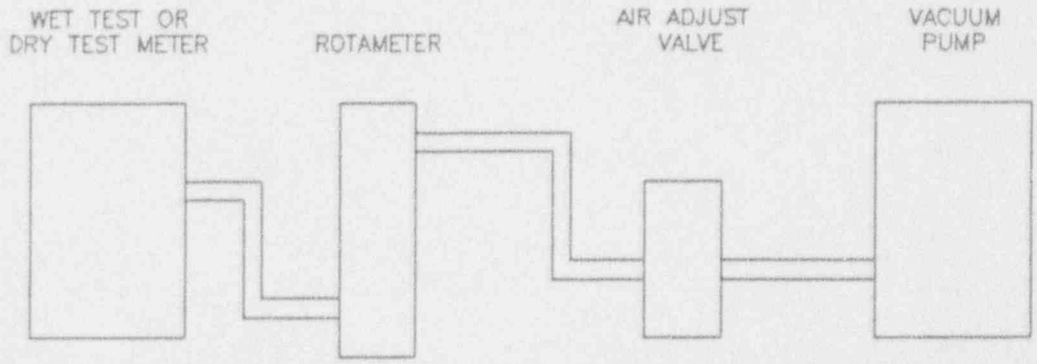
3.3.3 Repeat steps 3.3.1 and 3.3.2 for rotameter settings of 50%, 75% and 100% full scale.

3.3.4 Calculate the actual flow rates using the formula provided.

3.3.5 Plot the actual cfh or lpm data, vs. indicated cfh or lpm, on graph paper.

3.3.6 Record the ambient temperature, and pressure and the pressure differential of the manometer if using the wet test meter on the Rotameter Calibration Form (Figure B-8, or equivalent).

DIAGRAM OF ROTAMETER
CALIBRATION EQUIPMENT



\CHART\FIG1(5-92)

Figure 5.14-1

SECTION 6.0

SITE PREPARATION

SECTION 6.1

CLEARING TO PROVIDE ACCESS

1.0 PURPOSE

To establish a policy regarding requirements for clearing materials from facilities and open land areas in preparation for gridding and survey measurements and sampling

2.0 RESPONSIBILITIES

2.1 Removal or relocation of equipment and materials which may entail special precautions to prevent damage or maintain inventory accountability should be performed by the property owner whenever possible.

2.2 Clearing open land of brush and weeds will usually be performed by a professional land clearing organization under subcontract arrangements. However, survey personnel may perform limited minor land clearing activities as required.

2.3 The site coordinator is responsible for determining the degree of clearing needed and for supervising onsite clearing activities to assure compliance with conditions of survey plans and subcontract agreements.

2.4 The Project Manager will prepare or approve the necessary plans, subcontracts, and other documents describing and implementing the clearing operations.

3.0 PROCEDURES

3.1 The extent of site clearing required in specific areas will be primarily dependent upon the potential for radioactive contamination existing in those areas.

3.1.1 Where the radiological history and/or results of previous surveys do not indicate potential contamination of an area, it may be sufficient to perform only minimum clearing to establish a reference grid system.

3.1.2 Areas where contamination is known to exist or that have a high potential for contamination must be completely cleared to provide access to all surfaces.

3.1.3 Findings as the survey progresses may require that additional clearing be performed.

3.2 Clearing includes providing access to potentially contaminated interior surfaces, e.g., drains, ductwork, tanks, pits, and equipment by removal of covers, disassembly, or other means of producing adequate openings.

3.3 Open land areas may be cleared by heavy machinery, e.g., bulldozers, bushhogs, and hydroaxes; however, care must be exercised to prevent relocations of surface contamination or damage to site features such as drainage ditches, utilities, fences, and buildings.

3.4 Minor land clearing may be performed using manually operated equipment such as brushhooks, power saws, knives, and power trimmers.

3.5 Brush and weeds should be cut to the minimum practical height, not to exceed 30 cm. Care should be exercised to prevent unnecessary damage to or removal of mature trees.

SECTION 6.2

REFERENCE GRID SYSTEM

1.0 PURPOSE

To provide a procedure for establishing a grid system for referencing radiological survey activities

2.0 RESPONSIBILITIES

2.1 Indoor areas and some open land areas may already be gridded as part of the property owner's decontamination and survey activities. Where possible, ORISE surveys will utilize this same grid system.

2.2 Indoor grids not already in place will be established by the ORISE survey team.

2.3 Gridding of open land areas will usually be performed by a professional land survey organization under subcontract arrangements. Survey personnel may perform gridding of small land areas or may subdivide grids established by other groups.

2.4 The site coordinator is responsible for determining the gridding requirements and supervising onsite gridding activities to assure compliance with conditions of survey plans and subcontract agreements.

2.5 The Project Manager will prepare or approve the necessary plans, subcontracts, and other documents describing and implementing gridding operations.

3.0 PROCEDURES

NOTE: All measurements will be made using a calibrated measuring tape (see Section 5.13).

3.1 Selection of Baseline

The grid baseline is generally selected to be the longest dimension of the property or structure, or to be coincident with a property boundary.

3.2 Referencing to Other Systems

3.2.1 Open land grids should be referenced to a location on an existing state or local grid system. (This will usually require the services of a professional land surveyor.)

3.2.2 Building grids may be referenced to a permanent feature of the structure, such as a specific inside corner.

3.3 Grid Dimensions

3.3.1 ORISE prefers to use the metric system for gridding measurements. This system will be used, except where the property owner has established an acceptable grid system in English units.

3.3.2 Grid dimensions will be determined based on the potential for contamination in the area and must also allow for adequate systematic measurement and sampling points. A minimum of 30 grid blocks is required with 60 to 100 blocks preferable (to ensure that the appropriate data manipulation can be performed).

3.4 Open Land Grid System

3.4.1 Equipment

3.4.1.1 Transit/tripod

3.4.1.2 Sight pole

3.4.1.3 Measuring Tape

3.4.1.4 Grid markers; stakes, flags, flagging tape

3.4.1.5 Chaining pins

3.4.1.6 Waterproof marker

3.4.1.7 Fluorescent paint

3.4.1.8 Mallet

3.4.2 The basic ORISE grid interval is 10 m; however, this interval may be decreased or increased, depending on the total property area and the radiological history of the site.

3.4.3 Grid line intersections, also called grid points are marked using stakes, hubs, spikes, paint, flags, or survey tape. The selection of an appropriate marker depends upon the characteristics and routine uses of the surface.

3.4.4 A specific grid point is identified as the reference for the grid. This point, generally near the center or at a corner of the property, is identified on the grid marker as point 0,0.

3.4.5 Coordinates of other grid points are referenced to the 0,0 point using alpha-numeric identifiers. The numeric identifier indicates the distance (meters or feet) and the alphabetic identifier indicates the direction from the reference point, i.e. N(north), S(south), E(east), W(west), or L(left of baseline) and R(right of baseline).

3.4.6 Coordinates are identified on or adjacent to the grid point markers.

3.4.7 Any location within a grid system may be designated by measuring the distance and direction from the point of interest to a grid point marker.

3.4.8 Some examples of grid systems are shown on Figures 6.2-1, 6.2-2 and 6.2-3.

3.5 Building Grid System

3.5.1 Equipment

3.5.1.1 Measuring tape

3.5.1.2 Grid markers; masking tape, markers, paint, chalk

3.5.2 The basic ESSAP building grid interval is 1 meter. If a grid system has been previously established which does not exceed 3 m, ORISE may use that system.

3.5.3 Grid blocks are marked on the floor and lower wall (up to 2 m) using a chalk line or other appropriate marking system. The starting point for referencing the grid is usually selected as the southwest corner of the room. Grid blocks can be identified by the southwest coordinate for floors and the lower left coordinate for walls, or by an assigned grid block number (Figure 6.2-4, 6.2-5).

3.5.4 Grid points (Grid line intersections) are marked using paint, tape, grease pencil, chalk or equivalent. The owner's permission is required before using paint or other markers which may deface the surface.

3.5.5 Grid points are identified using an alpha-numeric system. Lines perpendicular to the baseline are identified alphabetically; lines parallel to the baseline are identified by a number indicating the distance from the baseline.

3.5.6 Any location within a grid system may be designated by measuring the distance from the point of interest to a grid marker.

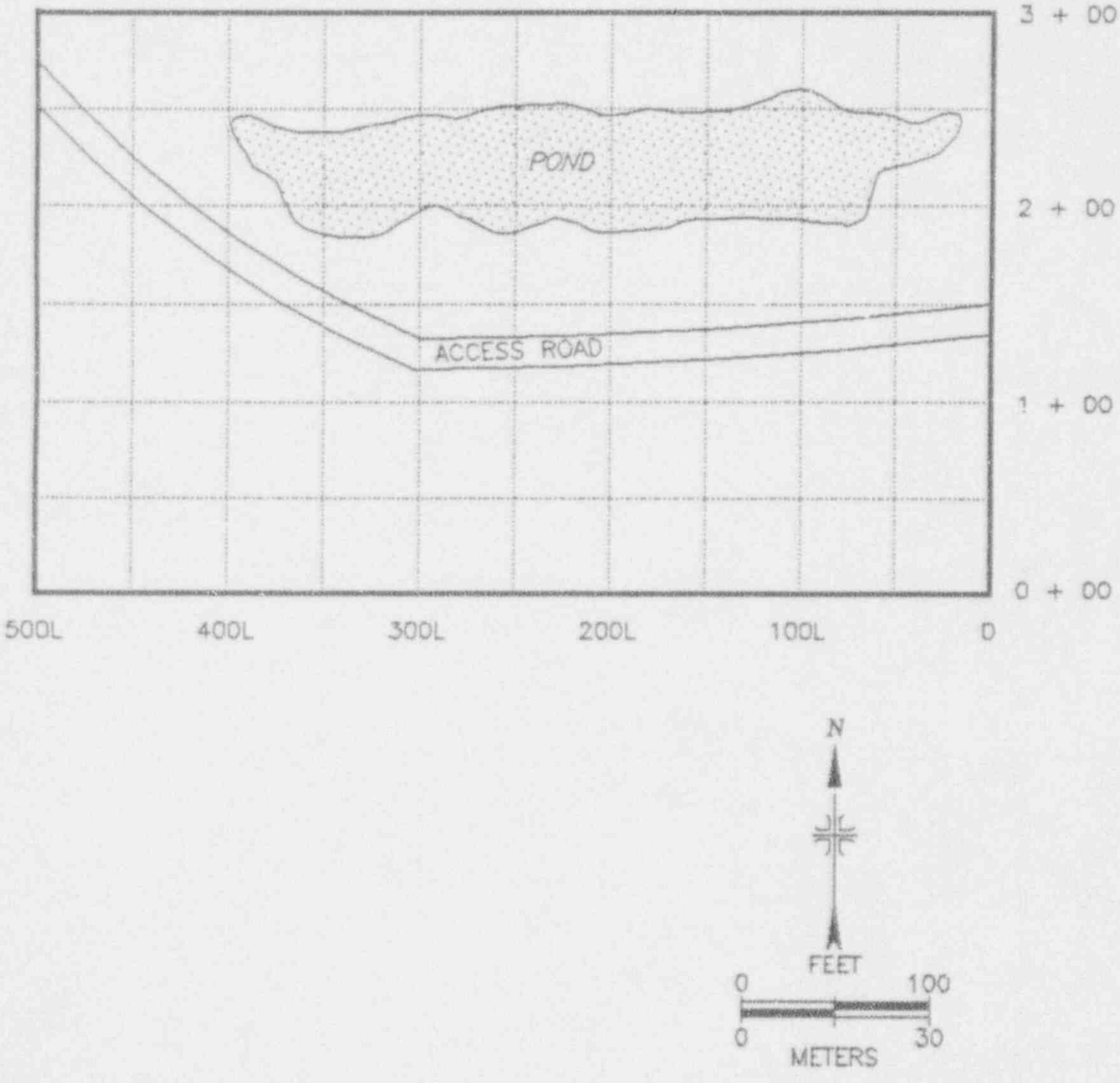
3.5.7 Where buildings contain multiple rooms, it may be convenient to individually grid each room, rather than attempting to include all areas on the same system. This is at the discretion of the site coordinator.

3.5.8 Small rooms (less than 10 m^2) do not require gridding.

3.5.9 Upper walls and ceiling areas are not usually gridded. Measurements on these surfaces are referenced to prominent building features or to locations corresponding to the gridded floor and lower walls.

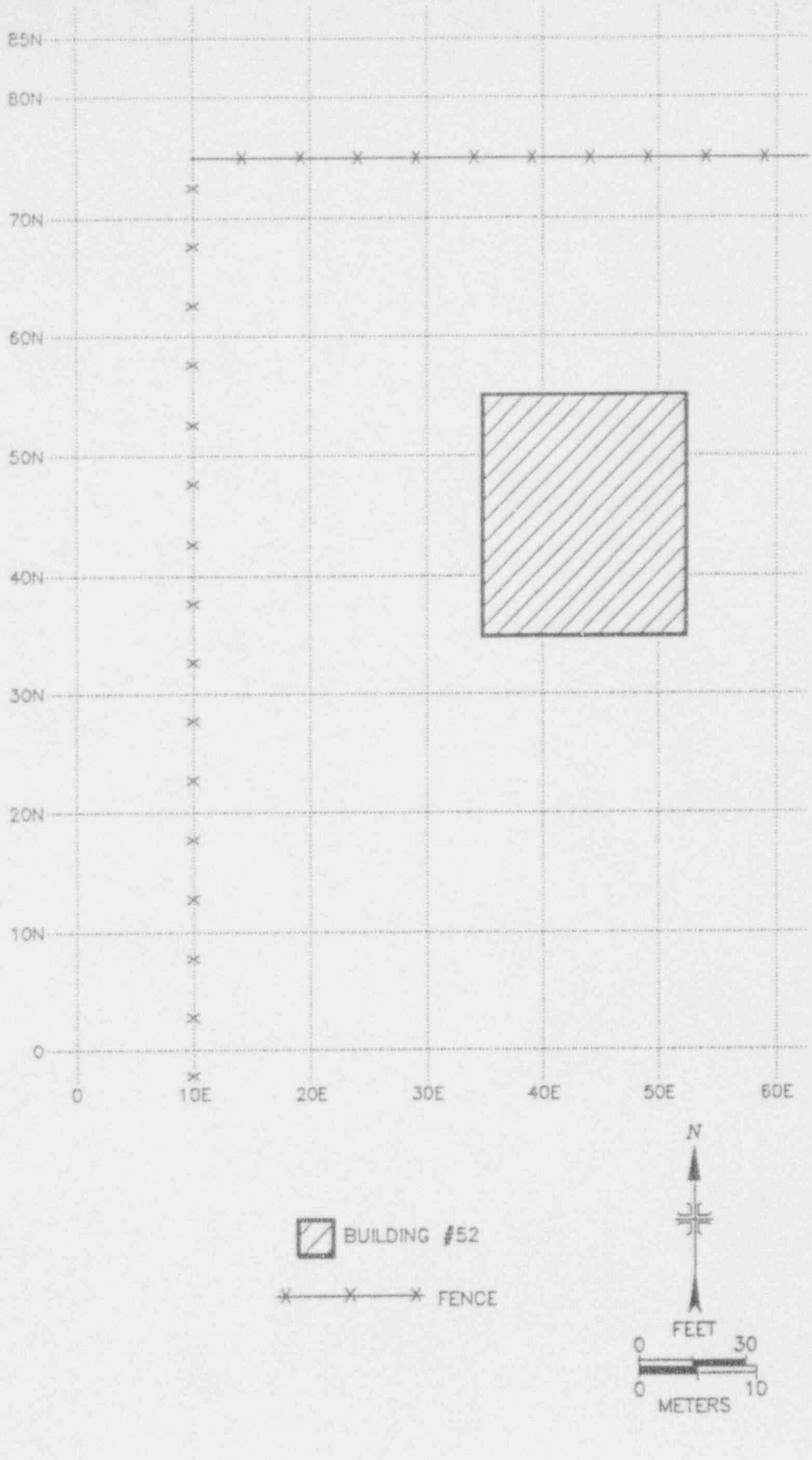
3.6 Site Drawings

Following establishment of the grid system, a drawing is prepared by the survey team or the land surveyor, indicating the grid, site boundaries, and other pertinent site features. A legend must be included on the drawing indicating the following information: site name, surveyor, date, distance scale and reference compass direction. Drawings used to record data must first be made permanent by tracing in ink or producing a photocopy prior to the addition of data to the page.



LAB20(5-92)

Figure 6.2-1



LAB15(5-92)

Figure 6.2-2

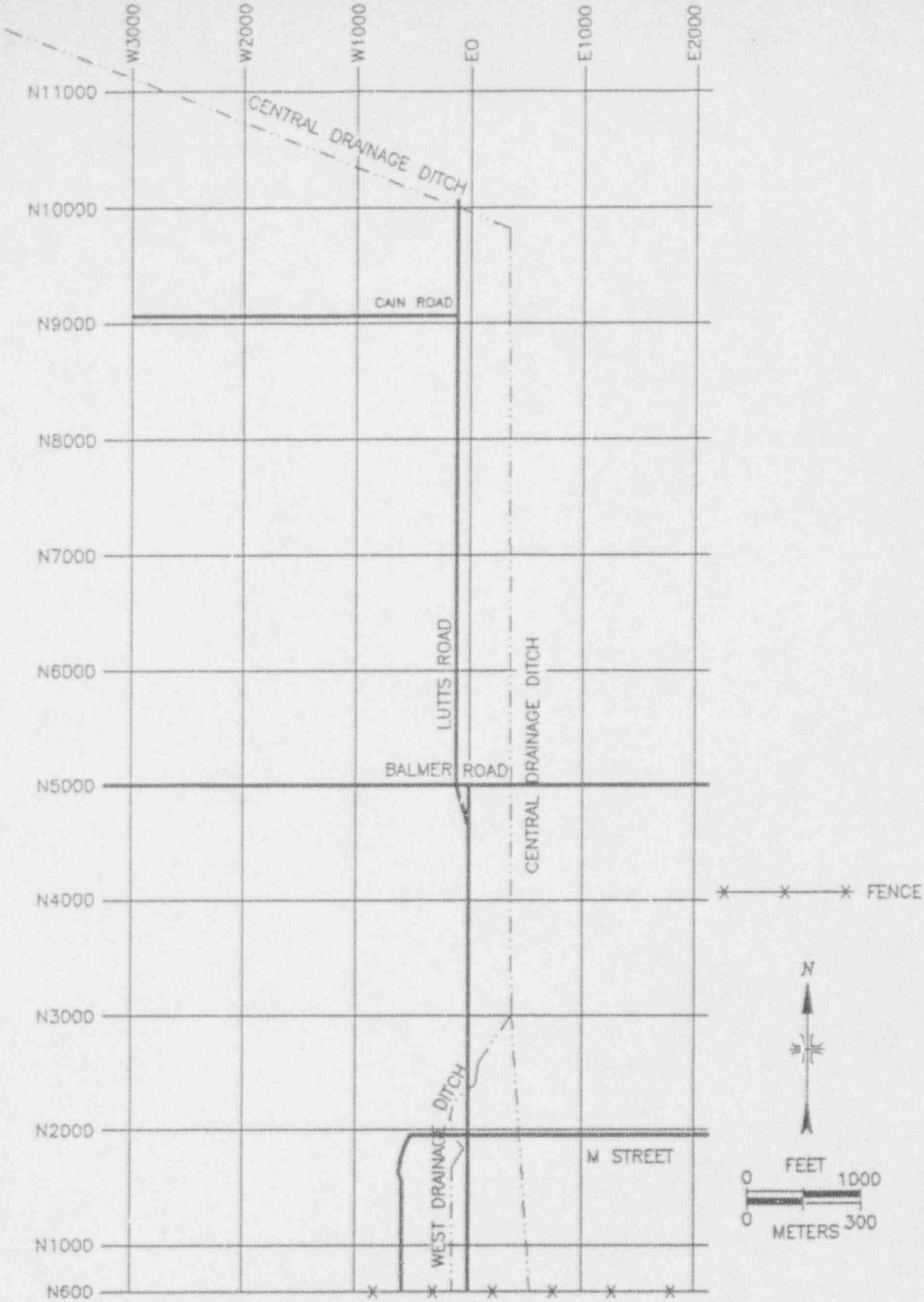
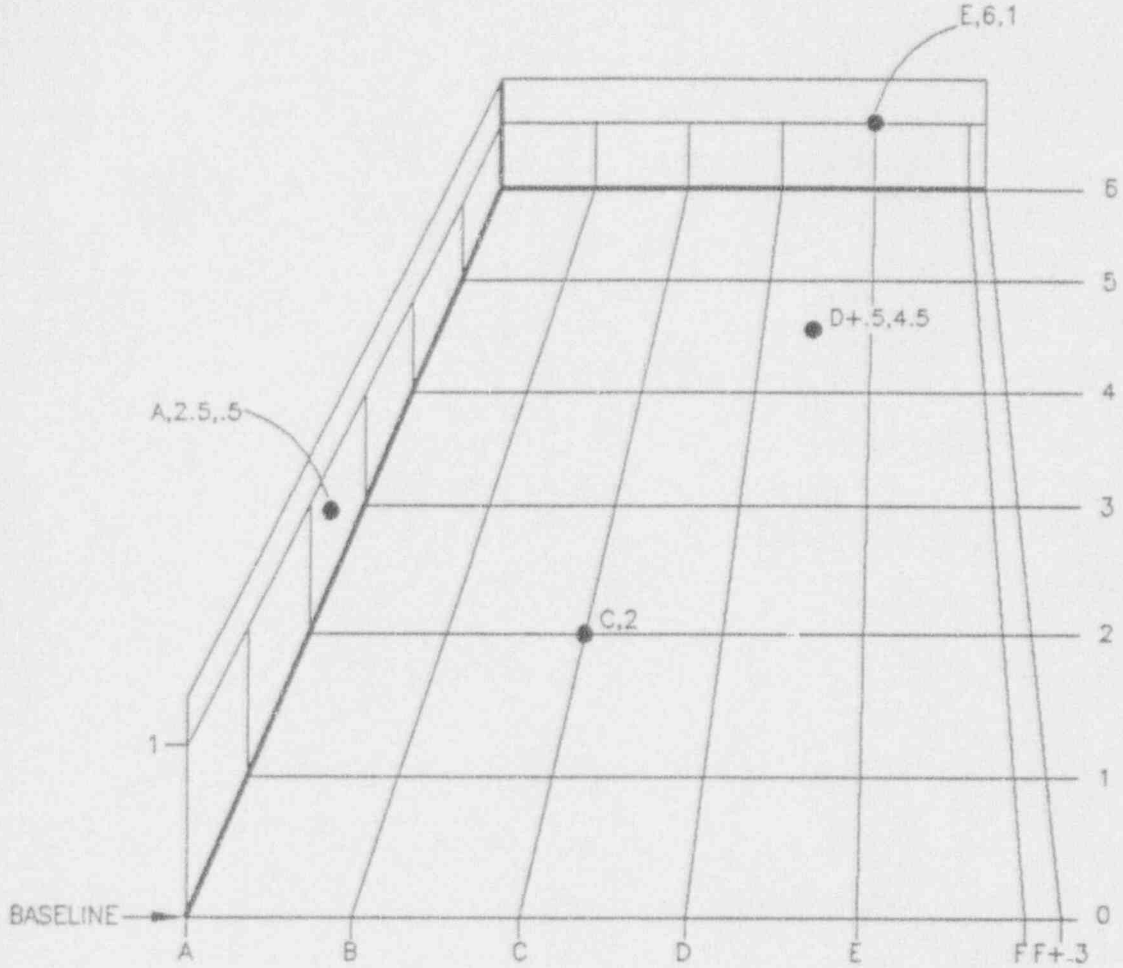
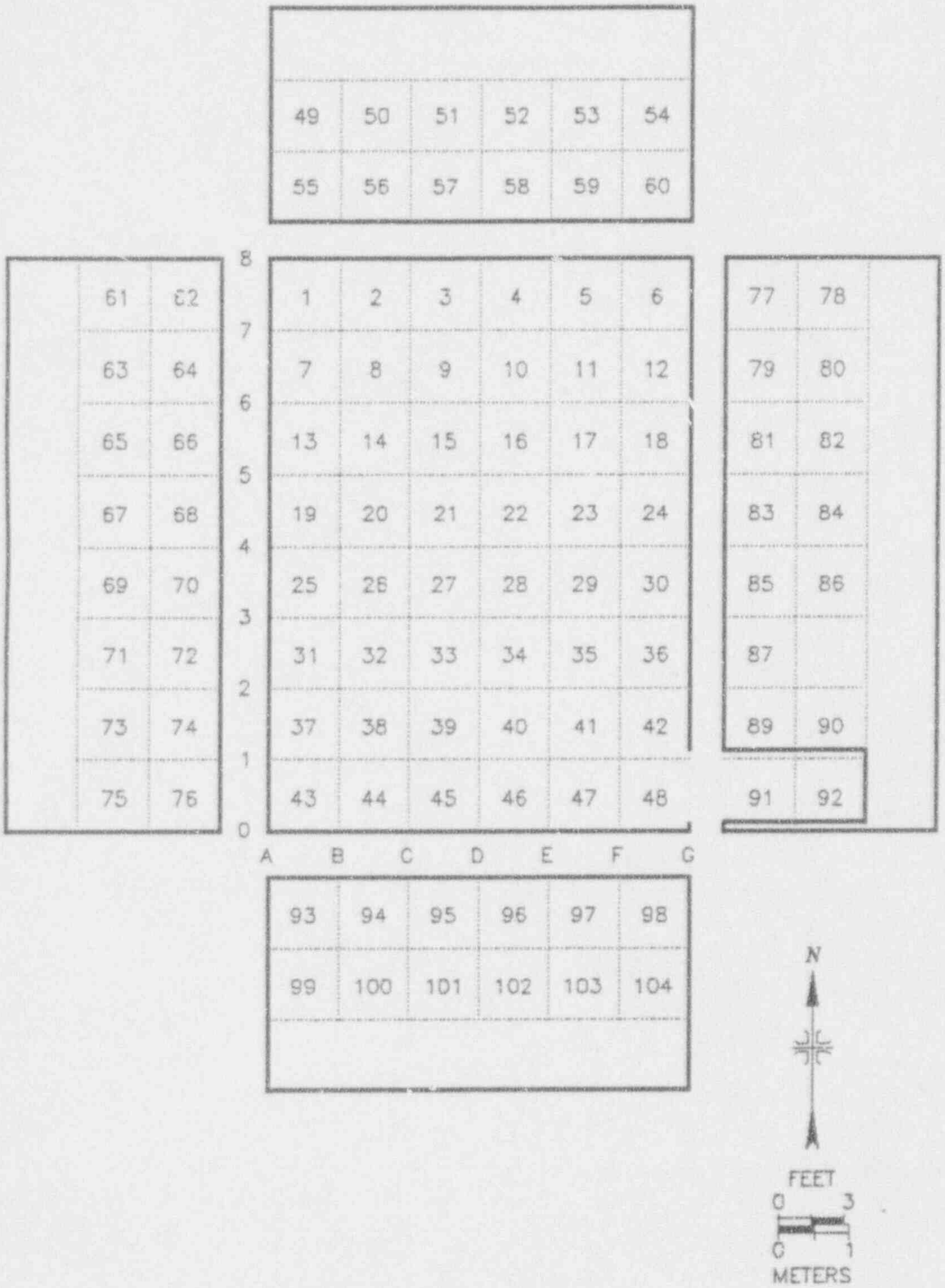

W3000
W2000
W1000
E0
E1000
E2000
N11000
N10000
N9000
N8000
N7000
N6000
N5000
N4000
N3000
N2000
N1000
N600
CENTRAL DRAINAGE DITCH
CAIN ROAD
LUTTS ROAD
CENTRAL DRAINAGE DITCH
BALMER ROAD
FENCE
N
WEST DRAINAGE DITCH
M STREET
FEET
0
1000
0
300
METERS
DOE PROPERTY

Figure 6.2-3



LAB14(5-92)

Figure 6.2-4



LAB15(5-92)

Figure 6.2-5

SECTION 7.0

SCANNING AND MEASUREMENT TECHNIQUES

SECTION 7.1

SURFACE SCANNING

1.0 PURPOSE

To provide a method for identifying areas of elevated surface radiation

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

Surfaces are scanned to determine the level of gross activity present. Action levels are determined based on guidelines established for each site (see Sections 7.3-7.5) and serve as indicators that further investigation is necessary. Scans are conducted for all radionuclides potentially present based on the site history. Monitoring for the unexpected is also recommended. Headphones are recommended for all scanning activities.

3.1 Gamma Scanning

3.1.1 Equipment

3.1.1.1 Sodium iodide gamma scintillator: Model 489-55, Victoreen Instrument Co.; Model SPA-3, Eberline Instrument Corporation; or equivalent (Thin crystal, Model PG-2, Eberline Instrument Corporation, Model G5 "FIDLER", Bicron Corporation, or equivalent may be used when low energy photons are the radiation of concern.)

3.1.1.2 Portable ratemeter-scaler: Model PRM-6; Eberline Instrument Corporation; Model 2221, Ludlum Instrument Corporation; or equivalent, equipped with audible speaker.

3.1.1.3 Cable: As appropriate (see Section 5).

3.1.1.4 Record forms.

3.1.1.5 Check source.

3.1.2 Operational Check-Out

Assemble equipment, check battery, and adjust high voltage, if necessary. Check background and gamma check source count rates. Follow procedures described in Section 5.

3.1.3 Scanning

3.1.3.1 Set the instrument for 'FAST' response.

3.1.3.2 Pass the detector slowly over the surface. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor, but is typically 0.5 to 1.0 m per second. Gamma scanning is usually performed by swinging the detector in front of the body in a pendulum manner while progressing at the speed of a slow walk. The detector should be kept as close to the surface as conditions allow.

3.1.3.3 Note increases in count rate as indicated by the audible meter output. Compare count rates to the established site action level (see Section 7.5).

3.1.3.4 Mark areas that meet or exceed action levels using survey flags for open land areas and paint, grease pencil or other appropriate method for other surfaces. Further investigation is necessary at these locations.

3.1.3.5 Continue traversing the area at intervals of 0.5-5 m, depending upon the site's radiological history, contamination potential, and findings as the survey progresses.

3.1.3.6 After a specific area (usually a grid block) has been scanned, map the dimensions of any areas of concern; record locations and levels of ambient gamma radiation and elevated gamma radiation on the appropriate survey form (Figures B-9, B-10, or equivalent).

3.2 Beta-Gamma Scanning

3.2.1 Equipment

3.2.1.1 Beta detector: Model 489 (GM "Pancake"), Victoreen Instrument Co., Model HP-260 (GM "Pancake"), Model 43-68 (proportional), Ludlum Instrument Corporation; or equivalent.

3.2.1.2 Portable ratemeter-scaler: Model PRM-6 or PRS-1, Eberline Instrument Corporation; Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent, equipped with audible speaker.

3.2.1.3 Cable: As appropriate (see Section 5).

3.2.1.4 Record forms.

3.2.1.5 Check source.

3.2.2 Operational Check-Out

Assemble equipment, check battery, and adjust high voltage and threshold, if necessary. Check background and check source count rates. Follow procedures described in Section 5.

3.2.3 Scanning

3.2.3.1 Pass the detector slowly over the surface. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor, but is typically one detector width per second. The detector should be kept as close to the surface as conditions allow.

3.2.3.2 Note increases in count rate as indicated by the audible meter output. Compare count rates to the established site action level.

3.2.3.3 Mark areas that meet or exceed action levels using flags, stakes, paint, chalk, markers etc., as necessary. Further investigation is necessary at these locations.

3.2.3.4 Continue traversing the area at close intervals. Due to the relatively short range of the particles and the directional dependence of the detector, scanning intervals may overlap.

3.2.3.5 After a specific area (usually a grid block) has been scanned, map the dimensions of any areas of concern; record all scan data, including the locations and activity levels of elevated radiation on the appropriate survey forms (Figures B-9, B-10, or equivalent).

3.3 Alpha Scanning (also see items 3.4 and 3.5)

3.3.1 Equipment

3.3.1.1 Alpha detector: Model AC3-7, AC3-8 or HP-100A, Eberline Instrument Corporation; Model 43-68 Ludlum Instrument Corporation; or equivalent.

3.3.1.2 Portable ratemeter-scaler: Model PRS-1, Eberline Instrument Corporation; Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent, with audible speaker.

3.3.1.3 Cable: As appropriate (see Section 5).

3.3.1.4 Record forms.

3.3.1.5 Check source.

3.3.2 Operational Check-Out

Assemble equipment, check battery, and adjust high voltage and threshold if necessary. Check background and alpha source count rates. Follow procedures described in Section 5.

3.3.3 Scanning

3.3.3.1 Pass the detector slowly over the surface. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor, but is typically one detector width per second. The detector should be kept as close to the surface as conditions allow.

3.3.3.2 Note increases in count rate as indicated by the audible meter output. Compare count rates to the established site action level.

3.3.3.3 Mark areas that meet or exceed site action levels using paint, chalk or grease pencil. Further investigation is necessary at these locations.

3.3.3.4 Continue traversing the area at close intervals. Due to the relatively short range of the particles and the directional dependence of the detector scanning, intervals may overlap.

3.3.3.5 After a specific area (usually a grid block) has been scanned, map the dimensions of any areas of concern; record scan data, including the operational mode (i.e. alpha only), if applicable, and the locations and activity levels of elevated radiation on the appropriate survey forms (Figures B-9, B-10, or equivalent).

3.4 Alpha-Beta Scanning

3.4.1 Equipment

3.4.1.1 Alpha-beta detector: Model HP-100A, Eberline Instrument Corporation; Model 43-68 Ludlum Instrument Corporation; or equivalent.

3.4.1.2 Portable ratemeter-scaler: Model PRS-1, Eberline Instrument Corporation; Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent with audible speaker.

3.4.1.3 Cable: As appropriate (see Section 5).

3.4.1.4 Record forms.

3.4.1.5 Check source.

3.4.2 Operational Check-Out

Assemble equipment, check batteries, and adjust high voltage and threshold, if necessary. Check background and source count rates. Follow procedures described in Section 5.

Note: This unit may be used to scan for either alpha or alpha-beta activity by varying the high voltage on the ratemeter-scaler.

3.4.3 Scanning

3.4.3.1 Pass the detector slowly over the surface. The speed of the detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor, but is typically one detector width per second. The detector should be kept as close to the surface as conditions allow.

3.4.3.2 Note increases in count rate as indicated by the audible output. Compare count rates to the established site action level.

3.4.3.3 Mark areas that meet or exceed site action levels using paint, chalk or grease pencil. Further investigation is necessary at these locations.

3.4.3.4 Continue traversing the area at close intervals. Due to the relatively short range of the particles and the directional dependence of the detector, scanning intervals may overlap.

3.4.3.5 After a specific area (usually a grid block) has been scanned, map the dimensions of any areas of concern; record all scan data, including the operational mode (i.e. alpha-beta) and the locations and activity levels of elevated radiation on the appropriate survey forms (Figures B-9, B-10, or equivalent).

NOTE: It may be necessary to perform a scan for alpha only in conjunction with the alpha-beta scan since significant levels of alpha activity may be masked by the background levels obtained when operating in the alpha-beta plateau region.

3.5 Floor Monitor Scanning

3.5.1 Equipment

3.5.1.1 Proportional floor monitor, Model 239-1, Ludlum Instrument Company.

3.5.1.2 Portable ratemeter-scaler: Model 2220 or 2221, Ludlum Instrument Corp.; or equivalent, equipped with audible speaker.

3.5.1.3 Cable: As appropriate (see Section 5).

3.5.1.4 P-10 counting gas.

3.5.1.5 Record forms.

3.5.1.6 Check source.

3.5.2 Operational Check-Out

Assemble equipment, check battery, and adjust high voltage and threshold if necessary. Purge detector with P-10 gas. Check background and alpha-beta source count rates. Follow procedures described in Section 5.

NOTE: This unit may be used to scan for either alpha or alpha-beta activity by varying the high voltage on the ratemeter-scaler.

3.5.3 Scanning

3.5.3.1 Pass the detector slowly over the floor. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor, but is typically about one detector width per second.

3.5.3.2 Note increases in count rate as indicated by the audible meter output. Typically, count rates 2-3 times the background rate are indicative of contamination or radionuclide concentrations exceeding allowable levels.

3.5.3.3 Circle areas of increased count rate using paint, chalk, or grease pencil.

3.5.3.4 Continue traversing the area at close intervals. Due to the relatively short range of the particles and the directional dependence of the detector, scanning intervals may overlap.

3.5.3.5 After a specific area (usually a grid block) has been scanned, map the dimensions of any areas of concern; record the operational mode (i.e., alpha or alpha-beta) and all scan data, including the locations and activity levels of elevated radiation on the appropriate survey forms (Figures B-9, B-10, or equivalent).

SECTION 7.2

GAMMA LOGGING OF BOREHOLES

1.0 PURPOSE

To describe the method for performing subsurface gamma logging measurements in boreholes

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Scintillation detector: Model 489-55 NaI probe, Victoreen Instrument Co.; or equivalent.

3.1.2 Lead collimator for scintillation probe, approximately 1 cm thick with four 2.5 cm x 7 mm slots at the detector midpoint, ORISE design.

3.1.3 Cable: As appropriate (see Section 5).

3.1.4 Winch assembly for lowering and raising collimated detector in borehole, ORISE design.

3.1.5 Portable ratemeter-scaler: Model 2200, Ludlum Instrument Co.; or equivalent.

3.1.6 As required, capped plastic (PVC) pipe of sufficient length to case borehole to desired logging depth. Pipe diameter will be determined by the dimensions of the drill bit.

3.1.7 Plastic bags (large enough to cover lead collimator).

3.1.8 Record forms.

3.1.9 Check source.

3.2 Operation

3.2.1 Assemble equipment; turn on scaler, test battery, and adjust voltage, if necessary. Check background and detector response to the gamma check source following procedures described in Section 5.

3.2.2 Enclose the collimated detector assembly in double plastic bags to protect detector against direct contact with water or soil from the borehole.

3.2.3 If the borehole has a tendency to cave in or contains water, insert an appropriate length of plastic pipe.

3.2.4 Position the winch assembly over the borehole.

3.2.5 Lower the detector assembly until the collimator slots are level with the ground surface.

3.2.6 Reset the depth recorder to 0.

3.2.7 Lower the detector assembly slowly into the borehole, noting the count ratemeter response for indications of locations of elevated gamma activity. Record the depths of these locations.

3.2.8 When the detector reaches the bottom of the borehole or borehole liner pipe record the depth of the hole.

3.2.9 Set the scaler timer to 0.5 or 1 minute, depending upon contaminant and ambient detection level; start and accumulate the counts.

3.2.10 Record depth and count rate on the Borehole Logging Form (Figure B-11, or equivalent).

3.2.11 Raise the detector to the nearest even multiple of 30 cm (1 unit on the depth recorder) and repeat steps 3.2.9 and 3.2.10.

3.2.12 Repeat at 30 cm intervals and at noted locations of elevated activity until a depth of 15 cm is reached.

3.2.13 Obtain a measurement at 15 cm below the ground surface and at the ground surface.

3.2.14 If the identities and ratios of the radionuclides in the subsurface soil are known, calibration factors can be developed and applied to the individual count rates at various depths to estimate the concentrations in picocuries per gram. If the ratios of radionuclides in the subsurface soil have been shown to vary, the logging is used only to indicate locations and relative levels of soil concentrations.

NOTE: Borehole logging can also be done using a non-collimated NaI for shallow or small diameter boreholes or for collecting general information concerning the radiation activity characteristics of the borehole (see Section 5 and 7.5).

SECTION 7.3

ALPHA RADIATION MEASUREMENT

1.0 PURPOSE

To describe the method for measuring total alpha radiation levels on equipment and building surfaces

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent.

3.1.2 Alpha detector: Model AC3-7, Eberline Instrument Corporation; Model 43-68, Ludlum Instrument Corporation; or equivalent.

3.1.3 Cable: As appropriate (see Section 5).

3.1.4 Record forms.

3.1.5 Check source.

3.2 Operational Check-Out

3.2.1 Assemble detector unit. Purge detector models 43-68 and HP-100A before beginning operational check. Check battery, and adjust high voltage and threshold, based on calibration data (see Section 5).

3.2.2 Check the background count rate and the response of the detector to the alpha check source. Record values on the Instrument Operational Check-Out Form (see Section 5).

NOTE: If the site background is not consistent with the predetermined response range, a new response range shall be established at the specific site and noted on the Instrument Operational Check-Out Form. The daily background count should be consistently measured on a surface in an area deemed appropriate by the site coordinator.

3.2.3 When applicable calculate both the average and maximum "field action levels" for the instrument combination based on the specific site criteria and background.

$$\text{Action level (cpm)} = [\text{site criteria (dpm/100 cm}^2) \times E \times G \times T] + B$$

T = count time (minutes)

E = operating efficiency $\left(\frac{\text{counts}}{\text{disintegration}}\right)$

G = geometry $\left(\frac{\text{detector area cm}^2}{100}\right)$

AC3-7 detector area = 59 cm^2

43-68 detector area = 100 cm^2

B = background (cpm)

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3 Measurements

3.3.1 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity value less than 50% of the applicable criteria. For most radionuclides a 1 minute count is applicable. For radionuclides having guidelines of 5000 dpm/100 cm^2 average and 15,000 dpm/100 cm^2 maximum, 0.5 minute counting times may be acceptable.

3.3.2 Place the detector face in contact with the surface to be surveyed. The detector face is constructed of a very thin and fragile mylar material, so care must be exercised to avoid damage by rough surfaces or sharp objects.

3.3.3 Set the meter timer switch, press the count reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.4 Record the count and time on the appropriate record form (Figures B-9, B-12, or equivalent).

3.3.5 Calculate alpha dpm/100 cm^2 by subtracting background to obtain net counts and applying appropriate time, detector efficiency, and effective area factors.

$$\alpha \text{ dpm/100 cm}^2 = \frac{N}{T \times E \times G \times \text{other modifying factors}}$$

N = net counts (counts)
T = count time (min)
$E = \text{operating efficiency} \left(\frac{\text{counts}}{\text{disintegration}}\right)$
$G = \text{geometry} \left(\frac{\text{detector area cm}^2}{100}\right)$
AC3-7 detector area = 59 cm^2
43-68 detector area = 100 cm^2

NOTE: If a complete area scan has not been done, the area around the measurement locations should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the Surface Activity Survey Form (Figure B-9, or equivalent).

3.3.6 Perform quality control measurements as required in the ESSAP Quality Assurance Manual.

SECTION 7.4

BETA RADIATION MEASUREMENT

1.0 PURPOSE

To describe the method for measuring total beta radiation levels on equipment and other surfaces

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that the procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent.

3.1.2 Beta detector: Model HP-260 (GM "Pancake"), Model 43-68 (proportional), Ludlum Instrument Corporation; or equivalent.

3.1.3 Cable: As appropriate (see Section 5).

3.1.4 Alpha shield - approximately 5 mg/cm^2 thickness

NOTE: The detector face may be covered with a thin layer of tracing paper to provide a total thickness of 7 mg/cm^2 and to increase the degree of protection of the detector face from accidental puncture and contamination, or to intentionally block alpha radiation.

3.1.5 Record forms.

3.1.6 Check source.

3.2 Operational Check-Out

3.2.1 Assemble detector unit. Purge detector models 43-68 and HP-100A before beginning operational check. Check battery and adjust high voltage and threshold, based on calibration data (see Section 5).

3.2.2 Check the background count rate and the detector response to the check source (If the check source response is outside the established limits, the unit is to be removed from service until the problem can be identified and corrected). Record the values on the daily Instrument Operational Check-Out Form (see Section 5).

NOTE: If the site background is not consistent with the predetermined response range, a new response range shall be established at the specific site and noted on the Instrument Operational Check-Out Form. The daily background count should be consistently measured on a surface in an area deemed appropriate by the site coordinator.

3.2.3 When applicable calculate both the average and maximum "field action levels" for the instrument combination based on the specific site criteria and background.

Action Level (cpm) = [site criteria (dpm/100 cm^2) x E x G x T] + B

T = count time (minutes)

E = operating efficiency $\left(\frac{\text{counts}}{\text{disintegration}}\right)$

G = geometry $\left(\frac{\text{detector area cm}^2}{100}\right)$

HP-260 detector area = 15.5 cm^2

43-68 detector area = 100 cm^2

B = background (cpm)

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3 Measurements

3.3.1 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity value less than 50% of the applicable criteria. For most radionuclides, a 1 minute count is applicable. For radionuclides having guidelines of 5000 dpm/100 cm^2 average and 15,000 dpm/100 cm^2 maximum, 0.5 minute counting times may be acceptable.

NOTE: If the count must be corrected for alpha contribution, cover the detector face with an alpha shield.

3.3.2 Place the detector in contact with the surface being surveyed. Avoid placing the detector on surfaces with sharp projections which may puncture the thin detector face.

3.3.3 Set the meter timer switch, press the count reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.4 Record the count and time on the appropriate record form (Figures B-9, B-12, B-13, B-14 or equivalent).

NOTE: If a complete area scan has not been done, the area around the measurement location should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate survey forms (Figure B-9, or equivalent).

3.3.5 Perform quality control measurements as required in the ESSAP Quality Assurance Manual.

3.3.6 Calculate beta dpm/100 cm^2 by subtracting background (to obtain net counts) and applying appropriate time, detector efficiency, and effective area factors.

$$\beta \text{ dpm}/100 \text{ cm}^2 = \frac{N}{T \times E \times G \times \text{other modifying factors}}$$

N = net counts (counts)
T = count time (min)
E = operating efficiency $\left(\frac{\text{counts}}{\text{disintegration}}\right)$

G = geometry $\left(\frac{\text{detector area cm}^2}{100}\right)$
HP-260 detector area = 15.5 cm^2
43-68 detector area = 100 cm^2

SECTION 7.5

GAMMA RADIATION (EXPOSURE RATE) MEASUREMENT

1.0 PURPOSE

To describe the method for measuring external gamma radiation levels in buildings and over ground surfaces

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Pressurized Ion Chamber (PIC) (0 - 500 μR)

3.1.1 Equipment

3.1.1.1 Pressurized Ion Chamber: Model RSS-111 or Model RSS-1011, Reuter Stokes Co.

3.1.1.2 Tripod.

3.1.1.3 Record forms.

3.1.1.4 Check source.

3.1.2 Operational Check-Out

3.1.2.1 Assemble instrument, turn on, check batteries, and allow to stabilize approximately 5 minutes. Check background level and response to the gamma check source. Follow procedures described in Section 5.

3.1.2.2 An action level will be determined based on the exposure rate guidelines that have been established for the site. For a particular site the action level may be established as any activity exceeding background. A field measurement at or above this value indicates that further investigation at this location is necessary.

3.1.3 Measurements

3.1.3.1 Adjust the tripod to place the center of the detector chamber approximately 1 m above the surface.

3.1.3.2 Press the "Push-to-Read" button. (The digital display will operate for approximately 30 seconds.)

3.1.3.3 Note the display reading for 10 cycles. Average these values to determine the exposure rate at this location and record on the Cross Calibration Form (Figure B-3, or equivalent).

3.1.3.4 For greater accuracy the exposure rate may be determined by accumulating the exposure over a known time period, using a Pulse Period Counter (PPC).

3.1.3.4.1 Connect the Pulse Period Counter to the PIC.

3.1.3.4.2 Select the number of μR to be counted on the PPC. Reset the PIC accumulating register, the PPC timer, and press the start enable button.

3.1.3.4.3 When the PPC alarm sounds, press reset, and record the total μR accumulated and the displayed time. Calculate the exposure rate in μR/h.

3.2 Sodium Iodide Scintillator (0 to 500 Kcpm: approximate exposure rate range 0-1000 μR/h)

3.2.1 Equipment

3.2.1.1 Portable ratemeter: Model PRM-6, Eberline Instrument Corporation; or equivalent.

3.2.1.2 Sodium iodide detector: Model 489-55, Victoreen Instrument Co; Model SPA-3, Eberline Instrument Corporation; or equivalent.

3.2.1.3 Cable: As appropriate (see Section 5).

3.2.1.4 Record forms.

3.2.1.5 Check source.

3.2.2 Operational Check-Out

3.2.2.1 Assemble unit, check battery, and adjust high voltage, as necessary. Set the PRM-6 for 'SLOW' response.

3.2.2.2 Check the background count rate and the detector response to the gamma check source. If the check source response is outside the established limits, the unit is to be removed from service until the problem can be identified and corrected. Record the values on the daily Instrument Field Check Form (see Section 5).

NOTE: If the site background is not consistent with the predetermined response range, then a new response range shall be established at the specific site and noted on the Instrument Operational Check-Out Form.

3.2.3 Measurements

3.2.3.1 Place the detector at the position where the measurement is desired.

3.2.3.2 Observe the count rate displayed on the meter; switch the range selector until the meter response is over 10 percent of full scale.

3.2.3.3 Estimate the average count rate and record it on the appropriate record form (Figures B-9, B-10, B-13, B-18, or equivalent).

3.2.3.4 Convert the count rate (cpm) to exposure rate (μR/h) using factors determined by cross calibration with the Pressurized Ion Chamber (see Section 5.0).

3.3 Compensated GM Detector (0 to 999,999) cpm: approximate exposure rate range (500 μR/h to 50 mR/h)

3.3.1 Equipment

3.3.1.1 Portable Scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2220, Ludlum Instrument Corporation; or equivalent.

3.3.1.2 Compensated GM detector: Model HP-270, Eberline Instrument Corporation; or equivalent.

3.3.1.3 Cable: As appropriate (see Section 5).

3.3.1.4 Record forms.

3.3.1.5 Check source.

3.3.2 Operational Check-Out

Assemble detector unit (detector shield closed), check battery, and adjust high voltage and threshold, if necessary.

3.3.3 Check the background count rate and the detector response to the gamma check source (If the check source response is outside the established limits, the unit is to be removed from service until the problem can be identified and corrected). Record the values on the daily Instrument Field Check Form (see Section 5).

NOTE: If the site background is not consistent with the predetermined response range, then a new response range shall be established at the specific site and noted on the daily check out form.

3.3.4 Measurements

3.3.4.1 Place the GM detector at the position where the measurement is desired.

3.3.4.2 Set the meter timer switch to 1 minute, press the count reset button, and accumulate count events until the meter display indicates the count cycle is complete.

3.3.4.3 Record the count rate measurement on the appropriate record form (Figures B-9, B-10, B-13, B-14, or equivalent).

3.3.4.4 Calculate the exposure rate by applying the calibration factor determined by comparison with the Pressurized Ion Chamber or by exposure to a source of known radiation intensity (Section 5.8).

3.3.4.5 Perform quality control measurements as required in the ESSAP Quality Assurance Manual.

3.4 Ionization Survey Meter (0 to 20 R/h)

3.4.1 Equipment

3.4.1.1 Ionization Survey Meter: Model 36100, Keithly Instruments, Inc.; or equivalent.

3.4.1.2 Record forms.

3.4.2 Operational Check-Out

Check battery and adjust zero balance control. If malfunctions are noted, remove instrument from service until problems are identified and corrected.

3.4.3 Measurements

3.4.3.1 Place the detector at the position where the measurement is desired.

3.4.3.2 Observe the rate displayed on the meter; switch the range selector until the meter response is over 10 percent of full scale. Record measurements on appropriate record form (Figures B-9, B-10, B-13, B-14, or equivalent).

3.4.3.3 Perform quality control measurements as required in the ESSAP Quality Assurance Manual.

SECTION 8.0

SAMPLING PROCEDURES

SECTION 8.1

SURFACE SOIL SAMPLING

1.0 PURPOSE

To describe the procedures for collecting samples of surface soil

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, shovel, spoons, post-hole digger, etc.

3.2 Special sampling apparatus (cup cutter, shelby tube, etc.) as required.

3.3 Plastic bags, approximately 10 cm diameter x 30 cm long.

3.4 Cardboard "ice cream" containers (1 quart size) or geology sample bags.

3.5 Twist-ties.

3.6 Masking tape.

3.7 Record forms and/or logbook.

3.8 Labels and security seals.

3.9 Indelible pen.

3.10 Equipment cleaning supplies, as appropriate (see Section 10).

4.0 PROCEDURE

NOTE: Because standard surface soil contamination criteria for radionuclides are applicable to the average concentration in the upper 15 cm of soil, the usual sampling protocol described here is based on obtaining a sample of this upper 15 cm. Special situations, such as to evaluate trends or airborne deposition, determining near surface contamination profiles, and measuring non-radiological contaminants, necessitate special sampling procedures. These special situations are evaluated and incorporated into site specific survey plans as the need arises.

Direct surface and 1 meter gamma radiation measurements may be performed at each location before initiating sampling. This will identify the presence of gross radionuclide contamination which will require special handling and equipment cleanup procedures. If contamination is suspected a beta-gamma "open" and "closed" measurement may also be desired before sampling begins.

4.1 Loosen the soil at the selected sampling location to a depth of 15 cm, using a trowel or other digging implement.

4.2 Remove large rocks, vegetation, and foreign objects (These items may also be collected as separate samples, if appropriate.)

4.3 Place approximately 1 kg of this soil into a plastic bag-lined cardboard container or geology sample bag. If it is not possible to reach a depth of 15 cm using a hand tool (i.e. trowel or shovel) 1 kg of soil should be collected from the accessible depth. The actual depth should be recorded on the sample container and the data form.

4.4 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie the sample bag strings).

4.5 Label and secure the sample container in accordance with Sections 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.6 Record sample identification, location, and other pertinent data on appropriate record forms (Figures B-13, B-14, or equivalent), maps, drawings, and/or site logbook.

4.7 If the location has been identified as having elevated activity a measurement should be obtained after the sample is collected to determine the possibility of contamination at a depth greater than 15 cm. If a subsurface sample is deemed necessary, refer to Section 8.2.

NOTE: Contact the site coordinator if the exposure rate measurement exceeds the capability of the instrumentation available on site.

4.8 Clean sampling tools, as necessary, before proceeding to the next sampling location in accordance with instructions in Section 10.

4.9 Perform quality control sampling as required in the ESSAP Quality Assurance Manual.

SECTION 8.2

SUBSURFACE SOIL SAMPLING

1.0 PURPOSE

To describe the procedure for collecting samples of subsurface soil

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Drilling equipment: drilling rig, portable motorized auger, manual auger.

3.2 Subsurface sampling apparatus: split-spoon samples, shelby tube sampler, downhole sampler - ORISE design.

3.3 Plastic bags, approximately 10 cm diameter X 30 cm long.

3.4 Trowel or spatula.

3.5 Cardboard "ice cream" containers (1 quart size) or geology sample bags.

3.6 Twist-ties.

3.7 Masking tape.

3.8 Large rubber bands.

3.9 Record forms, and/or logbook.

3.10 Labels and security seals.

3.11 Indelible pen.

3.12 Equipment cleaning supplies, as appropriate (see Section 10).

4.0 PROCEDURE

4.1 General

4.1.1 When direct radiation measurements are required (surface and borehole logging) they are to be performed prior to sample collection in order to identify the presence of gross radionuclide contamination requiring special handling or cleanup (see Section 10).

4.1.2 When a borehole fills with water and a water sample is desired refer to the subsurface water sampling procedure in Section 8.4.

NOTE: Special considerations, such as those described for surface sampling, may require deviations from this procedure. These will be described in the site specific survey plan as the need arises.

4.2 Systematic Subsurface Sampling (Option 1)

Procedure applicable to depths of approximately 3 m when boreholes or trenches have been dug and remain uncollapsed or do not contain water.

NOTE: If borehole logging is to be done it should be completed before sampling begins (see Section 7.2).

4.2.1 Place a plastic bag liner into the downhole sampler and secure with a large rubber band.

4.2.2 Lower the sampling tool to the desired depth in the borehole or trench.

4.2.3 Scrape the inside borehole or trench wall with the toothed edge of the tool until approximately 1 kg of sample is collected.

4.2.4 Transfer the plastic bag and sample into container.

4.2.5 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie sample bag ties).

4.2.6 Label and secure the sample container in accordance with Sections 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form, (Figure B-19, or equivalent).

4.2.7 Record sample identification, location, depth, and other pertinent data on the appropriate record forms (Figures B-11, B-14, or equivalent), map, drawing, and/or site logbook.

4.2.8 Clean sampling tools, as necessary, before proceeding with further sample collection, in accordance with instructions in Section 10.

4.3 Systematic Subsurface Sampling (Option 2)

Procedures applicable to depths exceeding 3 m and in boreholes where walls do not remain intact or that fill with water.

4.3.1 Drill the borehole to the desired sampling depth using an auger.

4.3.2 Drive a split-spoon or shelby tube collector beyond the augured depth. The driving distance should be 30 to 60 cm.

4.3.3 Withdraw the collecting device and remove the collected core.

4.3.4 Place the entire core, or a portion of the core, into a plastic bag-lined cardboard container or geology sample bag. (The core may be split into multiple segments, representing different sampling depths.)

4.3.5 Repeat steps 4.2.5 to 4.2.8.

4.4 Biased Subsurface Sampling

Procedures applicable when a surface sample has been collected and radiation levels are still elevated sufficiently above background as to require further investigation at the location.

4.4.1 Using a shovel or post hole diggers, collect 1 kg of the next 15 cm of soil.

4.4.2 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie sample bag ties).

4.4.3 Label and secure the sample container in accordance with Section 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.4.4 Record sample identification, location, depth, and other pertinent data on the appropriate record form, map, drawing, and/or site logbook.

4.4.5 Clean sampling tools, as necessary, before proceeding with further sample collection, in accordance with instructions in Section 10.

4.4.6 Monitor the sample hole to determine activity level. If the activity level is still elevated, repeat items 4.4.1-4.4.6. If the activity level has dropped to background, record the measurement and monitor the area, including personnel and equipment, to determine the extent of decontamination that may be necessary.

NOTE: Contact the site coordinator if the exposure rate measurement exceeds the capacity of the instrumentation available on site.

SECTION 8.3

SEDIMENT SAMPLING

1.0 PURPOSE

To describe the procedures for collecting samples of sediment

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, post-hole digger, etc.

3.2 Thin walled metal or plastic tube (shelby tube).

3.3 Ponar "clam-shell" dredge (with rope).

3.4 Wide-mouth plastic bottle (approximately 1 liter size).

3.5 Labels and security seals.

3.6 Record forms and/or logbook.

3.7 Indelible pen.

3.8 Cleaning supplies, as appropriate (see Section 10).

4.0 PROCEDURE

NOTE: This procedure applies to the usual requirements for shallow sediment samples for radiological contamination measurement. Special requirements will necessitate other sampling procedures and considerations; these will be evaluated and described in detail in site specific survey plans as the need arises.

4.1 Using a collecting tool, obtain approximately 1 kg of sediment. Include all material collected - rocks and foreign objects can be discarded during sample preparation, as appropriate.

4.2 Place the sediment into a plastic bottle and tighten the screw cap.

4.3 Label and secure the sample container in accordance with Section 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.4 Record sample identification, location, depth, and other pertinent information on the Miscellaneous Sample Record Forms (Figure B-15, or equivalent) and/or logbook.

4.5 Clean collecting equipment as described in Section 10 before proceeding with further sampling.

4.6 Perform quality control sampling as required in the ESSAP Quality Assurance Manual.

SECTION 8.4

WATER SAMPLING

1.0 PURPOSE

To describe the procedure for collecting samples of water from surface and subsurface sources

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Bailing implement: Borehole bailer - ORISE design, cup, can, pail, or other appropriate device.

3.2 Submersible, vacuum, or peristaltic pump with power source.

3.3 Four liter plastic container, storage boxes and tags, or other container type as applicable.

3.4 Funnel.

3.5 Large Erlenmeyer Flask with two-hole stopper.

3.6 Tygon tubing.

3.7 Labels and security seals.

3.8 Indelible pen.

3.9 Record forms and/or logbook.

3.10 Cleaning supplies, as appropriate (see Section 10).

4.0 PROCEDURE

4.1 Surface Sample

4.1.1 Dip water carefully from the selected location, being careful to avoid collection of bottom sediment or vegetation.

4.1.2 Using a funnel, transfer the water into a container.

4.1.3 Collect a total of 3.8 liters of sample.

4.1.4 Cap the container tightly.

4.1.5 Label and secure the sample in accordance with Section 8.9 and the chain-of-custody procedure in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.1.6 The container should be placed in a cardboard box (also properly labeled) for better storage.

4.1.7 Record pertinent data on the Miscellaneous Sample Record Form (Figure B-15, or equivalent) and/or site logbook.

4.1.8 Clean collecting equipment, as appropriate before proceeding with additional sampling (see Section 10).

4.2 Subsurface (well or borehole) Sample (Option 1)

4.2.1 Lower the bailer apparatus into the borehole or other sub-surface source of water.

4.2.2 Allow water to flow into the bailer (use care to avoid buildup of sediments on the bailer diaphragm, which could prevent the diaphragm from sealing).

4.2.3 Retrieve the bailer and empty contents through a funnel into a container.

4.2.4 Repeat procedure until 3.8 liters of sample has been collected.

4.2.5 Repeat steps 4.1.4 through 4.1.8.

4.3 Subsurface Sample (Option 2)

4.3.1 Lower the inlet end of tubing until it contacts the water surface.

4.3.2 Start pump and collect water in large flask.

4.3.3 Empty flask into container as necessary.

4.3.4 Repeat until 3.8 liters of sample has been collected.

4.3.5 Repeat steps 4.1.4 through 4.1.8.

SECTION 8.5

VEGETATION SAMPLING

1.0 PURPOSE

To describe the method for collecting samples of vegetation

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Knife, shears, or similar cutting tool.

3.2 Plastic bags, medium size.

3.3 Burlap bags.

3.4 Masking tape.

3.5 Baggage tags.

3.6 Labels and security seals.

3.7 Indelible pen.

3.8 Record forms and/or logbook.

3.9 Cleaning supplies, as appropriate (see Section 10).

4.0 PROCEDURE

4.1 Cut vegetation of desired type from selected location as close as possible to the surface.

4.2 Collect a total of approximately 1 kg of vegetation.

4.3 Place the sample in a plastic bag (if water is to be retained in the vegetation) or burlap bag (if vegetation is acceptable dry).

4.4 Secure the top of the bag with masking tape.

4.5 Attach a baggage tag.

4.6 Label and secure in accordance with Section 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.7 Record all pertinent information on the Miscellaneous Sample Record Forms (Figure B-15, or equivalent) and/or the site logbook.

4.8 Clean collecting equipment, as appropriate, before proceeding with additional sampling (Section 10).

4.9 Perform quality control sampling as required in the ESSAP Quality Assurance Manual.

SECTION 8.6

AIR SAMPLING

1.0 PURPOSE

To describe the procedures for sampling airborne radioactive materials

2.0 RESPONSIBILITY

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Commercial air sampler (HIVOL, Atomics, Andersen, etc.).

3.2 Velometer or inclined manometer and Pitot tube.

3.3 Sampling apparatus: pumps, pump housings, rotameters nozzles, tygon tubing, filters, filter housings, metal plates, probes, bubblers etc., as required.

3.4 Petri dishes or other small containers.

3.5 Tweezers.

3.6 Masking tape, teflon tape.

3.7 Record forms.

3.8 Thermometer.

3.9 Cleaning equipment.

3.10 Drill and appropriate size hole saw.

4.0 PROCEDURE

The following describes the techniques, methods and considerations generally applicable to air monitoring surveys. Because specific procedures will depend upon many site conditions and parameters, this section should be viewed primarily as providing guidance to program personnel for planning purposes. Site specific procedures will be described in detail in survey plans.

4.1 STACK SAMPLING

4.1.1 Select a location in the stack for insertion of sampling probe. The optimum location to obtain isolinetic flow is a minimum of 8 stack diameters downstream and 2 diameters upstream from any transitions or bends in the stack. However, stack design may not allow the choice of sampling location by this criteria.

NOTE: For certain facilities it may be necessary to use already existing probes or access points.

4.1.2 Drill (or hole saw) two 4 cm diameter access holes in the stack wall. These holes should be at approximately 90° angles to each other. Additional access holes may be required for stacks exceeding .75 m in diameter.

4.1.3 Using a pitot tube and Alnor velometer or inclined manometer, perform duct traverses to determine the velocity distribution. Locations of measurements are in accordance with EPA Standard Method #1 as determined using the Stack Velocity Worksheet (Figure B-16, or equivalent). A minimum of 12 points are required for diameters > 0.61 m; 8 are required for diameters between 0.30-0.61 m. Record all measurements.

4.1.4 Measure temperature and, if appropriate moisture content of stack gases.

4.1.5 Calculate appropriate nozzle diameter sizes and flow rates for isokinetic sampling, using the Stack Sampling Rate Worksheet (Figure B-17, or equivalent). Nominal sampling rates will be determined by the sample collection system design; these rates typically range from 5 to 30 1/m.

NOTE: The collection system selected will be specific for the stack conditions and contaminants of interest. Because of the wide variety of possibilities which may be encountered, there is no attempt in this procedure to address specific or individual systems. Such matters are addressed in detail in site specific survey plans.

4.1.6 Attach nozzles and secure plates to probe tubes.

4.1.7 Adjust nozzle location (sample tip to plate assembly distance) to the desired sampling position.

4.1.8 Insert nozzle the appropriate measured distance into stack with nozzle opening in direct alignment with stack air flow.

4.1.9 Secure metal plates against stacks with rope or bungee cords.

4.1.10 Place one probe at a fixed location, usually in the same approximate location as the licensee's sample probe; reposition a second probe periodically to various predetermined sampling locations within the stack.

4.2.11 Start pump and adjust needle valves to obtain the desired flow rate.

4.1.12 Test system for leakage by blocking intake or pinching hose near intake. If flow rate does not drop to $<10\%$ of the initial (unblocked) rate, re-check and tighten connections and components until the system is leak tight.

4.1.13 Note and record starting time and flow.

4.1.14 During initial sampling, periodically (every 2-4 hours) check the system to assure that the desired sampling rate is being maintained. Make flow rate adjustments or changes in collection system as necessary. Record on the Stack Sampling Record Form (Figure B-18, or equivalent).

4.1.15 Turn pump off at the previously determined time. Record final time and flow rate.

4.1.16 Transfer sample collection media to appropriate containers and label in accordance with Section 8.9 and the chain-of-custody procedures in the Quality Assurance Manual. Record pertinent information on the Chain-of-Custody Form (Figure B-19, or equivalent).

4.1.17 Clean equipment before initiating further sampling.

4.1.18 When sampling is complete, remove probe assemblies, and insert expansion plug into stack access hole, if appropriate.

4.2 SAMPLING AMBIENT AIR

4.2.1 Select sampling location, based on objective of sampling.

4.2.2 Select collection media or system, based on contaminants of interest and ambient atmospheric conditions (see NOTE in 4.1.5).

4.2.3 Assemble collection system, flow measuring device, and vacuum system.

4.2.4 Proceed as in items 4.1.12 to 4.1.16.

SECTION 8.7

DETERMINATION OF REMOVABLE ACTIVITY

1.0 PURPOSE

To provide guidelines for measuring removable alpha and beta radioactivity on equipment and building surfaces

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment and Materials

3.1.1 Filter papers (Whatman 50 or equivalent), 47 mm diameter, numbered.

3.1.2 Glassine or paper envelopes.

3.1.3 Record forms.

3.1.4 Counting equipment.

3.2 Sample Collection

NOTE: Direct measurements should be completed before a smear sample is taken.

3.2.1 Grasp the smear (filter) paper by the edge, between the thumb and index finger.

3.2.2 Applying moderate pressure with two or three fingers, wipe the numbered side of the paper over approximately 100 cm^2 of the surface.

3.2.3 Place the filter in an envelope.

3.2.4. Record the smear number, site, date, location of the smear, and name of sample collector on the envelope.

3.2.5 Record pertinent information on the appropriate form, (Figures B-9, B-12, or equivalent) and on the Chain-of-Custody Form (Figure B-19, or equivalent).

3.2.6 If the initial direct measurement was elevated, the smear should be monitored to determine whether contaminated material was transferred to the smear. If an activity level greater than 250 cpm is detected, the smear envelope should be marked as such.

NOTE: Smears having activity levels greater than 2500 cpm should be counted using field instrumentation.

3.3 Field Sample Measurement

3.3.1 If the object of the survey is to determine if radon or thoron daughter products or other short half-life radionuclides are present, the smears should be counted within 1-2 hours before significant decay of short-lived radionuclides has occurred.

3.3.2 If necessary, smears can be counted in the field using portable instrumentation (see Section 7).

3.3.3 Record count and counting time data on the appropriate record form (Figure B-9, B-12, or equivalent).

3.3.4 Subtract the background count (determined by counting blank or unused smear) and convert net count to dpm/100 cm², using proper time and detector efficiency values.

$$\text{dpm}/100\ \text{cm}^2 = \frac{\text{net count}}{\text{time(min)} \times \text{efficiency}\left(\frac{\text{count}}{\text{disintegration}}\right) \times \text{other modifying factors}}$$

SECTION 8.8

MISCELLANEOUS SAMPLING

1.0 PURPOSE

To discuss methods for collecting miscellaneous samples

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Equipment is chosen based on the type of material to be sampled. The following list represents some possibilities:

3.1.1 Paint sampling-heat gun, paint stripper solution, chisel and hammer.

3.1.2 Drains or pipes-plumber's snake, swabs - for drains or pipes.

3.1.3 Residues-trowels, scoops.

3.1.4 Concrete or asphalt-core bores, hammer and chisel - for concrete asphalt.

4.0 PROCEDURE

4.1 Methods for collecting miscellaneous samples should be determined based on the characteristics of the sample media. Care should be taken to limit the potential for spreading contamination during sample collection.

Sample quantities should be determined based on the following:

- Type of analyses required
- Number of analyses to be requested
- Detection sensitivity required of analytical result
- Estimated activity level of material

4.2 Label and secure all samples in accordance with Section 8.9 and the chain-of-custody procedure in the Quality Assurance Manual. Record pertinent information on the Miscellaneous Sampling Measurement and Chain-of-Custody Record Forms (Figures B-15, B-19, or equivalent).

SECTION 8.9

SAMPLE IDENTIFICATION AND LABELING

1.0 PURPOSE

To provide guidance for identifying and labeling survey samples

2.0 RESPONSIBILITIES

2.1 The site coordinator is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Samples, in appropriate containers.

3.2 Indelible pen.

4.0 PROCEDURE

4.1 Each sample will be identified by a 10-character alpha-numeric code.

4.1.1 The first three alphabetic characters represent a predetermined acronym for the facility or location.

EXAMPLES: "MAY" = Maywood Chemical
"MSP" = Medi-Physics, South Plainfield
"RPP" = Reduction Pilot Plant

4.1.2 The fourth character designates the general category describing the sampling approach.

"S" - SYSTEMATIC: Samples that are collected at regular grid intervals or collected without investigative intentions, e.g., locations where elevated radiation levels are not considered before sampling or measurement.

"B" - BIASED: Samples collected to provide further information about specific areas such as "hot spots" or locations suspected of having high potential for contamination.

"ϕ" - BACKGROUND: Samples collected offsite or in areas remote to points of suspected radioactivity.

"Q" - QUALITY CONTROL: Samples collected adjacent to survey samples.

4.1.3 The fifth and sixth characters are abbreviations of the medium or type of sample collected.

4.1.3.1 Soil Samples

"SS" = Surface
"SB" = Borehole
"SW" = Sediment or silt from aquatic system

4.1.3.2 Water Samples

"WS" = Surface (stream, standing, or pond)
"WB" = Borehole
"WW" = Well or spring
"WT" = Tap
"WC" = Collection tank
"WD" = Sanitary or storm drain

4.1.3.3 Vegetation Samples

"VS" = Surface, terrestrial
"VW" = Aquatic

4.1.3.4 Air Samples

"AP" = Air particulate filters
"AC" = Charcoal cartridge
"AM" = Molecular sieve
"AE" = Ethylene glycol
"AB" = Bubbler solution

4.1.3.5 Miscellaneous Sample Media

The fifth character will be "M"; the sixth character will indicate the sample type.

"MM" = Milk
"MF" = Fish

4.1.4 The seventh through ninth numeric characters indicate the particular number of a sample of a particular type or general category for the site. Each number will correspond to a location designation, on a map or grid area. When more than 999 samples are taken, the number of code characters will be expanded as necessary.

4.1.5 The tenth alphabetic character, A-Z, indicates the sequence of sample collection at a distinct location. For example, this character may designate samples at various depths in the same borehole.

4.1.6 Two examples of sample codes are:

MAYφSS021A - Background surface soil sample number 21, first sample collected at this location.

VELBSB003D - Borehole number 3, biased, and is the fourth depth from which a sample was collected.

SFCQSS010A - Quality Control soil sample collected adjacent to SSS010A.

4.2 Grid reference points, dates of sampling, and other pertinent information are entered with the identification code on the appropriate forms and on the sample container.

4.3 Labeling should be provided at two locations on each sample container, as size and other conditions permit.

4.4 Marking is performed using an indelible pen.

4.5 All samples known or suspected of containing levels of radioactivity, which could present a contamination or exposure problem in the field or laboratory, are to be placed in clean outer containers and clearly marked with explanatory information, as appropriate.

SECTION 9.0

INTEGRATED SURVEY PROCEDURES

SECTION 9.1

BACKGROUND MEASUREMENTS AND SAMPLING

1.0 PURPOSE

To describe the considerations for performing measurements of background direct radiation levels and for collecting samples of media to analyze for background radionuclide concentrations

2.0 RESPONSIBILITY

2.1 The site coordinator is responsible for selecting locations for background determinations and assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure while collecting background samples and measuring background radiation levels.

3.0 PROCEDURES

3.1 Locations

3.1.1 Outdoor

3.1.1.1 Locations for measurement and sampling are selected from within a 0.5 to 10 km radius of the site.

3.1.1.2 Locations should be undisturbed by radioactivity from the candidate site or other anthropogenic sources (e.g., fertilizers containing elevated concentrations of uranium and potassium and building materials with high natural levels of uranium and thorium).

3.1.1.3 A minimum of six samples and/or measurements, including the four major directions (if possible) from the site, should be obtained.

3.1.2 Indoor

3.1.2.1 Locations should be undisturbed by contamination, but may include influences determined to be naturally occurring in building materials.

3.1.2.2 If the background determined at the time of calibration is not representative of site conditions, or different areas on-site have influences causing backgrounds to vary, then site/area specific backgrounds should be determined. See Section 5 for procedures.

3.2 Background Measurements

3.2.1 Measure the external gamma exposure rate at 1 m above the ground surface using a pressurized ion chamber (PIC) (see Section 7.5).

3.2.2 If appropriate for the specific site, measure the alpha dpm/100 cm^2 and the beta dpm/100 cm^2 (see Sections 7.3 and 7.4).

3.3 Background Sampling

3.3.1 Collect a sample (approximately 1 kg) of soil. Soil sampling procedures are described in Sections 8.1 and 8.2.

3.3.2 When possible a water sample (3.8 liters) should be collected from surface sources upstream from the site of concern. Water sampling procedures are described in Section 8.4. Sediment samples should also be collected at locations where surface water is obtained (see Section 8.3).

3.3.3 Collect samples of other environmental media (e.g., air and vegetation) that are appropriate based on the samples to be collected on-site.

3.3.4 Collect samples of building materials, if necessary, to determine the extent of naturally occurring radioactivity present.

SECTION 9.2

GENERAL SURVEY APPROACHES AND STRATEGIES

1.0 PURPOSE

To describe the basic considerations for performing radiation measurements and collecting samples during surveys

2.0 BACKGROUND

Radiological surveys conducted by the Environmental Survey and Site Assessment Program may be for a variety of purposes. The purpose of the survey dictates the approach or strategy to be followed in developing the survey plan and, consequently, the number, location, and type of measurements and samples to be collected. This section describes the various types of surveys routinely performed and provides examples of the general survey strategies. It should be noted that the guidelines presented here represent the minimum; additional measurements and samples are usually obtained to assure an adequate evaluation of the radiological conditions on the site in question.

3.0 SURVEY TYPES AND STRATEGIES

3.1 Preliminary or Scoping Survey

A preliminary or scoping survey is performed to obtain information, sufficient to prepare a plan for a more in-depth survey. This type of survey usually includes only cursory scanning and measurements and limited sampling to determine the presence of radioactive contamination, identify the potential contaminants, evaluate the levels and area extent of contamination generally, and identify possible migration pathways. Survey locations are referenced to site specific (grid) coordinates or other "fixed" site features.

3.2 Designation or Inclusion Survey

To determine whether or not a site is contaminated to the extent that guideline levels are exceeded (and remedial action may be required), a designation or inclusion survey is performed. For this type of survey, measurement and sampling locations are identified in detail, relative to property lines, local coordinate systems, and/or buildings or other "fixed" site features. Survey procedures include a complete surface scan followed by direct measurements and samples. Sufficient samples and direct measurements to prove that portions of the property exceed guidelines are all that are necessary. Typically, up to 20 samples and measurements are required for this purpose.

3.3 Characterization Surveys

To delineate the extent of radiation or contamination, sufficient to evaluate potential radiological hazards and/or develop remedial action plans, a characterization survey is performed. The characterization survey includes thorough surface scans of designated and adjacent areas to identify locations of direct radiation which may indicate residual contamination. Systematic measurements and sampling are then performed throughout these areas. These measurement and sampling locations are usually at equal intervals on an established reference grid system. This number and spacing of the grid intervals must be such that sufficient data points to determine averages over the guideline area (typically 100 m^2 for open land areas and 1 m^2 for building surfaces) are generated. The usual approach is to obtain at least 5 data points for each 100 m^2 of open land and 1 m^2 of building surface. Representative "hot spot" locations, identified by surface scans, are also measured and sampled to provide data on upper ranges of residual contamination levels.

3.4 Remedial Action Support Survey

This type of survey consists primarily of multiple direct measurements and field evaluation of samples to evaluate effectiveness of remedial action as it progresses. It is a field decision tool and minimum documentation of the results is necessary.

3.5 Post-Remedial Action Survey

Evidence of the radiological conditions following remedial action is provided by the post-remedial action survey. The survey strategy, including the number and location of measurement and sampling points is very similar to that of the characterization survey.

3.6 Confirmatory or Verification Survey

The purpose of the confirmatory or verification survey is to provide independent evidence that radiological data developed by another organization is accurate and adequately represents the condition of the property. The approach for this type of survey is to select portions of the property randomly and conduct thorough (characterization or post remedial action type) surveys independently. The portion of the property selected for such a survey typically ranges from 1 to 10% of the total area covered by the report to be verified or confirmed. This type of survey also usually includes a review of the documents associated with the decontamination and decommissioning activities and replication of measurements and/or analysis performed by other organizations which have developed data.

During a verification survey, representatives of the site management or their decontamination contractors may be present, and may wish to remediate areas of previously undetected contamination identified by the ORISE survey. This is acceptable as long as the pre-remediation condition of the site is documented. After remediation by site personnel the remediated areas should be resurveyed and the final condition of the site documented.

SECTION 10.0

HEALTH AND SAFETY AND CONTROL OF CONTAMINATION

SECTION 10.0

HEALTH AND SAFETY AND CONTROL OF CONTAMINATION

ORISE has established policies and procedures to assist personnel in minimizing the risk of injury; to assure that exposures to hazardous agents and releases of contaminants to the environment are controlled to as-low-as reasonably achievable (ALARA); and to comply with applicable state and federal regulations. These policies and procedures are presented in manuals, prepared by the ORISE Office of Safety and Environmental Assurance. All ESSAP personnel are expected to familiarize themselves with those aspects of safety, which are applicable to their job duties, and to abide by the appropriate regulations. In addition, ORISE personnel, who may be performing activities on sites for which other organizations have safety responsibility, must comply with that organization's policies and procedures.

ORISE safety procedures are not recounted in this section; the reader is referred to the appropriate ORISE manuals for that information. Rather, what is presented here are some of the specific safety requirements of particular concern to the Program operations.

1.0 RESPONSIBILITIES

1.1 Supervisors are responsible for assuring that activities under their control are performed in accordance with applicable safety and health standards and that deviations, problems, accidents, and injuries are reported to the program administration.

1.2 The Health and Safety Officer is responsible for developing health and safety plans as necessary and coordinating efforts to resolve health and safety issues.

1.3 Employees are to perform duties in accordance with the applicable safety and health standards and report to their supervisors conditions or practices, considered detrimental.

Note: Responsibilities Specific to sample screening are listed in item 2.6.4 of this section.

2.0 PROCEDURES

2.1 Training

All Program personnel must receive the mandated health and safety training, e.g., radiation worker, hazards communication, emergency response, etc., as established by the ORISE Office of Safety and Environmental Assurance. In addition, field survey personnel will receive specific OSHA training for hazardous waste site activities and other such training as may be required by federal, state, or site regulation or policy. The ORISE Office of Safety and Environmental Assurance will provide assistance in determining requirements on a case-by-case basis.

2.2 Health and Safety Work Plans

For most ESSAP work sites, special hazards have been removed as part of the remedial action activities; associated safety hazards are typically limited to those common to industrial and construction sites. The Health and Safety Coordinator is responsible for working with the Project Manager and site coordinator to evaluate any special hazards associated with a specific activity, and, if considered necessary, developing a formal health and safety plan for that activity. Copies of this plan will be provided to all ORISE employees and/or contractors working on the site. The site coordinator will conduct job specific health and safety instruction, commensurate with the level of hazard and the background and experience of the personnel.

2.3 Accident and Injuries

Any on-the-job accident involving property damage or personal injury must be reported immediately to the supervisor. All injuries should receive prompt medical attention; first aid and/or professional medical treatment. Supervisors are required to report incidents/accidents to the ESSAP office as soon as circumstances allow. The following forms must be filled out and submitted to the E/ES Division Office and the Office of Safety and Environmental Assurance within seven days of the event (see Figures 10-1, 10-2, and 10-3):

Employer's First Report of Work Injury

Supervisor's Investigation Report

Privacy Act Statement

If medical attention is required, apprise the attending physician that the injury will be covered under ORISE's Worker's Compensation program. If the provider should refuse treatment on this basis, notify the Office of Safety and Environmental Assurance immediately at (615) 576-3333.

The nature of activities performed by the Program involves a variety of potential hazards. Some of the more common injuries which have occurred during past operations are back injuries, poison ivy, chemical (acid) burns, and minor cuts, scratches, and abrasions. Wearing appropriate protective clothing, following established procedures, and using good common sense will prevent practically all accidents and injuries associated with Program activities.

2.4 Protective Clothing and Equipment

ORISE provides protective clothing and equipment as required for the job. This may include coveralls, lab coats, gloves, eye protection, hard hats, safety shoes, boots, respirators, safety belts, etc. It is the responsibility of the supervisor to assure that appropriate protective equipment is provided and used.

2.5 Motor Vehicle Operation

ORISE vehicles (including rental vehicles) are to be used for official business only. Practice concepts of defensive driving and adjust driving to road and weather conditions. Report all accidents immediately in accordance with procedures which are provided in each ORISE vehicle. Vehicles used for out of town travel are to be inspected before leaving Oak Ridge, before leaving to return to Oak Ridge, and after returning, using the Vehicle Checklist (Figure 10-4).

2.6 Radiation and Contamination Control

With very few exceptions, Program activities deal with radiation levels and radioactive material concentrations near typical background values; it is very unlikely that measurable radiation exposures will occur. Special precautions will be taken in cases where the possibility of significant personnel exposure exists. Of greater concern in survey activities is the potential contamination of field and laboratory equipment and cross contamination of analytical samples.

2.6.1 Personnel

In potentially contaminated areas all personnel shall wear appropriate personal protective clothing and refrain from eating, drinking, smoking, or other activities that could lead to intake of material. Radiation dosimeters are to be worn during all assignments having a potential for exposure to personnel.

ORISE will provide appropriate personnel radiation monitoring services and contamination control clothing for use by contractor personnel. Details regarding selections and assignment of monitoring devices and control equipment will be provided by the ORISE Office of Safety and Environmental Assurance. Upon exiting potentially contaminated areas, thorough monitoring of clothing and skin surfaces is required. If contamination is identified, the site coordinator will determine the appropriate action to be taken. Instances of personal contamination and steps taken to remove the contaminant shall be recorded in the site log.

When situations arise which cause exposure rates to exceed the detection capability of the NaI(Tl) probe, personnel should leave the area and contact the site coordinator.

2.6.2 Equipment and Vehicle Surveys

All equipment and vehicles used in potentially contaminated areas are to be scanned, and cleaned if necessary, prior to leaving the site to assure that activity levels are as low as reasonably achievable. The results of these scans must be documented in the site logbook.

When there is a potential for contamination of containers or vehicles or during sample transport, suspect surfaces will be surveyed. Should decontamination be necessary, a follow-up survey will be performed to assure that all surfaces maintain activities that are as low as reasonably achievable. The results of vehicle surveys must be documented by following the instructions listed on the Vehicle Survey Sheet (Figure 10-5). Documentation that no potential for contamination was encountered can be done by noting the situation on the Vehicle Checklist (Figure 10-4). Surveys of other items should be documented in the site logbook.

2.6.3 Field Control of Cross Contamination

Equipment and supplies used for collection and storage of samples must be handled in such a manner as to prevent accidental contamination. The degree of concern and precautions followed will be determined by the specific site conditions and activity levels involved. Equipment used for sample collection should be surveyed, and cleaned as necessary, following each use.

Cleaning supplies which may be required are tap water, deionized water, non-phosphate detergent, alcohol (isopropyl), spray bottles, stiff bristle brush, and paper towels.

Cleaning Procedure for Contaminated Sampling Equipment

- Wipe equipment surfaces free of loose material using paper towels.
- Rinse with tap water.
- Wash with detergent solution and brush.
- Rinse with tap water.
- Rinse with deionized water.
- Rinse thoroughly with isopropyl alcohol.
- Allow to air dry.

Monitoring routinely performed at the sampling location will provide an indication as to the need for special attention following sampling. Any necessary decontamination should be performed such that potentially contaminated waste, generated in the process, can be collected and assessed to determine the appropriate disposal method. All samples known or suspected of containing levels of radioactivity which could present a contamination or exposure problem in the field or laboratory are to be placed in clean outer containers and identified with a radiation warning label or other explanatory information, as appropriate.

2.6.4 Screening Samples for Laboratory Contamination Control

2.6.4.1 Responsibilities

Project Leaders/Radiochemistry Laboratory Supervisor

- Evaluate projects to identify those with potential for samples containing activity levels that may require special laboratory handling in accordance with the procedure, "Radiochemical Contamination Control," August 17, 1992.
- Document in the project file (e.g., memo, logbook, health and safety plan, etc.) the need for screening and the screening method and action levels, if appropriate, to be used.
- Provide direction to sample collectors and those performing log-in as to screening and records requirements.
- Develop a listing of samples from each project, which exceed the activity levels requiring special handling and submit with the laboratory work request.

Field Survey Personnel (sample collectors)

- Determine at collection time, those samples in categories requiring special handling and note on sample container and collection record form.
- During log-in, record screening information in sample logbook, and confirm proper container labeling.

Laboratory Technicians/Field Survey Personnel

- During log-in of samples not previously screened by ESSAP personnel, e.g., samples received from outside organizations, screen samples, label containers requiring special handling, and record findings in sample logbook.

2.6.4.2 Procedure

The following three categories of samples have been established for the purpose of controlling contamination in the laboratory during sample analysis.

- Low Activity (LA) - Samples containing less than 1000 pCi/g (soil/sediment) or 1000 pCi/l (liquid). Samples of small size, e.g, smears, are limited to 1000 pCi total activity, when the activity is dispersable (i.e., in other than a solid matrix) or the analysis entails other than strictly physical operations (weighing or direct counting.)

- Moderate Activity (MA) - Samples with activity levels between 1 and 100 times the upper limits for the Low Activity category.

- High Activity (HA) - Samples containing greater than the Moderate Activity category limits.

On the basis of empirical data, responses of typical field survey instruments to samples, containing Moderate Activity and High Activity levels of some commonly encountered contaminants, have been determined; these response data are summarized in Table 1. When potential sample contaminants would be expected to provide instrument responses comparable to those in this Table, action levels from this Table may be used. Action levels for other contaminants or mixtures of contaminants, for which a comparable material is not provided in this Table, may be chosen on the basis of conservative assumptions and expected instrument response characteristics.

Certain contaminants (for example, very low energy pure beta emitters, and pure alpha emitters in soil and water) will not be detectable at the Moderate Activity and/or High Activity levels using direct monitoring methods. Site history and other analytical data (if available) may be used as a basis for initially identifying samples as potentially containing contaminant levels requiring special laboratory handling. The conservatively estimated activity level should be assumed. Any such samples would, in addition to the activity category, be further identified as "Suspect."

Prior to collection of samples (or receipt of samples that are submitted directly to the laboratory by other organizations), the cognizant project supervisor will evaluate the potential that samples may contain activity levels in excess of the Low Activity category limits. If it is determined that such a potential does not exist, that evaluation is documented by a note to the project file, a notation in the project logbook, a statement in the project Health and Safety Plan, or other documentation in the permanent record.

If it is determined that there is a potential for receiving samples containing Moderate Activity and/or High Activities levels, a plan for screening will be developed by the project supervisor. The plan will identify:

- potential radionuclide contaminants which may exceed Low Activity Levels.
- areas of the survey site, from which samples may contain such levels.
- screening techniques (instruments, site history) to be used.
- instrument response action levels (if appropriate) to be used for designating categories.

This information becomes part of the project file; project personnel will receive instruction in its implementation.

At the time of collection by ESSAP personnel, those samples containing other than Low Activity levels (by virtue of field measurements, site history, or sample characteristics) will be identified. Warning labels, containing the designation MA (Moderate Activity) or HA (High Activity), will be affixed to the containers and a notation will be added to the sampling record form. Samples for which screening by direct monitoring is not applicable, but which are suspect for other reasons, will also include the wording "Suspect."

The following method will be used to facilitate the sample labeling requirements.

- High Activity (HA) samples will be labeled with red tape.
- Moderate Activity (MA) samples will be labeled with yellow tape.
- Low Activity (LA) samples will not require special labeling.

The tape is available in the signs/placards drawer in the Instrument Room and in the Sample Log-In Room. If at all possible, label the sample containers so that the tape is visible from all sides. To avoid confusion, please use this tape only for the above purposes.

When samples are to be received from other collecting organizations, the ESSAP project supervisor will request the providing organization to include information as to the anticipated activity levels and to identify those specific samples suspected of containing Moderate Activity and High Activity.

During log-in, samples received from other organizations will be monitored by direct measurement to confirm (where possible) the activity category. Again, the information in Table 1 will provide guidance as to the category levels. Those samples which have not previously been identified as requiring special handling, will be labeled. Categories and screening level data will be noted on the containers and in the sample logbook.

Guidance for performing sample screening

- Select the instrument which will provide the greatest sensitivity for the potential contaminant.

- Scan the sample to locate the point of maximum direct radiation. Determine the maximum direct contact radiation level and compare with the appropriate action levels for sample category. Note the screening category on the sample label and in the sampling record form or sample logbook, as appropriate. The scan and measurement should be performed in a manner that provides an optimum condition for identifying activity, but prevents the possibility of contaminating instruments, personnel, and other samples. For example, soil samples may be monitored through the plastic collection bag and smears may be monitored directly, while avoiding contact between the probe face and the smear.

- Where direct screening methods are not sufficiently sensitive to identify activity levels of the Moderate and High categories, but the sample is suspected for other reasons of containing such levels, enter the notation "Suspect" on the sample label and on the logbook.

- In certain cases, other routine measurements may be sufficient to categorize a sample, without additional screening. Examples are: 1. where surface activity measurements indicate a total activity level below the upper limit for Low Activity Samples, screening of smears will not be necessary, and 2. When an in-situ soil contact gamma measurement indicates that a sampling location does not potentially contain elevated concentrations of gamma emitters, gamma screening of the sample will not be required.

The cognizant supervisor will prepare or direct preparation of the lab work request, such that analyses of samples of Low, Moderate, and High activity are requested separately and that lab work requests include notation as to the sample activity category.

TABLE 1

EXAMPLES OF TYPICAL
INSTRUMENT RESPONSE FOR SAMPLE SCREENING PURPOSES

Sample Media	Contaminant	Contact Radiation Level (c/m)								
		Low Activity (<1000 pCi)			Moderate Activity (1000 to 10,000 pCi)			High Activity (>100,000 pCi)		
		α scintillation[a]	GM[b]	γ scintillation[c]	α scintillation	GM	γ scintillation	α scintillation	GM	γ scintillation
Smear	alpha	<400	---[d]	---	400-40,000	---	---	>40,000	---	---
	beta E-max >200 keV	---	<450	---	---	450-40,000	---	---	40,000	---
	E-max 100-200 keV (C-14)	---	<250	---	---	250-20,000	---	---	>20,000	---
	E-max 50-100 keV (Ni-63)	---	<150	---	---	150-10,000	---	---	>10,000	---
	E-max <50 keV (H-3)	---	---	---	---	---	---	---	---	---

[a]Eberline AC3-7 or equivalent.

[b]Pancake detector-Eberline HP-260 or equivalent.

[c]NaI-Victoreen 489-55 or equivalent.

[d]Dash indicates instrument not adequately sensitive to radiation.

TABLE 1 (Continued)

EXAMPLES OF TYPICAL
INSTRUMENT RESPONSE FOR SAMPLE SCREENING PURPOSES

Sample Media	Contaminant	Contact Radiation Level (c/m)								
		Low Activity (<1000 pCi/g)			Moderate Activity (1000 to 10,000 pCi/g)			High Activity (>100,000 pCi/g)		
		α scintillation[a]	GM[b]	γ scintillation	α scintillation	GM	γ scintillation	α scintillation	GM	γ scintillation
soil/sediment other residues	Sr-90	---	<4300	---	---	4300-430,000	---	---	>430,000	---
	Cs-137	---	<1100	<14,000	---	1100-110,000	14,000-500,000	---	>110,000	>500,000
	Co-60	---	<10,000	<150,000	---	10,000-1,000,000	150,000-500,000	---	>1,000,000	>500,000
	Thorium (natural)	---	<2300	<45,000	---	2300-230,000	45,000-500,000	---	>230,000	>500,000
	Uranium (processed-natural)	---	<1700	<4000	---	1700-170,000	4000-400,000	---	>170,000	>400,000
	Ra-226	---	<3500	<50,000	---	3500-350,000	50,000-500,000	---	>350,000	>500,000
	pure alpha emitters	---	---	---	---	---	---		---	---
	pure beta emitters E-max <150 keV	---	---	---	---	---	---	---	---	---

[a]Eberline AC3-7 or equivalent.
[b]Pancake detector-Eberline HP-260 or equivalent.
[c]NaI-Victoreen 489-55 or equivalent.
[d]Dash indicates instrument not adequately sensitive to radiation.

TABLE 1 (Continued)

EXAMPLES OF TYPICAL
INSTRUMENT RESPONSE FOR SAMPLE SCREENING PURPOSES

Sample Media	Contaminant	Contact Radiation Level (c/m)								
		Low Activity (<1000 pCi/l)			Moderate Activity (1000 to 10,000 pCi/l)			High Activity (>100,000 pCi/l)		
		α scintillation[a]	GM[b]	γ scintillation	α scintillation	GM	γ scintillation	α scintillation	GM	γ scintillation
Liquid	Sr-90	---	---	---	---	---	---	---	>430	---
	Cs-137	---	---	---	---	---	---	---	>110	>5000
	Co-60	---	---	---	---	---	---	---	>1000	>20,000
	Thorium (natural)	---	---	---	---	---	---	---	>230	>8000
	Uranium (processed-natural)	---	---	---	---	---	---	---	>170	---
	Ra-226	---	---	---	---	---	---	---	>350	---
	pure alpha emitters	---	---	---	---	---	---	---	---	---
	pure beta emitters E-max <150 keV	---	---	---	---	---	---	---	---	---

[a]Eberline AC3-7 or equivalent.

[b]Pancake detector-Eberline HP-260 or equivalent.

[c]NaI-Victoreen 489-55 or equivalent.

[d]Dash indicates instrument not adequately sensitive to radiation.

2.7 Transport of Hazardous Material

It may occasionally be necessary to transport materials which require special packaging, labeling, and vehicle placarding. Examples of such materials are compressed gases, chemical reagents, and radioactive materials. The site coordinator, or their designee, is responsible for working with the Technical Resource Manager to assure that the appropriate paperwork is completed according to Department of Transportation regulations and that the appropriate containers and restraining devises are used.

2.7.1 The Technical Resource Manager (TRM), or designee will call the ORISE Manager of Traffic and Materials Control and provide the following information:

Destination name
Destination address
Name of contact person at designation
Material type
Quantity and size of containers

2.7.2 The Traffic and Materials Control office will send the TRM the following:

Material Safety Data Sheets
DOT regulation
Shipping papers for transport (one way or round trip, as applicable)

2.7.3 The driver transporting the material must sign the shipping papers before leaving the Scarboro Facility. The completed paperwork must be carried in the cab of the vehicle at all times that hazardous materials are being transported. When the driver is in the vehicle, the documents must be carried in the drivers side door pocket or on the seat to the right of the driver. When the driver is not in the vehicle they must be in the drivers side door or on the drivers seat.

2.7.4 When it is necessary to transport the material (or any remaining portions) back to the Scarboro Facility, the return trip shipping papers must be signed by the driver prior to departure.

2.7.5 Upon arrival at the Scarboro Facility, the driver must give the signed shipping papers to the TRM, or their designee, for return to the Manager of Traffic and Materials Control.

NOTE: If you are unsure of the classification of a material, check with the TRM or call the Manager of Traffic and Materials Control.

2.8 Air Quality Assessment

Prior to entering areas having questionable air quality, monitoring must be done or results of monitoring by others must be reviewed, to assure safe working conditions.

To perform monitoring, follow manufacturers instruction for calibration, check-out, and use of the O_2/combustible gas meter. Record pertinent information in the site log book.

C-20
Insurer/Self-Insurer
Service Office

WAUSAU INSURANCE COMPANIES
Name
BOX 105067
Address
ATLANTA, GA 30348

TENNESSEE
EMPLOYER'S FIRST REPORT OF WORK INJURY

PLEASE TYPE FORM

The Use of this Form is Required Under the Provisions of the Tennessee Workers' Compensation Law and Must be Completed and Filed With Your Insurance Carrier Immediately After Notice of Injury.

EMPLOYER

1. Name (Give name under which concern does business) Oak Ridge Associated Universities
2. Federal Employer Identification Number (FEIN) ________
3. Mail address PO Box 117 Oak Ridge, TN (No., Street, & City) Zip Code 37831
4. Nature of business (Manufacturing shoes, retailing men's clothes, trucking for hire, etc.) ________ Phone ________ Class Code ________ Loc Code ________
5. Name of workmen's compensation insurance company ________

INJURED EMPLOYEE

6. Name ________ Social Security No. ________
7. Telephone Number ________ Home Address (No. & Street) ________
8. (City or town) ________ Zip Code ________
9. Age ________ 10. Sex: Check (X) Male ________ Female ________ 11. Check (X) Married ________ Single ________
12. Occupation (job title) ________ Department ________
13. No. of hours worked per day ________; per week ________; No. of days worked per week ________
14. Wages: $ ________ per hour; or $ ________ per day; or $ ________ per week. If paid on other than a time basis, such as piece work or commissions, indicate the method and enter actual average weekly earnings during the last weeks: ________ $ ________ per week.
15. If board, lodging, or other advantages were furnished in addition to wages, state nature and estimated weekly value: ________ $ ________ per week.

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL DISEASE

16. Place of accident or exposure (Number and St.) ________ (City) ________ (County) ________ Was it on employer's premises? ________
17. What was the employee doing when injured? (Be specific. If he was using tools or equipment or handling material, name them and tell what he was doing with them.) ________
18. How did the accident occur? (Describe fully the events which resulted in the injury or occupational disease. Tell what happened and how it happened. Name any objects or substances involved and tell how they were involved. Give full details on all factors which led or contributed to the accident. Use other side for additional space.) ________

INJURY OR OCCUPATIONAL DISEASE

19. Describe the injury or disease in detail and indicate the part of the body affected. (For example: amputation of right index finger at second joint; fracture of ribs, lead poisoning, etc.) ________
20. Name the object or substance which directly injured the employee. (For example, the machine or thing he struck against or which struck him; the vapor or poison he inhaled or swallowed; the chemical or radiation which irritated his skin; or in cases of strains, hernias, etc., the thing he was lifting pulling, pushing, etc.) ________
21. Date of injury, or occupational disease ________ Hour of day ________ p.m. a.m. Was employee paid in full for this day? ________ Date employee gave notice of injury if different from date of injury ________
22. Was employee unable to work because of the injury or disease on any day after the day of injury (including Sunday or any other day on which he would not usually work)? ________ If yes, give date last worked: Date ________
23. Has employee returned to work? ________ If yes, give date ________ At what wage? $ ________ per hour; or $ ________ per day; or $ ________ per week.
24. Did employee die? Yes ________ No ________. If yes, give date of death ________, and name and address of nearest relative ________
25. Name and address of physician ________
26. If hospitalized, name and address of hospital ________

Date of report ________ Prepared by ________ Position ________

DO NOT WRITE IN THIS COLUMN
Carrier Number(6)
County Number (3)
Occupation (3)
Industry (4)
Ownership (2)
Nature (3)
Body Part (3)
Type (3)
Source (4)
Agency (4)
Disability (1)

(R) 1303-4106 886

Figure 10-1

Oak Ridge Associated Universities

SUPERVISOR'S INVESTIGATION

1. NAME OF INJURED: ______________________________ 2. ___/___/___
LAST FIRST MIDDLE — SOC SEC NO.

3. AGE _____ 4. JOB TITLE ______________________________

5. DIVISION/DEPARTMENT ____________________ 6.YEARS OF SERVICE _______

7. PLACE OF ALLEGED ACCIDENT OR EXPOSURE: (Give exact location, bldg. room):
____

8. DATE OF ALLEGED ACCIDENT OR INITIAL DIAGNOSIS OF OCCUPATIONAL ILLNESS: ____________________

9. WHAT WAS EMPLOYEE DOING WHEN INJURED? (Include tools, machine, and materials used):
____

10. HOW DID THE ALLEGED ACCIDENT OCCUR? (Describe fully the events which resulted in the injury or occupational illness. Tell what happened and how it happened):
____
____

11. DESCRIBE THE INJURY OR ILLNESS IN DETAIL AND INDICATE PART(s) OF BODY AFFECTED:
____
____

12. WHAT WAS DEFECTIVE? UNSAFE CONDITION, WRONG METHOD, ETC? ______________
____

13. WHAT STEPS WILL BE TAKEN TO PREVENT SIMILAR INJURIES? ______________
____

14. WAS INJURED HOSPITALIZED ____ YES ___ NO IF SO, WHERE? ______________

15. NAME OF PHYSICIAN ____________________ 16. TIME LOST: ______________

17. WITNESSES TO ACCIDENT: ______________________________

18. DATE OF INVESTIGATION ________________ ______________________
SUPERVISOR'S SIGNATURE

____
DIVISION or DEPARTMENT HEAD SIGNATURE

____
OFFICE OF SAFETY & ENVIRONMENTAL ASSURANCE SIGNATURE

copies:
Original: OSEA
1st Copy: Division/Department Head
2nd Copy: Supervisor

OSEA 9/90

CONTRACTOR EMPLOYEES INSURANCE CLAIMS

P R I V A C Y   A C T   S T A T E M E N T

Privacy Act of 1974, P.L. 93.579

[This information is requested by the Office of Safety and Environmental Assurance of Oak Ridge Associated Universities, Inc., Oak Ridge, Tennessee, a Management and Operating Contractor of the U.S. Department of Energy (DOE)].

AUTHORITY

5 U.S.C 301; Department of Energy Organization Act, including authorities incorporated by reference in Title III of the DOE Reorganization Act; Executive Order 12009.

PRINCIPAL PURPOSE

The personnel information obtained will be used to process claims under worker's compensation insurance and third party claims.

WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUALS OF NOT PROVIDING INFORMATION

Information furnished by you is voluntary. However, if the requested information is not provided, the determination of any claim you make or for which you otherwise will be eligible will be based on existing information on record.

ROUTINE USES

These records may be used to assist insurance companies in administering claims against DOE Contractors and DOE; to assist state and local agencies in the consideration of insurance claims; and to assist physicians, lawyers, state industrial commissions, and claims adjustment service firms in the evaluation of claims. In addition, these records are subject to the standard Privacy Act routine uses established by the Department of Energy in Appendix B of the DOE Annual Publication of System Notices, 47 FEDERAL REGISTER 14333.

APPLICABILITY

This statement applies to accident reports, physician statements, pictures, maps, sketches, claimant and witness statements, doctor and hospital bills, reports from engineering firms, and claims activity reports.

____________________________ __________________

Signature Date

____________________________ __________________

Witness Date

gf/11-90

Figure 10-3

VEHICLE CHECKLIST

The vehicle should be inspected **(1) before it leaves Oak Ridge, (2) before leaving the site, and (3) after it returns to Oak Ridge.** Copy to Project Leader of trip and completed original to Technical Resource Manager. Please explain in detail any discrepancies on back of form.

Trip destination ______________________ Trip dates ______________________

Vehicle ______________________ License number ______________________

Ending mileage ______________________

Before Starting

1 2 3

- [ ] [ ] [ ] Accident/insurance package in glove compartment
- [ ] [ ] [ ] Parking brake (apply)
- [ ] [ ] [ ] Check seat belts
- [ ] [ ] [ ] Check oil level and coolant level
- [ ] [ ] [ ] Check belts, hoses, etc.
- [ ] [ ] [ ] Fire extinguisher, warning devise, and flares
- [ ] [ ] [ ] Tires and wheels (lugs)
- [ ] [ ] [ ] Tires and wheels (pressure visual)
- [ ] [ ] [ ] Mirrors (outside and inside)
- [ ] [ ] [ ] Fuel tank and cap
- [ ] [ ] [ ] Cargo doors latch and lock
- [ ] [ ] [ ] Ice scrapper and/or deicer (winter)

With Motor Running

1 2 3

- [ ] [ ] [ ] Oil pressure (light or gauge)
- [ ] [ ] [ ] Instrument panel (warning lights and buzzers)
- [ ] [ ] [ ] Windshield wipers/washer
- [ ] [ ] [ ] Heater/defroster/air conditioning
- [ ] [ ] [ ] Fuel level (gauge reading)
- [ ] [ ] [ ] Steering wheel (excessive play)
- [ ] [ ] [ ] Head lights
- [ ] [ ] [ ] Tail lights, brake lights, backup light
- [ ] [ ] [ ] Turn signals (front, back, and side)
- [ ] [ ] [ ] Running lights (side and top)
- [ ] [ ] [ ] Emergency flashers
- [ ] [ ] Transmission fluid level (automatic)

Vehicles Transporting Hazardous Material

- [ ] [ ] [ ] Marking or placards
- [ ] [ ] [ ] Shipping papers (P-10 gas and other hazardous materials)

Survey 1 ______________________ Date ______________________

Survey 2 ______________________ Date ______________________

Survey 3 ______________________ Date ______________________

Project leader ______________________ Date ______________________

Reviewed by ______________________ Date ______________________

(5-92)

VEHICLE SURVEY SHEET

SITE ____________________

TRIP DATES ____________________

PROJECT LEADER ____________________

VEHICLE ____________________

LICENSE NO. ____________________

DATE ____________________

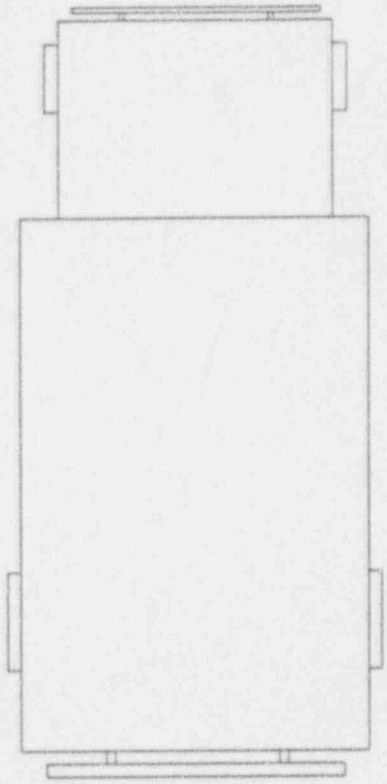
SURVEYOR(S) ____________________

____

	INSTRUMENT	PROBE	BACK-GROUND	EFFI-CIENCY	MDA $dpm/100cm^2$
ALPHA					
BETA					
GAMMA					

INSTRUCTIONS:

1. Vehicle interiors should be surveyed after transporting potentially contaminated samples.
2. After vehicle is unloaded
   a. Scan inside the vehicle (front and back) and record results
   b. Take at least five single points noting locations on figure to the right.
3. Count the smears and record data on table below.
4. Distribution:
   Original to Technical Resource Manager
   Xerox copy to Project Leader



SCAN RESULTS ____________________

LOCATION	DIRECT PROBE MEASUREMENTS: ALPHA c/____m		BETA c/____m		REMOVABLE CONTAMINATION (Smears): SMEAR #	ALPHA	BETA
	c/____m	$d/m/100cm^2$	c/____m	$d/m/100cm^2$	SMEAR #	$dpm/100cm^2$	$dpm/100cm^2$
QC*							

*Quality Control Sample

REMARKS: ____________________ REVIEWED BY: ____________________

____________________ DATE: ____________________ FORM25(8-93)

SECTION 11.0

QUALITY ASSURANCE AND QUALITY CONTROL

SECTION 11.0

QUALITY ASSURANCE AND QUALITY CONTROL

The Environmental Survey and Site Assessment Program conducts field surveys in a manner that assures the quality and accuracy of developed data and provides auditable documentation of activities.

Details of quality assurance and quality control procedures are presented in the ESSAP Quality Assurance Manual. Elements of the QA/QC program that are applicable to field activities include:

- Procedure Review and Approval
- Personnel Training and Qualification
- Instrument Calibration and Performance Criteria
- Sample Chain-Of-Custody
- Records Review and Management
- Internal and External Audit Program

Individual sections of this manual incorporate pertinent aspects of these elements for rapid user reference; these are, therefore, usually in abbreviated form.

APPENDIX A

Radiological Guidelines
used by DOE and NRC

NOTE: The guidelines provided in this Appendix are treated by the DOE and NRC as target values and may be modified by the responsible regulatory agency, based on site specific conditions and consideration of the ALARA philosophy. They are provided here, primarily to provide the reader with an idea of the approximate levels of interest.

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

July 1982

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface [illegible], together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in
Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle and Material Safety, USNRC, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

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

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

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Fed‹ral Register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document establishes guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	---	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	---	1,000
Insoluble	35	300	---	3,000
Enriched Uranium:				
Soluble	30	100	---	1,000
Insoluble	30	250	---	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.

Option 1 concentrations permit unrestricted use of the property and is the guideline applicable to surface soils. Options 2, 3, and 4 apply to buried wastes and assume that intrusions into the burial sites may occur. Regardless of the concentrations in the buried materials, surface soil must meet the Option 1 concentration guidelines.

U.S. ATOMIC ENERGY COMMISSION

June 1974

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 1.86

TERMINATION OF OPERATING LICENSES FOR NUCLEAR REACTORS

A. INTRODUCTION

Section 50.51, "Duration of license, renewal," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each license to operate a production and utilization facility be issued for a specified duration. Upon expiration of the specified period, the license may be either renewed or terminated by the Commission. Section 50.82, "Applications for termination of licenses," specifies the requirements that must be satisfied to terminate an operating license, including the requirement that the dismantlement of the facility and disposal of the component parts not be inimical to the common defense and security or to the health and safety of the public. This guide describes methods and procedures considered acceptable by the Regulatory staff for the termination of operating licenses for nuclear reactors. The advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

When a licensee decides to terminate his nuclear reactor operating license, he may, as a first step in the process, request that his operating license be amended to restrict him to possess but not operate the facility. The advantage to the licensee of converting to such a possession-only license is reduced surveillance requirements in that periodic surveillance of equipment important to the safety of reactor operation is no longer required. Once this possession-only license is issued, reactor operation is not permitted. Other activities from the reactor and placing it in storage (either onsite or offsite) may be continued.

A licensee having a possession-only license must retain, with the Part 50 license, authorization for special nuclear material (10 CFR Part, 70, "Special Nuclear Material"), byproduct material (10 CFR Part 30, "Rules of General Applicability to Licensing of Byproduct Material"), and source material (10 CFR Part 40, "Licensing of Source Material"), until the fuel, radioactive components, and sources are removed from the facility. Appropriate administrative controls and facility requirements are imposed by the Part 50 license and the technical specifications to assure that proper surveillance is performed and that the reactor facility is maintained in a safe condition and not operated.

A possession-only license permits various options and procedures for decommissioning, such as mothballing, entombment, or dismantling. The requirements imposed depend on the option selected.

Section 50.82 provides that the licensee may dismantle and dispose of the component parts of a nuclear reactor in accordance with existing regulations. For research reactors and critical facilities, this has

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usually meant the disassembly of a reactor and its shipment organization for further use. The site from which a reactor has been removed must be decontaminated, as necessary, and inspected by the Commission to determine whether unrestricted access can be approved. In the case of nuclear power reactors, dismantling has usually been accomplished by shipping fuel offsite, making the reactor inoperable, and disposing of some of the radioactive components.

Radioactive components may be either shipped off-site for burial at an authorized burial ground or secured on the site. Those radioactive materials remaining on the site must be isolated from the public by physical barriers or other means to prevent public access to hazardous levels of radiation. Surveillance is necessary to assure the long term integrity of the barriers. The amount of surveillance required depends upon (1) the potential hazard to the health and safety of the public from radioactive material remaining on the site and (2) the integrity of the physical barriers. Before areas may be released for unrestricted use, they must have been decontaminated or the radioactivity must have decayed to less than prescribed limits (Table 1).

The hazard associated with the returned facility is evaluated by considering the amount and type of remaining contamination, the degree of confinement of the remaining radioactive materials, the physical security provided by the confinement, the susceptibility to release of radiation as a result of natural phenomena, and the duration of required surveillance.

C. REGULATORY POSITION

1. APPLICATION FOR A LICENSE TO POSSESS BUT NOT OPERATE (POSSESSION-ONLY LICENSE)

A request to amend an operating license to a possession-only license should be made to the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545. The request should include the following information:

a. A description of the current status of the facility.

b. A description of measures that will be taken to prevent criticality or reactivity changes and to minimize releases of radioactivity from the facility.

c. Any proposed changes to the technical specifications that reflect the possession-only facility status and the necessary disassembly/retirement activities to be performed.

d. A safety analysis of both the activities to be accomplished and the proposed changes to the technical specifications.

e. An inventory of activated materials and their location in the facility.

2. ALTERNATIVES FOR REACTOR RETIREMENT

Four alternatives for retirement of nuclear reactor facilities are considered acceptable by the Regulatory staff. These are:

a. Mothballing. Mothballing of a nuclear reactor facility consists of putting the facility in a state of protective storage. In general, the facility may be left intact except that all fuel assemblies and the radioactive fluids and waste should be removed from the site. Adequate radiation monitoring, environmental surveillance, and appropriate security procedures should be established under a possession-only license to ensure that the health and safety of the public is not endangered.

b. In-Place Entombment. In-place entombment consists of sealing all the remaining highly radioactive or contaminated components (e.g., the pressure vessel and reactor internals) within a structure integral with the biological shield after having all fuel assemblies, radioactive fluids and wastes, and certain selected components shipped offsite. The structure should provide integrity over the period of time in which significant quantities (greater than Table 1 levels) of radioactivity remain with the material in the entombment. An appropriate and continuing surveillance program should be established under a possession-only license.

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c. Removal of Radioactive. Components and Dismantling. All fuel assemblies, radioactive fluids and waste, and other materials having activities above accepted unrestricted activity levels (Table 1) should be removed from the site. The facility owner may then have unrestricted use of the site with no requirement for a license. If the facility owner so desires, the remainder of the reactor facility may be dismantled and all vestiges removed and disposed of.

d. Conversion to a New Nuclear System or a Fossil Fuel System. This alternative, which applies only to nuclear power plants, utilizes the existing turbine system with a new steam supply system. The original nuclear steam supply system should be separated from the electric generating system and disposed of in accordance with one of the previous three retirement alternatives.

3. SURVEILLANCE AND SECURITY FOR THE RETIREMENT ALTERNATIVES WHOSE FINAL STATUS REQUIRES A POSSESSION-ONLY LICENSE

A facility which has been licensed under a possession-only license may contain a significant amount of radioactivity in the form of activated and contaminated hardware and structural materials. Surveillance and commensurate security should be provided to assure that the public health and safety are not endangered.

a. Physical security to prevent inadvertent exposure of personnel should be provided by multiple locked barriers. The presence of these barriers should make it extremely difficult for an unauthorized person to gain access to areas where radiation or contamination levels exceed those specified in Regulatory Position C.4. To prevent inadvertent exposure, radiation areas above 5 mR/hr, such as near the activated primary system of a power plant, should be appropriately marked and should not be accessible except by cutting of welded closures or the disassembly and removal of substantial structures and/or shielding material. Means such as a remote-readout intrusion alarm system should be provided to indicate to designated personnel when a physical barrier is penetrated. Security personnel that provide access control to the facility may be used instead of the physical barriers and the intrusion alarm systems.

b. The physical barriers to unauthorized entrance into the facility, e.g., fences, buildings, welded doors, and access openings, should be inspected at least quarterly to assure that these barriers have not deteriorated and that locks and locking apparatus are intact.

c. A facility radiation survey should be performed at least quarterly to verify that no radioactive material is escaping or being transported through the containment barriers in the facility. Sampling should be done along the most probable path by which radioactive material such as that stored in the inner containment regions could be transported to the outer regions of the facility and ultimately to the environs.

d. An environmental radiation survey should be performed at least semiannually to verify that no significant amounts of radiation have been released to the environment from the facility. Samples such as soil, vegetation, and water should be taken at locations for which statistical data has been established during reactor operations.

e. A site representative should be designated to be responsible for controlling authorized access into and movement within the facility.

f. Administrative procedures should be established for the notification and reporting of abnormal occurrences such as (1) the entrance of an unauthorized person or persons into the facility and (2) a significant change in the radiation or contamination levels in the facility or the offsite environment.

g. The following reports should be made:

(1) An annual report to the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545, describing the results of the environmental and facility radiation surveys, the status of the facility, and an evaluation of the performance of security and surveillance measures.

(2) An abnormal occurrence report to the Regulatory Operations Regional Office by telephone within 24 hours of discovery of an abnormal occurrence. The abnormal occurrence will also be reported in the annual report described in the preceding item.

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h. Records or logs relative to the following items should be kept and retained until the license is terminated, after which they must be stored with other plant records:

(1) Environmental surveys,

(2) Facility radiation surveys,

(3) Inspections of the physical barriers, and

(4) Abnormal occurrences.

4. DECONTAMINATION FOR RELEASE FOR UNRESTRICTED USE

If it is desired to terminate a license and to eliminate any further surveillance requirements, the facility should be sufficiently decontaminated to prevent risk to the public health and safety. After the decontamination is satisfactorily accomplished and the site inspected by the Commission, the Commission may authorize the license to be terminated and the facility abandoned or released for unrestricted use. The licensee should perform the decontamination using the following guidelines:

a. The licensee should make a reasonable effort to eliminate residual contamination.

b. No covering should be applied to radioactive surfaces of equipment of structures by paint, plating, or other covering material until it is known that contamination levels (determined by a survey and documented) are below the limits specified in Table 1. In addition, a reasonable effort should be made (and documented) to further minimize contamination prior to any such covering.

c. The radioactivity of the interior surfaces of pipes, drain lines, or ductwork should be determined by making measurements at all traps and other appropriate access points, provided contamination at these locations is likely to be representative of 2contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement should be assumed to be contaminated in excess of the permissible radiation limits.

d. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated in excess of the limits specified. This may include, but is not limited to, special circumstances such as the transfer of premises to another licensed organization that will continue to work with radioactive materials. Requests for such authorization should provide:

(1) Detailed, specific information describing the premises, equipment, scrap, and radioactive contaminants and the nature, extent, and degree of residual surface contamination.

(2) A detailed health and safety analysis indicating that the residual amounts of materials on surface areas, together with other considerations such as the prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

e. Prior to release of the premises for unrestricted use, the licensee should make a comprehensive radiation survey establishing that contamination is within the limits specified in Table 1. A survey report should be filed with the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545, with a copy to the Director of the Regulatory Operations regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report should:

(1) Identify the premises;

(2) Show that reasonable effort has been made to reduce residual contamination to as low as practicable levels;

(3) Describe the scope of the survey and the general procedures followed; and

(4) State the finding of the survey in units specified in Table 1.

After review of the report, the Commission may inspect the facilities to confirm the survey prior to granting approval for abandonment.

5. REACTOR RETIREMENT PROCEDURES

As indicated in Regulatory Position C.2, several alternatives are acceptable for reactor facility retirement. If minor disassembly or "mothballing" is planned, this could be done by the existing operating and maintenance procedures under the license in effect. Any planned actions involving an unreviewed safety question or a change in the technical specifications should be reviewed and approved in accordance with the requirements of 10 CFR § 50.59.

If major structural changes to radioactive components of the facility are planned, such as removal of the pressure vessel or major components of the primary system, a dismantlement plan including the information required by § 50.82 should be submitted to the Commission. A dismantlement plan should be submitted for all the alternatives of Regulatory Position C.2 except mothballing. However, minor disassembly activities may still be performed in the absence of such a plan, provided they are permitted by existing operating and maintenance procedures. A dismantlement plan should include the following:

a. A description of the ultimate status of the facility

b. A description of the dismantling activities and the precautions to be taken.

c. A safety analysis of the dismantling activities including any effluents which may be released.

d. A safety analysis of the facility in its ultimate status.

Upon satisfactory review and approval of the dismantling plan, a dismantling order is issued by the Commission in accordance with § 50.82. When dismantling is completed and the Commission has been notified by letter, the appropriate Regulatory Operations Regional Office inspects the facility and verifies completion in accordance with the dismantlement plan. If residual radiation levels do not exceed the values in Table 1, the Commission may terminate the license. If possession-only license under which the dismantling activities have been conducted or, as an alternative, may make application to the State (if an Agreement State) for a byproduct materials license.

Note: Section electronically reproduced from photocopy.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

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

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

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document established guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options				
	1[a]		2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	--	500	
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200	
Depleted Uranium:					
Soluble	35	100	--	1,000	
Insoluble	35	300	--	3,000	
Enriched Uranium:					
Soluble	30	100	--	1,000	
Insoluble	30	250	--	2,500	

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).* The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are

*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

provided for (1) residual concentrations of radionuclides in soil,* (2) concentrations of airborne radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactive or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each

*"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent." Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbably, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m^2. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

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

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface

- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or 2) the sum of the ratios of the soil concentration of each radionuclide to [illegible]able limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)* and will be applied to a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

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*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

TABLE 1
SURFACE CONTAMINATION GUIDELINES

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm²)[1] Average[3,4]	Maximum[4,5]	Removable[4,6]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ

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

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

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

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

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

6
The amount of removeable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to the appropriate limits and guidelines (i.e., state or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and

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*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

subsequent guidance or superseding Orders require compliance with applicable Federal and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

a. 5000.3, Unusual Occurrence Reporting System

b. 5440.1C, Implementation of the National Environmental Policy Act

c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution

d. 5480.2, Hazardous and Radioactive Mixed Waste Management

e. 5480.4, Environmental Protection, Safety, and Health Protection Standards

f. 5482.1A, Environmental, Safety, and Health Appraisal Program

g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.

b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 Pci/L at any given point, (2) an annual average concentration of 30 Pci/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-I).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.

d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, as effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

a. A site may be release under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.

b. The administrative controls as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.

c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere form the wastes shall not (1) exceed an annual average release rate of 20 $pCi/m^2/s$ and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).

d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.

e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate protection, giving due consideration to health and safety, the environment, and costs. The filed office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents., The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, in the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines wither do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment. The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.

d. Where the cost of remedial action for contaminated soil is unreasonably high relative t long-term benefits and where the residual radioactive material does not pose a clear present o: future risk after taking necessary control measures. The likelihood the buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
Basic Dose Limits	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
Generic Guidelines for Residual Radioactivity	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
Control of Radioactive Wastes and Residues	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

H. REFERENCES

International Commission on Radiological Protection, 1977. Recommendations of the International Commission on Radiological Protection (Adopted January 17; 1977). ICRP Publication 26. Pergamon Press, Oxford. [As modified by "Statement from the 1978 Stockholm Meeting of the ICRP." Annals of the ICRP, Vol. 2, No. 1, 1978.]

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U.S. Department of Energy, 1987. Supplement to U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites. A Manual for Implementing Residual Radioactive Material Guidelines. Prepared by Argonne National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratory for the U.S. Department of Energy [In press.]

U.S. Environmental Protection Agency, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites; Final Rule (40 CFR Part 192). Federal Register 48(3):590-604 (January 5, 1983).

U.S. Nuclear Regulatory Commission, 1982. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, D.C. July 1982.

APPENDIX B

FIELD SURVEY FORMS

INSTRUMENT OPERATIONAL CHECK-OUT FORM

INSTRUMENT TYPE ______________ DETECTOR TYPE ______________

INSTRUMENT # ______________ DETECTOR # ______________

SITE ______________ EFFICIENCY ______________

VOLTAGE ______________ THRESHOLD ______________

	Check Out Date/Time	Background (c/__m)	*Source Type: ID#: c/__m	**Source Type: ID#: c/__m	Checked Out By	Comments (see reverse)
						ORAU Data
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

Background Response limits ________ to ________ c/m

*Source Response limits ________ to ________ c/m

**Source Response limits ________ to ________ c/m

DATA REVIEWED

FORM2b(11-93)

Figure B-1

SITE BACKGROUND DETERMINATION

LOCATION ______________

____

c/__m

AVE ______________

3σ ______________

RANGE ________ TO ________

MDA ______ dpm/100cm²

PERFORMED BY: __________

DATE: __________

LOCATION ______________

____

c/__m

AVE ______________

3σ ______________

RANGE ________ TO ________

MDA ______ dpm/100cm²

PERFORMED BY: __________

DATE: __________

COMMENTS:

FORM23b(5-92)

ELECTRONIC CALIBRATION RECORD

INSTRUMENT TYPE ______________________________

INSTRUMENT NUMBER ______________________________

PULSAR TYPE/NUMBER ______________________________

PULSER VOLTAGE	INSTRUMENT VOLTAGE

INSTRUMENT SCALE	PULSER SCALE (pulses/min)	INITIAL INSTRUMENT READING (c/m)	ADJUSTED INSTRUMENT RESPONSE (c/m)
X1000 (1K)	400,000		
X100	40,000		
X10	4,000		
X1	400		
X1000 (1K)	200,000		
X100	20,000		
X10	2,000		
X1	200		

REMARKS ______________________________

____

____

CALIBRATED BY ____________________ DATE ____________

☐ DATA REVIEWED

FORM24(5-92)

Figure B-2

CROSS CALIBRATION FORM

SITE ____________________ PIC NUMBER ____________________ SURVEYORS: ____________________

CALIBRATION POINT										
DATE										
PIC READINGS $\mu R/hr$										
MEAN: PIC										
OBSERVED READINGS IN K COUNTS/MINUTE										
METER NO. / DETECTOR NO.										
/										
/										
/										
/										
/										
/										
MEAN: METER										

REMARKS: ____________________

☐ DATA REVIEWED ☐ CALCULATIONS REVIEWED

FORM5a(5-92)

Figure B-3

CALIBRATION DATA--ALPHA/BETA

SITE ____________

INSTRUMENT TYPE ____________ INSTRUMENT NUMBER ____________

DETECTOR TYPE ____________ DETECTOR NUMBER ____________

CALIBRATION SOURCE: RADIONUCLIDE ____________

ID NUMBERS ____________ ____________

____________ ____________

PURGE CHECK: (check source) 1ST COUNT ____________ TIME ____________

2ND COUNT ____________ TIME ____________

SOURCE DISINTEGRATION RATE (dpm)	GROSS INSTRUMENT COUNT RATE (cpm)	NET INSTRUMENT COUNT RATE (cpm)	EFFICIENCY (cpm/dpm)

CHECK SOURCE REPRODUCIBILITY TEST (c/__m)

OPERATING EFFICIENCY (highest activity source) [ ]

AVE = ____________

3σ= ____________

HIGH VOLTAGE ____________ THRESHOLD ____________ WINDOW ____________

CHECK SOURCE RADIONUCLIDE ____________ CHECK SOURCE I.D. # ____________

POSITION OF CHECK SOURCE RELATIVE TO DETECTOR ____________

AVERAGE BACKGROUND c/__m ____________ CHECK SOURCE RANGE ____________ TO ____________ c/__m
(AVE ± 3σ)

IMPORTANT: ALL OF THE ABOVE INFORMATION MUST BE PROVIDED

DATE ____________ CALIBRATED BY ____________

[ ] DATA REVIEWED

FORM3a(5-92)

Figure B-4

BACKGROUND DETERMINATION

LOCATION ____________________

____

c/___m

AVE. ____________

3σ ____________

RANGE ______ TO ______

MDA _____ dpm/100cm^2

PERFORMED BY: __________

DATE: __________

COMMENTS:

FORM23a(5-92)

PIC TRACKING FORM

INSTRUMENT # ______________________

	Checkout Date	Background (μR/hr)	Source Check # ________		Battery Check	Performed By	Comments (see reverse)
			Gross μR/hr	Net μR/hr*	% Charge**		
							Initial Operational Check
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

* Response limits ________ to ________ μR/hr (NET)

** Response must be >85% for the 300V battery

NOTE: This form is kept in the ESSAP instrument room files.

FORM2d(5-92)

Figure B-5

PIC FIELD CHECK–OUT FORM

INSTRUMENT # ______________________

SITE ______________________________

	Checkout Date/Time	Background (μR/hr)	Source Check # ______ Gross μR/hr	Net μR/hr*	Battery Check % Charge**	Performed By	Comments (see reverse)
							ORAU DATA
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

* Response limits ________ to ________ μR/hr (NET)

** Response must be >85% for the 300V battery

FORM2c(5-92)

Figure B-6

TAPE CALIBRATION FORM

TAPE IDENTIFIER NUMBER ______________________

FULL TAPE LENGTH ______________________

LENGTH OR SECTION TO BE CALIBRATED ______________________

RECALIBRATION ____________ OR NEW TAPE ____________ ?

% OF LENGTH	TAPE POSITION (m or ft)	STANDARD POSITION (m or ft)	DIFFERENCE (m or ft)	% DIFFERENCE *
0				
1%				
5%				
10%				
25%				
50%				
75%				
100%				
OTHER				

*MUST BE LESS THAN 1.0% FOR ACCEPTANCE

REMARKS ______________________

CALIBRATED BY ______________________ DATE ______________________

LAB18(5-92)

Figure B-7

ROTAMETER CALIBRATION

NAME ______________________

DATE ______________________

ROTAMETER NO. ______________________

TEMPERATURE ______________________

PRESSURE ______________________

FULL SCALE ON ROTAMETER ______________________

PERCENT OF FULL SCALE	ROTAMETER SETTING cfh or lpm	TIME / _ ft^3 or _ l[a]	PRESSURE DIFFERENTIAL inches H_2O	AVERAGE TIME	ACTUAL cfh or lpm

[a] FOR ROTAMETERS WITH FULL SCALE VALUES OF 20, 50, AND 100 cfh, USE A TOTAL VOLUME OF 0.5, 1.0, AND 2.0, RESPECTIVELY

TO CALCULATE ACTUAL FLOW RATE:

$$\frac{\text{TOTAL VOLUME } (ft^3 \text{ or } l)}{\text{AVERAGE TIME (minutes or hours)}} = \text{ACTUAL cfh or lpm}$$

NOTE: $\frac{\text{lpm} \times 60}{28.3} = \text{cfh}$

FORM16(5-92)

Figure B-8

SURFACE ACTIVITY SURVEY

SITE ______________________

AREA ______________________

DATE/TIME ______________________

SURVEYOR(S) ______________________

____

	INSTRUMENT	PROBE	BACK-GROUND	EFFI-CIENCY	MDA dpm/100cm^2
ALPHA					
BETA					
GAMMA					

________ GRID POINT

________ GRID POINT

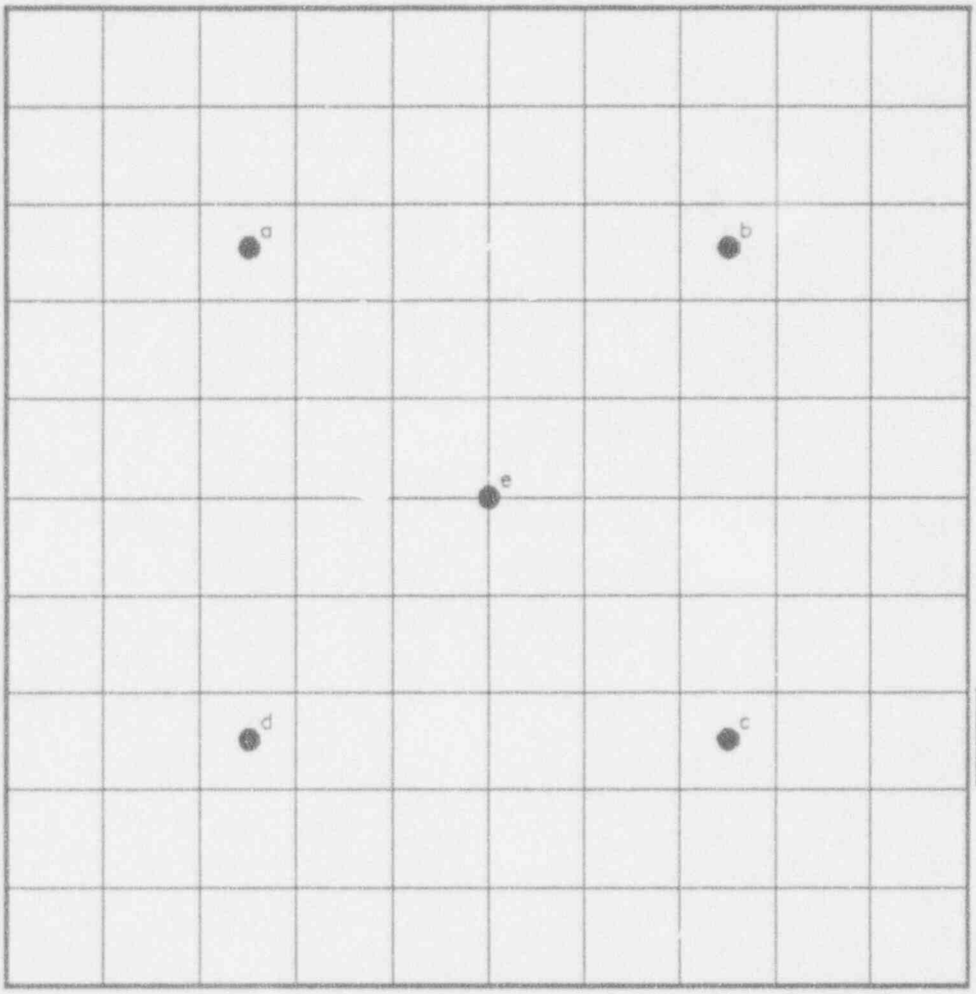
FLOOR

LOWER WALL

UPPER WALL

CEILING

OTHER ______



REFERENCE DIRECTION

SCALE:
1/2" = ________

________ GRID POINT

________ GRID POINT

SCAN RANGE: α ______________ β ______________ γ ______________

LOCATION	DIRECT PROBE MEASUREMENTS				REMOVABLE CONTAMINATION (Smears)		
	ALPHA		BETA-GAMMA			ALPHA	BETA
	c/____m	d/m/100cm^2	c/____m	d/m/100cm^2	SMEAR #	dpm/100cm^2	dpm/100cm^2
A							
B							
C							
D							
E							
AVERAGE					X	X	X

REMARKS: ____

CALCULATIONS BY: ______________________ REVIEWED BY: ______________________

DATE: ______________________ DATE: ______________________ FORM19(11-93)

Figure B-9

AREA SCAN AND RADIATION LEVEL SURVEY

SITE ______________________ INSTRUMENT ______________________

DATE/TIME ______________________ PROBE ______________________

SURVEYOR(S) ______________________ ______________________

GRID POINT ________ GRID POINT ________

SCALE:
1/2" = ________

REFERENCE DIRECTION

GRID POINT ________ GRID POINT ________

AVERAGE OR RANGE OF LEVELS: ______________________

ELEVATED READING			ELEVATED READING		
GRID LOCATION	cpm	μR/hr	GRID LOCATION	cpm	μR/hr

REMARKS: ______________________

CALCULATIONS BY: ______________________ REVIEWED BY: ______________________

DATE: ______________________ DATE: ______________________

FORM14a(11-93)

Figure B-10

BOREHOLE LOGGING AND SAMPLING

SITE ____________________ SURVEYOR(S) ____________________

AREA ____________________ ____________________

DATE ____________________

START TIME __________ END TIME __________

GRID LOCATION/HOLE NO. __________

HOLE CASING TYPE __________

DEPTH TO WATER __________

WATER SAMPLE I.D. __________

TYPE	INSTRUMENT	DETECTOR

DEPTH	MEASUREMENT c/___m	SOIL SAMPLE	REMARKS

REMARKS: ____________________

☐ DATA REVIEWED

FORM1a(11-93)

Figure B-11

ACTIVITY SURVEY RECORD

SITE ______________________________

AREA ______________________________

START TIME: __________ END TIME: __________

DATE ______________________________

SURVEYOR(S) ______________________________

____

TYPE	INSTRUMENT	DETECTOR	BKG. (cpm)	EFF.	MDA dpm/100cm²

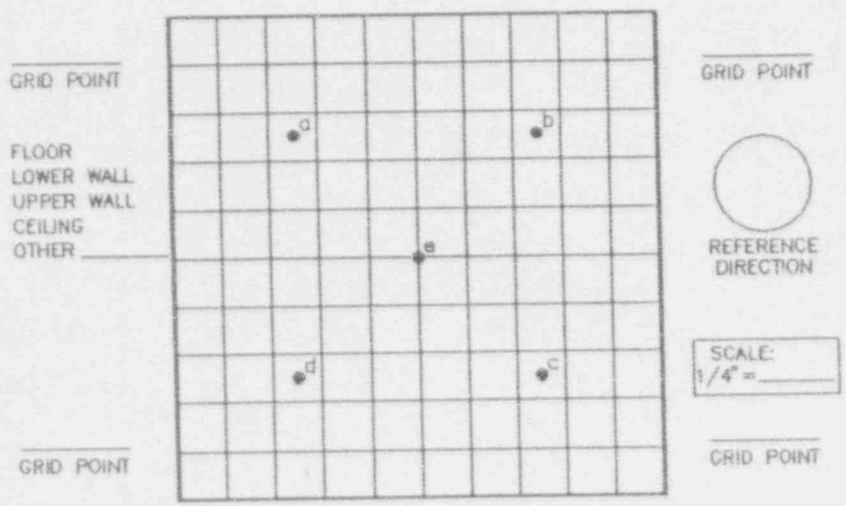
LOCATION	DIRECT DETECTOR MEASUREMENTS				REMOVABLE ACTIVITY			REMARKS
	TYPE:		TYPE:			ALPHA	BETA	
	c/____m	dpm/100cm²	c/____m	dpm/100cm²	SMEAR #	dpm/100cm²	dpm/100cm²	

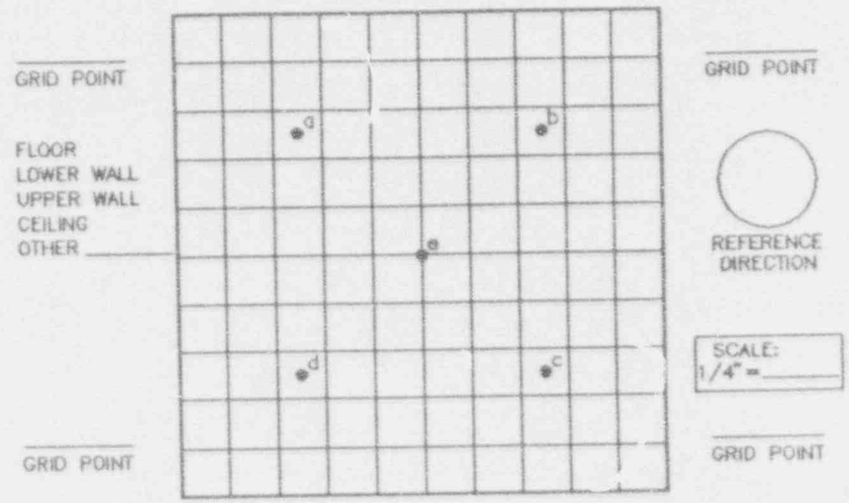
CALCULATIONS BY: ______________________________ DATE: ______________________

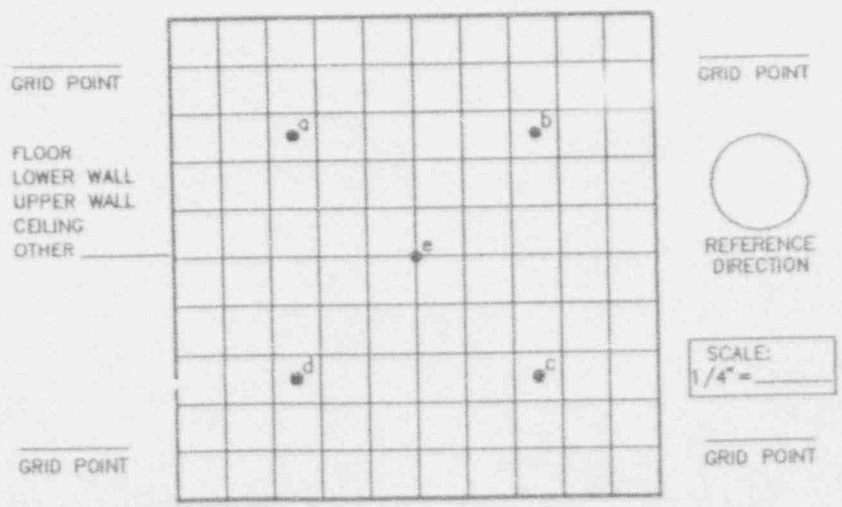
☐ DATA REVIEWED ☐ CALCULATIONS REVIEWED

FORM35(11–93)

Figure B-12


GRID POINT
FLOOR
LOWER WALL
UPPER WALL
CEILING
OTHER ____
GRID POINT
a
b
e
d
c
GRID POINT
REFERENCE DIRECTION
SCALE:
1/4" = ____
GRID POINT


GRID POINT
FLOOR
LOWER WALL
UPPER WALL
CEILING
OTHER ____
GRID POINT
a
b
e
d
c
GRID POINT
REFERENCE DIRECTION
SCALE:
1/4" = ____
GRID POINT


GRID POINT
FLOOR
LOWER WALL
UPPER WALL
CEILING
OTHER ____
GRID POINT
a
b
e
d
c
GRID POINT
REFERENCE DIRECTION
SCALE:
1/4" = ____
GRID POINT

SYSTEMATIC/RANDOM SURFACE MEASUREMENTS

SITE ______________ SURVEYOR(S) ______________

AREA ______________ ______________

DATE ______________ ______________

START TIME __________ END TIME __________

TYPE	INSTRUMENT	DETECTOR	BACK-GROUND	EFFI-CIENCY

LOCATION	SCINTILLATION			GM		SOIL SAMPLE	REMARKS
	1 METER		CONTACT	OPEN	CLOSED		
	Kcpm	μR/hr	Kcpm	c/ __m	c/__m		

REMARKS: ____

____

CALCULATIONS BY: ______________________

DATE: ______________________

☐ DATA REVIEWED ☐ CALCULATIONS REVIEWED

FORM80(11-93)

Figure B-13

BIAS SURFACE MEASUREMENTS

SURVEYOR(S)

SITE ______________________ ________________

AREA ______________________ ________________

DATE ______________________ ________________

TYPE	INSTRUMENT	DETECTOR	BACK-GROUND	EFFI-CIENCY

START TIME: ________ END TIME: ________

LOCATION	SCINTILLATION			GM		SOIL SAMPLE	ESTIMATED AREA OF ELEVATED ACTIVITY
	1 METER		CONTACT	OPEN	CLOSED		
	Kcpm	μR/hr	Kcpm	c/__m	c/__m		

REMARKS: ____

CALCULATIONS BY: ______________________

DATE: ______________________

☐ DATA REVIEWED ☐ CALCULATIONS REVIEWED

FORMBb(11-93)

Figure B-14

MISCELLANEOUS SAMPLE RECORD FORM

SITE ______________________

AREA ______________________

DATE ______________________

START TIME ________ END TIME ________

SURVEYOR(S) ______________________

____

TYPE	INSTRUMENT	DETECTOR	BKG. (cpm)	EFF.

LOCATION	DIRECT DETECTOR MEASUREMENTS				SAMPLE TYPE	SAMPLE NUMBER	REMARKS
	TYPE:		TYPE:				
	c/____m	dpm/100cm²	c/____m	dpm/100cm²			

CALCULATIONS BY: ______________________ DATE: ______________________

☐ DATA REVIEWED ☐ CALCULATIONS REVIEWED

FORM38(11-93)

Figure B-15

STACK VELOCITY WORKSHEET

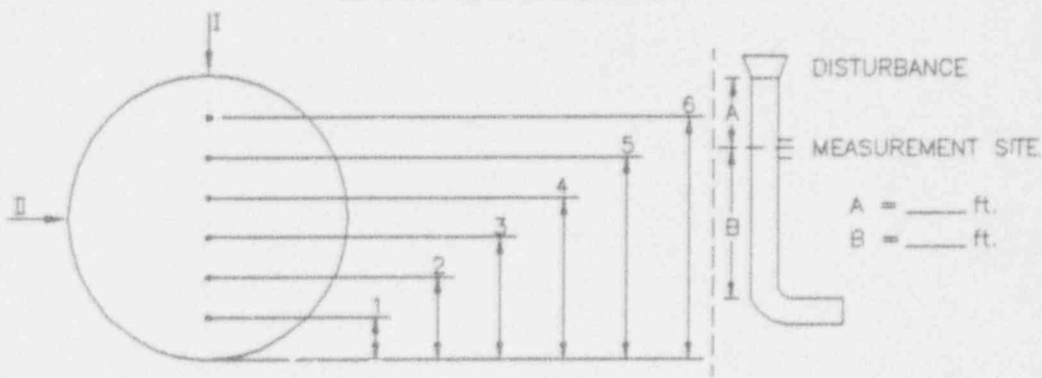
SITE ______________________________ DATE ______________________________

PERSONNEL ______________________________

STACK NAME OR DESCRIPTION ______________________________

STACK DIAMETER ______________________________ INCHES

SAMPLE VELOCITY TRAVERSE



LOOKING DOWN ONTO STACK OR DUCT

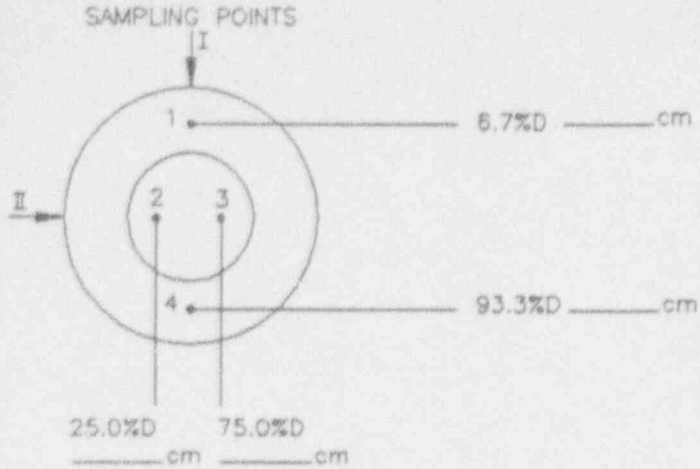
8 POINTS (<61 CM/24 IN. DIAMETER)				
POINT	% DISTANCE FROM WALL	DISTANCE (IN.) FROM WALL	PORT I VELOCITY (ft/m)	PORT II VELOCITY (ft/m)
1	0.032			
2	0.105			
3	0.194			
4	0.323			
5	0.677			
6	0.806			
7	0.895			
8	0.968			
12 POINTS (>61 CM/24 IN DIAMETER)				
1	0.021			
2	0.067			
3	0.118			
4	0.177			
5	0.250			
6	0.356			
7	0.644			
8	0.750			
9	0.823			
10	0.882			
11	0.933			
12	0.979			

STACK NAME ______________________________

FORM10(5-92)

Figure B-16

STACK SAMPLING RATE WORKSHEET



SAMPLING RATES				
SAMPLING POINT	VELOCITY (ft/m) (V)	NOZZLE DIAMETER (in)	NOZZLE NUMBER	SAMPLING RATE (1/m)
1				
2				
3				
4				

Calculation of nozzle size and actual sampling rate:

Velocity Required (V) = ft/m

Approximate Sampling Rate Desired (Q_T) = ______ 1/m

Required Nozzle Diameter = $\sqrt{\frac{6.47\ Q_T}{V}}$ inches

Selected Nozzle Size Number ______ and Diameter (D) ______ in

Actual Sampling Rate = $0.1545\ VD^2$ = ______ 1/m

NOZZLE IN INCHES VS. NOZZLE NUMBER					
SIZE (D) (in)	NUMBER	SIZE	NUMBER	SIZE	NUMBER
.125	4				
.150	5				
.1825	6	.2813	9	.375	12
.250	8	.3125	10	.4063	13
				.500	16

REMARKS: ______________________________

____

FORM18(5-92)

Figure B-17

STACK SAMPLING RECORD

STACK NAME ______________________

SAMPLING POINT AND PROBE DISTANCE	START			PERIODIC FLOW RATE CHECKS						FINISH			REMARKS
	DATE	TIME	CFH	DATE	TIME	CFH	DATE	TIME	CFH	DATE	TIME	CFH	

REMARKS: ______________________

____

FORM11(5-92)

Figure B-18

ORISE/ESSAP
P. O. Box 117
Oak Ridge, TN 37830

CHAIN-OF-CUSTODY RECORD

EMERGENCY CONTACTS
(615)-576-9246
(615) 576-3180

Site ______________________ Sample Type ______________________

Samplers ____

NOTE: If more than one name is listed, circle the sample custodian.

Sample Number	Sampling Location	Collected		Remarks
		Date	Time	

Transport Method ______________________ Seal No. ______________________

Relinquished by	Date	Time	Received in good condition by
1. Relinquished by:	Date	Time	*Received in good condition by:
2. Relinquished by:	Date	Time	*Received in good condition by:
3. Relinquished by:	Date	Time	Received in good condition by:
4. Relinquished by:	Date	Time	*Received in good condition by:

*For samples received in unacceptable condition explain in Remarks Column.

Distribution: Original to individual having custody
Copy filed with field data

FORM25a(5-92)

Figure B-19

EXPOSURE RATE CALIBRATION DATA

INSTRUMENT TYPE ______________________ PROBE ______________________

INSTRUMENT NUMBER ______________________ SOURCE ______________________

CHECK SOURCE ______________________ BACKGROUND ______________________

CALIBRATION				
DISTANCE	CALCULATED RATE	PIC MEASURED RATE	INSTRUMENT MEASURED RATE	CPM/μR/HR

EFFICIENCY ______________________ CPM/μR/HR (average) ______________________

CHECK SOURCE RANGE ______________ TO ______________ c/m

CALIBRATED BY ______________________ DATE ______________________

FORM7(5-92)

Figure B-20