IL.27-2

IL.27

ORAU 89/G-74

11433

Prepared by
Oak Ridge Associated
Universities

Prepared for
Division of
Facility and Site
Decommissioning

U.S. Department
of Energy

RADIOLOGICAL SURVEY AT 2501 WEST HOMER STREET CHICAGO, ILLINOIS

M. R. LANDIS

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
OCTOBER 1989

RADIOLOGICAL SURVEY AT 2501 WEST HOMER STREET CHICAGO, ILLINOIS

Prepared by

M.R. LANDIS

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division
Oak Ridge Associated Universities
Oak Ridge, TN 37831-0117

Project Staff

J.D. Berger
R.C. Gosslee
E.A. Powell
G.R. Foltz
M.J. Laudeman
A. Wallo*
C.F. Weaver

Prepared for

U.S. Department of Energy
as part of the
Formerly Utilized Sites - Remedial Action Program

FINAL REPORT

OCTOBER 1989

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

*with the U.S. Department of Energy, Division of Facility and Site Decommissioning

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

RADIOLOGICAL SURVEY
AT
2501 WEST HOMER STREET
CHICAGO, ILLINOIS

INTRODUCTION

Between 1942 and 1952, the University of Chicago conducted research and development activities under contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC) - predecessors of the Department of Energy (DOE). Some of the work involving machining of uranium was subcontracted to various companies in the Chicago area, one of these was the R. Krasberg and Sons Manufacturing Company, Chicago, Illinois. During the period from April 1944 through December 1944, R. Krasberg and Sons Manufacturing Company entered into a subcontract with the University of Chicago for services and supplies to the Metallurgical Laboratory. The subcontract, number 7401-37-115, provided for necessary personnel, facilities and equipment, tools, jigs, fixtures, etc., from materials furnished by the University. The Department of Energy has reviewed available historical documentation which describes the previous MED/AEC activities conducted at this facility. Based upon this review, the Department determined that there was not potential for significant residual radioactive material to be present as a result of the past MED/AEC activities; however, there was not adequate documentation to verify the radiological condition of the site at the termination of the MED/AEC activities. As a result, DOE requested that a preliminary survey be performed in order to determine if additional investigations were required under the Formerly Utilized Sites Remedial Action Program (FUSRAP) or if the site could be eliminated from the program.

The Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities (ORAU) was requested by DOE's Division of Facility and Site Decommissioning Projects to conduct a preliminary survey of the facility and property at 2501 West Homer Street.

FACILITY DESCRIPTION

The facility is located at the corner of West Homer and Campbell Streets, approximately 7 kilometers (4.4 miles) northwest of the Chicago Loop

(Figure 1). It is a brick-veneer concrete block structure on a concrete slab; total floor area is about 3600 m^2 (38,600 ft^2). Internal main walls are also concrete block; however, there are numerous smaller rooms of wood frame construction. Floors of main processing areas are bare, while those of offices and reception areas are tiled or carpeted. The building is single story, with exception of a mezzanine in the east-central portion and a second story room in the southwest corner. A flat, tar and gravel roof covers the building; there are multiple skylights in the main processing areas. The building is presently used for light manufacturing.

PROCEDURES

On May 23, 1989 ORAU performed a preliminary survey at 2501 West Homer Street, Chicago, Illinois. The objective of this survey was to obtain sufficient radiological data, upon which to base a decision for inclusion or exclusion from the Formerly Utilized Sites Remedial Action Program.

Procedures

1. Access consent was obtained from the site owner prior to performing the survey.

2. Surface scans were performed on accessible areas of the floors, lower walls, roof and the outside area immediately surrounding the facility to identify areas of elevated direct radiation. Gamma scans were performed on interior and soil surfaces using NaI(Tl) gamma scintillation detectors coupled to countrate meters with audible indicators. Beta-gamma scans were performed on interior, non-soil surfaces and roofs using thin window GM detectors coupled to countrate meters with audible indicators.

3. Measurements of total and removable alpha and beta-gamma activity were made at randomly selected locations. Measurement locations were referenced to prominent features of the property and building.

4. Exposure rates were measured at 1 meter (3.3 ft) above the surface at representative locations.

5. Samples of soil were collected from representative locations.

6. Samples and direct measurement data were returned to Oak Ridge, Tennessee, for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. Smears were analyzed for gross alpha and beta. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared with DOE's Guidelines for Residual Radioactivity at Formerly Utilized Sites, Remedial Action Program and Remote Surplus Facilities Management Program Sites, which is included as Appendix C.

FINDINGS AND RESULTS

Gamma and beta-gamma scans of the facility perimeter, building interior and roof did not identify any areas of elevated contact radiation. Forty-six measurements for total and removable activity were performed and the results are summarized in Table 1. Total activity levels ranged from <27 to 40 dpm/100 cm^2 for alpha and <480 to 910 dpm/100 cm^2 for beta-gamma, respectively. Removable activity levels ranged from <3 to 5 dpm/100 cm^2 for alpha and <6 to 23 dpm/100 cm^2 for beta-gamma. For comparison, the DOE surface contamination guideline levels for uranium are:

5,000 dpm/100 cm^2, averaged over 1 m^2
15,000 dpm/100 cm^2, maximum in 100 cm^2
1,000 dpm/100 cm^2, removable

All measurements were within these guideline levels.

Exposure rates measured at 19 locations throughout the facility ranged from 7.3 to 10.2 μR/hr (Table 2), typical of background for this area[1] and are therefore, below the DOE external gamma radiation guideline of 20 μR/h above background.

Radionuclide concentrations in soil samples are presented in Table 3. Concentration ranges were: U-238, 1.8 to 3.1 pCi/g; Ra-226, 1.1 to 3.7 pCi/g; and Th-232, 1.0 to 1.4 pCi/g. The U-238 concentrations are in the range of

natural background and the Ra-226 and Th-232 concentrations are below the DOE guideline concentrations of 5 pCi/g, averaged over the first 15 cm and 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.

SUMMARY

On May 23, 1989, ORAU performed a preliminary survey of the facility and property at 2501 West Homer Street, Chicago, Illinois. Survey activities included gamma and beta-gamma scans, and measurements of exposure rates, total and removable surface activity and radionuclide concentrations in soil samples. No areas of residual activity in excess of the guideline levels were identified.

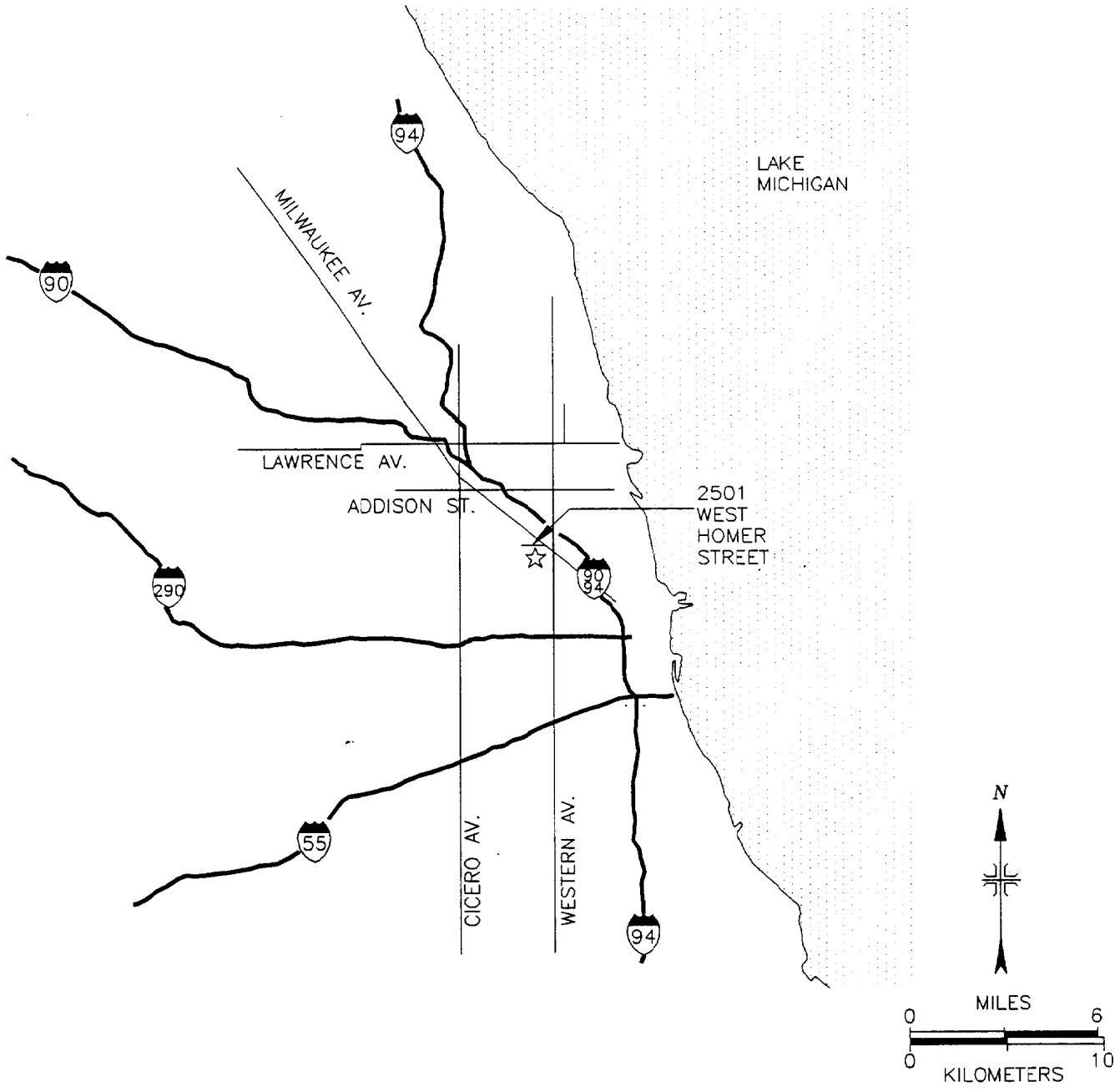

FIGURE 1: Map of Chicago, Illinois Indicating the Location of the Facility at 2501 West Homer Street

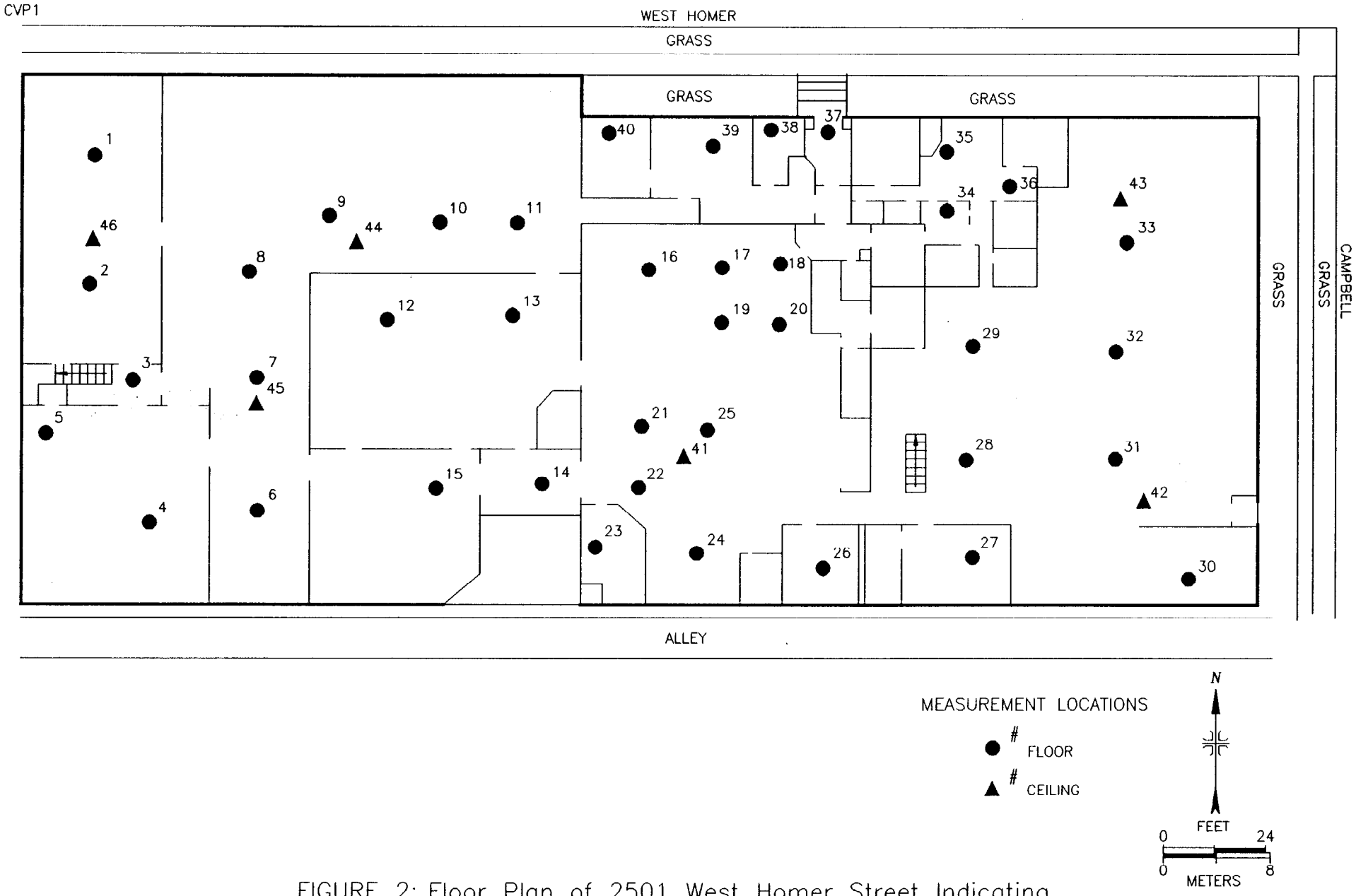

FIGURE 2: Floor Plan of 2501 West Homer Street Indicating Locations of Contamination Measurements

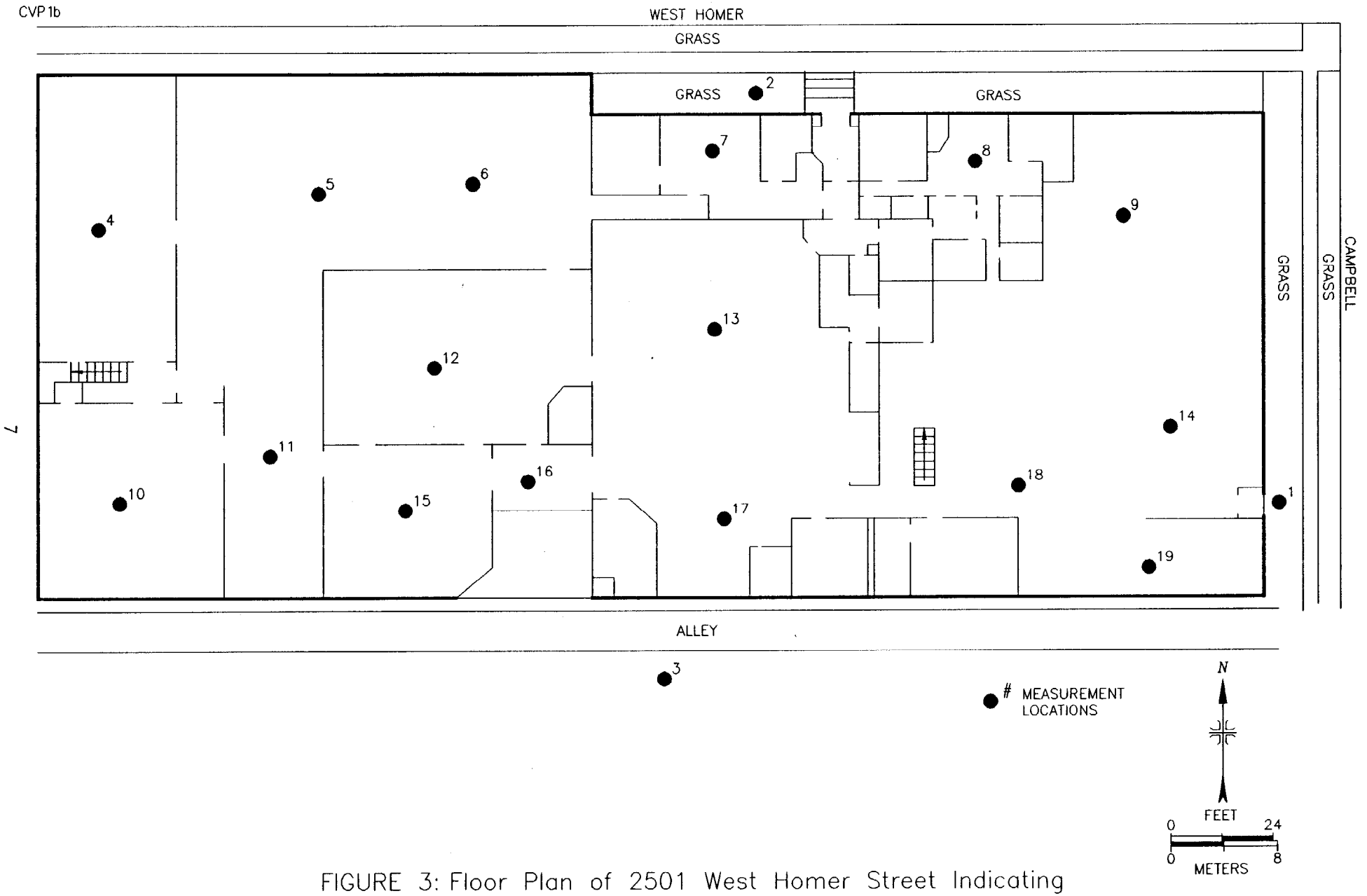

FIGURE 3: Floor Plan of 2501 West Homer Street Indicating Locations of Exposure Rate Measurements

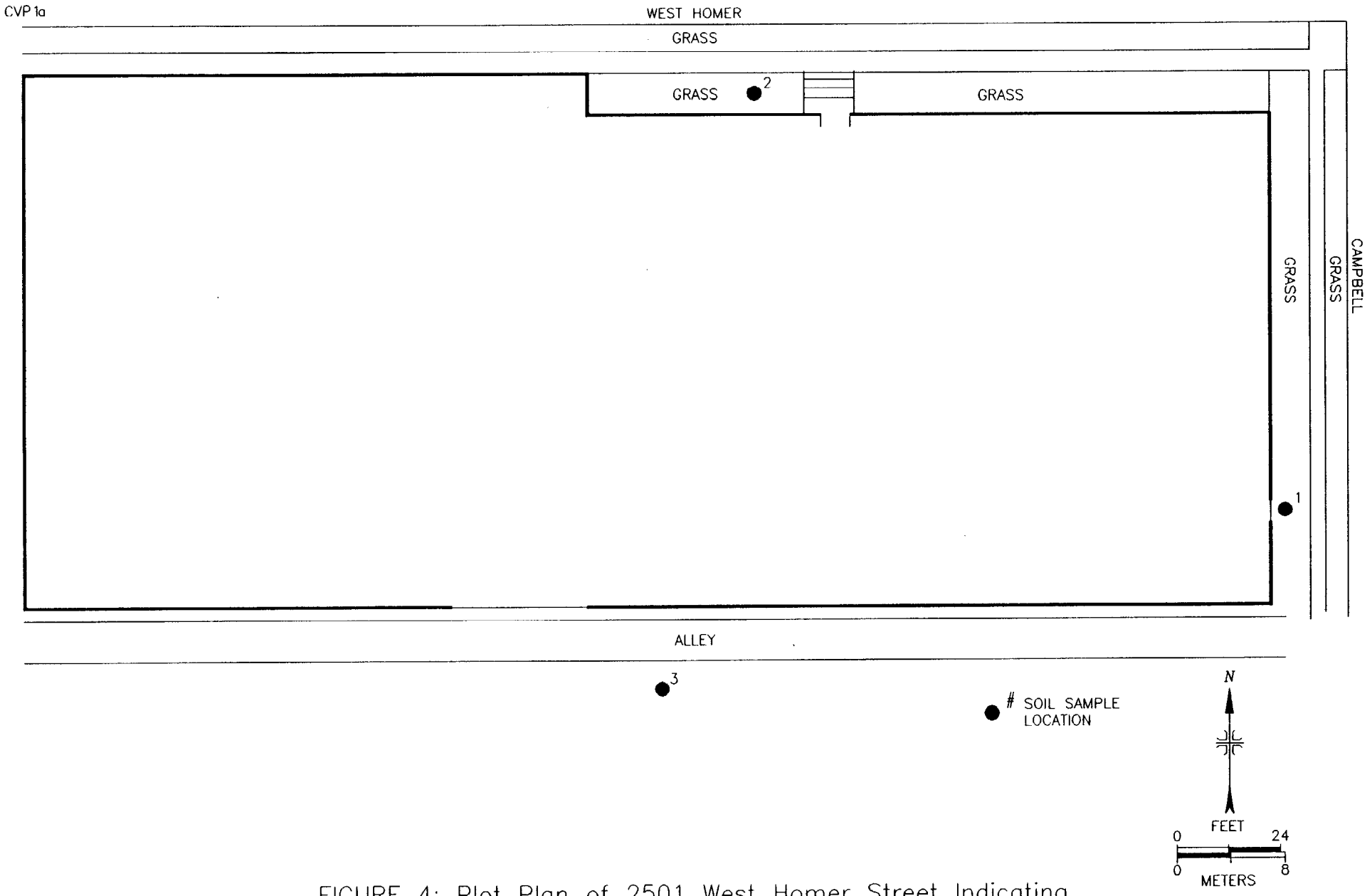

FIGURE 4: Plot Plan of 2501 West Homer Street Indicating Locations of Soil Samples

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
2501 WEST HOMER STREET
CHICAGO, ILLINOIS

Location[a]	Total Activity		Removable Activity	
	Alpha (dpm/100 cm^2)	Beta-Gamma (dpm/100 cm^2)	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)
1	<27	<480	<3	<6
2	<27	850	3	<6
3	27	<480	<3	<6
4	<27	<480	<3	<6
5	<27	730	3	<6
6	56	<480	<3	<6
7	<27	<480	<3	7
8	<27	<480	<3	<6
9	27	<480	<3	<6
10	<27	<480	<3	<6
11	<27	<480	<3	<6
12	<27	<480	<3	<6
13	<27	730	<3	<6
14	27	<480	<3	<6
15	<27	<480	<3	<6
16	<27	<480	3	<6
17	<27	<480	3	<6
18	<27	<480	5	<6
19	<27	<480	<3	<6
20	27	<480	<3	9
21	<27	<480	<3	<6
22	27	<480	<3	<6
23	<27	<480	<3	<6
24	<27	<480	<3	<6
25	<27	<480	<3	<6
26	27	<480	<3	<6
27	<27	480	<3	<6

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
2501 WEST HOMER STREET
CHICAGO, ILLINOIS

Location[a]	Total Activity		Removable Activity	
	Alpha (dpm/100 cm^2)	Beta-Gamma (dpm/100 cm^2)	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)
28	<27	<480	3	<6
29	<27	<480	<3	7
30	<27	910	<3	<6
31	27	<480	<3	<6
32	<27	<480	<3	<6
33	<27	<480	<3	<6
34	<27	<480	<3	<6
35	<27	<480	<3	<6
36	<27	<480	3	<6
37	<27	<480	<3	<6
38	<27	<480	<3	8
39	<27	<480	<3	<6
40	27	480	3	<6
41	<28	<550	<3	8
42	40	<550	<3	<6
43	<28	<550	<3	<6
44	<28	<550	<3	<6
45	28	<550	<3	<6
46	<28	<550	<3	23

[a]Refer to Figure 2.

TABLE 2

EXPOSURE RATE MEASUREMENTS
2501 WEST HOMER STREET
CHICAGO, ILLINOIS

Location[a]	Exposure Rate (μR/h)
1	8.5
2	10.2
3	9.8
4	9.2
5	8.0
6	8.4
7	8.3
8	8.2
9	8.0
10	9.5
11	9.4
12	9.3
13	7.3
14	7.3
15	9.8
16	9.4
17	7.8
18	7.6
19	8.5

[a]Refer to Figure 3.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
2501 WEST HOMER STREET
CHICAGO, ILLINOIS

Location[a]	Radionuclide Concentrations (pCi/g)		
	U-238	Ra-226	Th-232
1	2.5 ± 0.8[b]	1.1 ± 0.3	1.0 ± 0.4
2	1.8 ± 1.2	1.4 ± 0.3	1.4 ± 0.3
3	3.1 ± 1.4	3.7 ± 0.4	1.2 ± 0.4

[a]Refer to Figure 3.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

REFERENCES

1. T.E. Myrick, et al., State Background Radiation Levels: Results of Measurements Taken During 1975-1979, Oak Ridge National Laboratory, Oak Ridge, TN, November 1981.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

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

A. Direct Radiation Measurements

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

Eberline PRM-6
Portable Ratemeter
(Eberline, Santa Fe, NM)

Eberline Alpha Scintillation Detector
Model AC-3-7 or AC-3-8
(Eberline, Santa Fe, NM)

Eberline Beta-Gamma "Pancake" Detector
Model HP-260
(Eberline, Santa Fe, NM)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

Victoreen Beta-Gamma "Pancake" Detector
Model 489-110
(Victoreen, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
(Victoreen, Cleveland, OH)

B. Laboratory Analyses

Low Background Alpha-Beta Counter
Model LB-5110
(Tennelec, Oak Ridge, TN)

High-Purity Germanium Detector
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield, G-16
(Gamma Products, Inc., Palos Hills, IL)

High Purity Germanium Coaxial Well Detector
Model GWL-1102010-PWS-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA)

Multichannel Analyzer
ND-66/ND-680 System
(Nuclear Data Inc., Schaumburg, IL)

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

Gamma Scintillation Measurement

Walkover surface scans were performed using Eberline Model PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes.

Alpha and Beta-Gamma Scans and Measurements

Floors were scanned for elevated levels by passing slowly over the surface with Eberline Model PRS-1 portable scaler/ratemeters coupled to Victoreen Model 489-110 beta-gamma "pancake" detectors.

Measurements of total alpha radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model AC3-7 alpha scintillation probes. Measurement of direct beta-gamma radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model HP-260 thin-window pancake GM probes. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for active area of the detector. The effective window area was 59 cm^2 for the alpha detectors and 15 cm^2 for the GM detectors. The average background count rate was approximately 2 cpm for alpha probes and 44 cpm for the GM probes.

Removable Contamination Measurements

Gross Alpha and Gross Beta

Smears for determination of removable contamination levels were collected on numbered filter paper disks 47 mm in diameter, then placed in individually labeled envelopes with the location and other pertinent information recorded. The smears were counted on a low background gas proportional alpha-beta counter.

Gamma Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a Reuter-Stokes pressurized ionization chamber. The chamber was placed 1 meter above the surface at several locations throughout the facility.

Soil Sample Analysis

Gamma Spectrometry

Soil samples were dried, mixed, and a portion sealed in 0.5-liter Marinelli beaker. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry and typically ranged from 600 to 800 g of soil. Net soil weights were determined and the samples counted using intrinsic germanium and Ge(Li) detectors coupled to a Nuclear Data Model ND-680 pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U-238	0.093 MeV from Th-234*
Ra-226	0.609 MeV from Bi-214*
Th-232	0.911 MeV from Ac-228*

*Secular equilibrium assumed.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report, represent the 95% (2σ) confidence levels for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the (2σ) statistical deviation of the background count, the sample

concentration was reported as less than the minimum detectable concentration (<MDC). Because of variation in background levels and the effects of the Compton continuum caused by other radionuclides in the samples, the MDC's for specific radionuclides differ from sample to sample.

Calibration and Quality Assurance

Laboratory and field survey procedures are documented in manuals developed specifically for the Oak Ridge Associated Universities' Environmental Survey and Site Assessment Program.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NBS-traceable standards. The calibration procedures for the portable gamma instruments are performed by comparison with an NBS calibrated pressurized ionization chamber.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.

APPENDIX C

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)

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 materials 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

---

* 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.

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 materials derived from operations or sites over which the Department of Energy has authority. Guidelines or guidance to limit the levels of radioactive material to protect the public and environment are provided for: (1) residual concentrations of radionuclides in soil material, (2) concentrations of airborne radon decay products, (3) external gamma radiation level, (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 material. 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 or guidelines (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are only used 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 radioactivity or of the radioactive material that is acceptable if the 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 scenario for a 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 Limit for a site will include limits for each radionuclide or group of radionuclides, as appropriate, associated with the residual radioactive material in the soil or in surface contamination of structures and equipment, and in the air or water, and, 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. A site may be released for unrestricted use only if the 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 the site conditions exceed the approved limits, or if there is potential to exceed the dose limit if the site use was 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 dose limit for the annual radiation dose received by an individual member of the general public is 100 mrem/year. 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 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 dose limit as is reasonably achievable.

Under unusual circumstances it will be permissible to allow potential doses to exceed 100 mrem/year where such exposures are based upon scenarios which do not persist for long periods and where the annual life time exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/year. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, 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 sq meters. 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 sq meters 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. These Hot Spot Limits depend on the extent of the elevated local concentrations and 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 soil limit irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of the 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 the allowable 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 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 materials are 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 guidelines provided in the Table 1, Surface Contamination Guidelines are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory

---

* 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 cm^2) [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	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β-γ	15,000 β-γ	1,000 β-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 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 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.

Commission (1982)* and will be applied in 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.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

The Authorized Limits shall be established to: 1) ensure that, as a minimum, the 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) where applicable generic guidelines are provided, be consistent with such guidelines. The Authorized Limits for each site and 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

---

* These guidelines are functionally equivalent to Section 4 - Decontamination for Release for Unrestricted Use of NRC Regulatory Guide 1.86, but are applicable to Non-Reactor facilities.

should also be given to ensure that the limits comply with or provide an equivalent level of protection as other 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 it covers an entire site.

Remedial actions 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 only be considered 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 (Oak Ridge Technical Services Division for FUSRAP) and approved by the headquarters program office (the Division of Facility and Site Decommissioning Projects).

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 subsequent guidance or superceding 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. 5440.1C, Implementation of the National Environmental Policy Act

b. 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

c. 5480.2, Hazardous and Radioactive Mixed Waste Management

d. 5480.4, Environmental Protection, Safety, and Health Protection Standards

e. 5482.1A, Environmental Safety, and Health Appraisal Program

f. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

g. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

h. 5000.3, Unusual Occurrence Reporting System

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-1).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive materials shall not exceed existing Federal, or state standards.

d. Access to a site shall be controlled and misuse of onsite 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, an 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 released under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material is 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 radioactivity 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 from the waste 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 onsite material contaminated by residual radioactive material 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 a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field 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,

environment and costs. The field 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 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 insure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F1. 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 the site and/or vicinity property. Supplemental limits may be applied to a property or portion of a property or site if, on the basis of a site specific analysis, it is determined that certain aspects of the property or portion of the site were not considered in the development of the established Authorized Limits and associated guidelines for the site, and as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F2. Exceptions

Exceptions to the Authorized Limits defined for unrestricted use of the site may be applied to a portion of a site or a vicinity property when it is established that the Authorized Limits cannot be achieved and restrictions on use of the site or vicinity property are necessary to provide adequate protection of the public and environment. The field office must clearly demonstrate that the exception is necessary, and the restrictions will provide the necessary degree of protection and that they comply with the requirements for control of residual radioactive material as set forth in Part E of these guidelines.

F3. 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 the use of the supplemental limits and exceptions. Examples of specific situations that warrant the use of supplemental standards and exceptions are:

a. Where remedial actions 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 actions--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 can 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 actions for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive materials do not pose a clear present or future risk after taking necessary control measures. The likelihood that 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 actions will generally not be necessary where only minor quantities of residual radioactive

materials are involved or where residual radioactive materials occur in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples are residual radioactive materials 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 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 Material	40 CFR 192
Airborne Radon Decay Products	40 CFR 192
External Gamma Radiation	40 CFR 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 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.]

International Commission on Radiological Protection, 1978. Limits for Intakes of Radionuclides by Workers. A Report of Committee 2 of the International Commission on Radiological Protection. Adopted by the Commission in July 1978. ICRP Publication 30. Part 1 (and Supplement), Part 2 (and Supplement), Part 3 (and Supplements A and B), and Index. Pergamon Press, Oxford.

U.S. Evironmental Protection Agency, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites; Final Rule (40 CFR 192). Federal Register 48(3):590-604 (January 5, 1983).

U.S. Department of Energy, 1984. Formerly Utilized Sites Remedial Action Program. Summary Protocol: Identification - Characterization - Designation - Remedial Action - Certification. Office of Nuclear Energy, Office of Terminal Waste Disposal and Remedial Action, Division of Remedial Action Projects. April 1984.

U.S. Department of Energy, 1987. Supplement to U.S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites. A Manual for Implementing Residual Radioactivity 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.

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.

U.S. Atomic Energy Commission, 1974. Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974