MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0350070 8

ORNL-6645/V2/R1

ornl

OAK RIDGE
NATIONAL
LABORATORY

MARTIN MARIETTA

POLLUTANT ASSESSMENTS GROUP PROCEDURES MANUAL VOLUME II: TECHNICAL PROCEDURES

OAK RIDGE NATIONAL LABORATORY
CENTRAL RESEARCH LIBRARY
CIRCULATION SECTION
4500N ROOM 175
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this report, send in name with report and the library will arrange a loan.
UCN-7969 (3 9-77)

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

ORNL-6645/V2/R1

Health and Safety Research Division

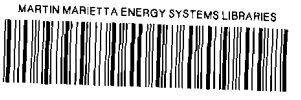
POLLUTANT ASSESSMENTS GROUP PROCEDURES MANUAL VOLUME II: TECHNICAL PROCEDURES

prepared by
Pollution Assessments Group
Oak Ridge National Laboratory
Grand Junction, Colorado

Date Manuscript Completed: February 1992

Date Published: March 1992

Oak Ridge National Laboratory
Oak Ridge, Tenn. 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-840R21400



3 4456 0350070 8

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PREFACE

This manual describes procedures currently in use by the Pollutant Assessments Group. The manual is divided into two volumes: Volume 1 includes administrative and support procedures, and Volume 2 includes technical procedures. These procedures are revised in an ongoing process to incorporate new developments in hazardous waste assessment technology and changes in administrative policy. Format inconsistencies will be corrected in subsequent revisions of individual procedures.

TABLE OF CONTENTS

02/03/92

PREFACE

I. ADMINISTRATIVE PROCEDURES

Number	Title	Revision	Date
AD-010	Introduction	0	10/01/90
AD-020	Program Administration	0	10/01/90
AD-030	Project Management	0	10/01/90
AD-031	Remedial Investigation and Feasibility Study Budget and Schedule Forecasts	0	11/14/91
AD-040	Support Activities	0	10/01/90
AD-050	Quality Assurance	0	10/01/90
AD-051	Quality Assurance for Preexisting Custom Software	0	11/20/91
AD-060	Preparation, Control, and Distribution of Procedures	1	01/02/92

II. SUPPORT PROCEDURES

SU-010	Control of Radioactive Sources	0	03/25/91
SU-020	Calibration of Portable Gamma Scintillation Detectors	0	10/01/90
SU-021	Calibration of Pressurized Ionization Chamber (PIC)	0	10/01/90
SU-022	Calibration of Soil Laboratory Gamma Spectrometry System	1	12/02/91
SU-025	Quality Control of Soil Analysis Laboratory Samples	1	02/03/92
SU-030	Computer Equipment Control, Maintenance, and Inventory	0	10/01/90
SU-040	Database Management	0	10/01/90

SUPPORT PROCEDURES (continued)

Number	Title	Revision	Date
SU-061	Graphics for Inclusion Surveys of Vicinity Properties	0	102/03/92
SU-062	Graphics for Verification of Vicinity Properties	0	02/03/92
SU-070	Document Control	0	10/01/90
SU-080	Subcontract Planning and Administration	0	10/01/90
SU-085	Property Management	0	10/01/90
SU-090	Identification of Properties for Inclusion Surveys	0	10/01/90
SU-091	Consent for Access to Survey	0	10/01/90

III. TECHNICAL PROCEDURES

TE-010	Mobile Gamma Scanning Van	0	10/01/90
TE-020	Inclusion Survey Activities	1	02/03/92

1.0 Purpose
2.0 Applicability
3.0 Other Documents
4.0 Equipment and Materials
5.0 Responsibility
6.0 Definitions
7.0 Safety
8.0 Procedure
- 8.1 Property Sketch
- 8.2 Extent of Inclusion Survey
- 8.3 Gamma Screening
- 8.4 Deposit Definition
- 8.5 Point Sources
- 8.6 Soil Sample Collection
- 8.7 Measurements in Uncontaminated Areas
- 8.8 Data Recording
- 8.9 Inspection and Decontamination of Equipment and Personnel

TE-021	Gamma Scintillation Detector Operation	0	03/25/91
TE-022	Pressurized Ionization Chamber (PIC) Operation	0	03/25/91

TECHNICAL PROCEDURES (continued)

Number	Title	Revision	Date
TE-023	GR-410 Portable Gamma Spectrometer Operation	0	03/25/91
TE-024	Delta Counter Operation	0	03/25/91
TE-025	Alpha Radiation Measurement	1	02/03/92
TE-026	Beta-Gamma Radiation Measurement	1	02/03/92
TE-027	Determination of Removable Contamination	1	02/03/92
TE-028	Site Preparation for Radiological Surveying	0	10/01/90
TE-030	Inclusion Survey Report Completion	1	12/02/91
	1.0 Purpose 2.0 Applicability 3.0 Other Documents 4.0 Equipment and Materials 5.0 Responsibility 6.0 Definitions 7.0 Procedure 7.1 Team Leader Prereport Activities 7.2 Calculations 7.3 Report Skeleton 7.4 Letter of Recommendation 7.5 Vicinity Property Summary Evaluation 7.6 VPDMS Form 7.7 Condensed Exclusion Reports 7.8 Report Completion 7.9 Report Review 7.10 File Transmittal 7.11 Data Base Entry		
TE-031	Coring Drill Operation	0	02/03/92
TE-032	Alpha-Track Radon Detector Placement and Retrieval	0	02/03/92
TE-034	Chain of Sample Custody	0	07/01/91
TE-035	Soil Sample Preparation for Radionuclide Analysis	0	12/02/91
TE-036	Analysis of Radionuclides in Soils	0	12/02/91

TECHNICAL PROCEDURES (continued)

Number	Title	Revision	Date
TE-040	Verification Survey Activities	1	02/03/92
	1.0 Purpose 2.0 Other Documents 3.0 Types of Verification 4.0 Roles of Agencies 5.0 Data Management 6.0 Verification Tracking 6.1 Logbook 6.2 Forms and Equipment 6.3 Database 7.0 Confirmatory Soil Analysis 7.1 Type I 7.2 Type II 7.3 Types I and II 8.0 Type I Verification Activities 8.1 Procedure 8.2 DOE Notification 8.3 Report Review Process 9.0 Type II Verification Activities 9.1 Equipment 9.2 Data Recording 9.3 Extent of Type II Verification Survey 9.4 Post-Verification Survey Activities 9.5 Soil Samples 9.6 Type II Verification Report 9.7 Verification Report Review 10.0 Type III Verification Activities 10.1 Equipment 10.2 Data Recording 10.3 Extent of Type III Verification Field Survey 11.0 Document Storage 11.1 Purpose 11.2 Applicability 11.3 Stages		
TE-046	Type B Field Verification Activities for Large Areas	0	08/19/91
TE-050	Monticello Vicinity Properties Project	1	02/03/92
TE-051	Ultrasonic Ranging and Data System (USRADS) Operation	0	02/03/92

TECHNICAL PROCEDURES (continued)

Number	Title	Revision	Date
TE-055	Opposed Crystal System (OCS) Van Analysis	0	10/01/90
TE-060	Water Quality Parameters: pH, Specific Conductance, Dissolved Oxygen, and Alkalinity	0	10/01/90
TE-070	Soil Sampling with a Barrel Auger	0	10/01/90
TE-071	Sample Documentation	0	10/01/90
TE-072	Soil Sample Packaging and Preservation	0	10/01/90
TE-073	Equipment Decontamination	0	10/01/90
TE-074	Stream Sediment Sampling Using a Piston-Type Core Sampler	0	10/01/90
TE-075	Stream Sediment Sampling Using a Scooping Device	0	10/01/90
TE-076	Soil-Gas and Water Field Screening System	0	10/01/90
TE-077	Soil Augering Using a Little Beaver Mechanical Earth Drill	1	02/03/92
TE-078	Subsoil Sampling Probe	0	10/01/90
TE-079	Collecting Soil Samples Using Brass Sleeves	0	10/01/90
TE-080	Headspace Sampling with a Gas Chromatograph	0	10/01/90
TE-081	Surface and Groundwater Sampling for Inorganic, Radionuclide, and Physical Parameters	0	10/01/90
TE-082	Surface and Groundwater Sampling for Organic Parameters	1	02/03/92
TE-090	Measurement of Hydraulic Conductivity Using a Bail Test	0	10/01/90
TE-091	Field Determination of Gravimetric Moisture	0	10/01/90
TE-092	Determining Permeability Using a Packer Test	0	10/01/90
TE-093	Pumping Test in an Unconfined Aquifer	0	10/01/90

TECHNICAL PROCEDURES (continued)

Number	Title	Revision	Date
TE-094	Water Level Measurement	1	02/03/92
TE-100	Drilling Log Preparation and Well Construction Documentation	0	10/01/90
TE-101	Subsurface Sampling Using a 5-ft. Continuous Sampler and a Split-barrel Sampler	0	10/01/90
TE-102	Subsurface Sampling Using a Shelby Thin-Wall Tube Sampler	0	10/01/90
TE-105	U2CRT Operation	0	05/01/91
TE-110	Monitoring Well Design	0	10/01/90
TE-111	Well Development	0	10/01/90
TE-112	Well Inspection and Maintenance	0	10/01/90
TE-120	Physical Survey	0	10/01/90
TE-130	Peristaltic Pump Operation	0	10/01/90
TE-131	Bladder Pump Operation	0	10/01/90
TE-132	Well Development Pump Operation	0	10/01/90

INDEX

02/03/92

10 CFR 20	SU-010 p.1
40 CFR 192	TE-040 p.3, 8, 30
ACAD	SU-040 p.2 SU-061 p.5 TE-030 p.3, 17
Action Level	TE-025 p.4 TE-026 p.5
ADC	SU-022 p.2, 4 TE-036 p.2
Air development	TE-112 p.3
Air Quality Monitoring Record	TE-079 p.2
Alkalinity test kit	TE-060 p.18, 19
Alpha radiation	TE-020 p.1 TE-025 p.1 TE-046 p.1, 3
Alpha scintillation probe	TE-025 p.1
Alpha track detector	TE-040 p.2, 14, 15, 62 TE-032 p.1
Archival	AD-050 p.4 TE-036 p.4 TE-046 p.4, 24, 38 TE-046 p.4 TE-050 p.6, 13, 16
Area Scan & Radiation Level Survey form	TE-026 p.1, 6
ARIX	SU-090 p.3
Asphalt coring	TE-023 p.5 TE-031 p.1
Audits	AD-050 p.7-9

Auger	TE-040 p.11, 19, 22, 23, 35, 36 TE-070 p.1-4 TE-077 p.1-3 TE-078 p.3 TE-100 p.2 TE-101 p.1, 2 TE-102 p.2 TE-105 p.1-4, 6-8, 11
Authorized limit	TE-030 p.3, 28 TE-050 p.14
Automatic can sealer	TE-035 p.1, 8, 12
Background	SU-010 p.4 SU-020 p.2, 3 SU-022 p.1, 4, 5 SU-025 p.3, 4 TE-010 p.1, 2, 6, 10, 13-16, 19, 22, 25, 28-31 TE-020 p.9, 11, 12, 15, 18 TE-021 p.3, 4 TE-022 p.3, 4 TE-023 p.4 TE-025 p.2, 3, 5, 6, 8 TE-026 p.2, 3, 5, 6, 9 TE-027 p.3-5 TE-030 p.1, 2, 7-10, 13, 27 TE-040 p.13, 18, 23, 24, 27 TE-050 p.2, 7, 13, 15 TE-060 p.6
Bail tests	TE-090 p.1
Bailing	TE-082 p.3, 4 TE-111 p.1
Barrel auger	TE-070 p.1-4
Beta-Gamma probe	SU-025 p.1, 3, 4 TE-026 p.1, 2
Beta-Gamma radiation	SU-025 p.1, 3 TE-020 p.1 TE-026 p.1 TE-046 p.1
Biased samples	TE-040 p.19, 24 TE-046 p.3
Bladder pump	TE-060 p.10, 14, 16, 20 TE-081 p.8 TE-082 p.2, 7 TE-131 p.1 TE-132 p.1

Blue ice	TE-072 p.2, 3 TE-081 p.9 TE-082 p.8
Brunton compass	TE-020 p.2, 6 TE-120 p.1
Budget and schedule	AD-031 p.1, 4
Buffer solutions	TE-060 p.4, 5, 7, 9
Calibration	AD-040 p.2 AD-050 p.7 AD-051 p.7 AD-060 p.2, 4 SU-010 p.1 SU-020 p.1-3 SU-021 p.1, 2 SU-022 p.1-4, 6, 8 SU-025 p.1 TE-010 p.1, 9, 10, 22-27 TE-022 p.1, 3 TE-023 p.3 TE-024 p.1, 3 TE-025 p.2 TE-026 p.2, 6, 7 TE-027 p.3 TE-035 p.2, 6 TE-036 p.1 TE-040 p.10, 15, 16 TE-051 p.3, 4 TE-055 p.3, 5 TE-060 p.2, 5-19 TE-080 p.4 TE-081 p.2, 7 TE-092 p.2 TE-120 p.2
CDH	SU-070 p.2 SU-091 p.4 6
CERCLA	AD-030 p.5 AD-031 p.1, 3
Chain of custody	TE-034 p.1-4, 7 TE-046 p.2 TE-050 p.4, 6, 13 TE-071 p.4
Chain of sample custody	SU-025 p.1, 3, 4, 10 TE-020 p.1, 2, 20, 25 TE-034 p.1-3, 5, 6 TE-035 p.1, 3, 9 TE-036 p.1, 3-5

Chain of sample custody (cont.)	TE-040 p.1, 6, 16, 20, 26, 34, 43 TE-046 p.1 TE-071 p.1, 4, 7 TE-081 p.2, 9, TE-082 p.2, 8, 14
Chain of Sample Custody form	TE-034 p.2, 3 TE-071 p.1, 4 TE-081 p.9 TE-082 p.8
Chain of Sample Custody/Soil Sample Analysis Form	SU-025 p.1, 3, 4, 10, TE-020 p.2, 20, 25, TE-034 p.1, TE-035 p.1, 9, TE-036 p.1, 5 TE-040 p.1, 6, 16, 20, 26, 34, 43
Check source	SU-020 p.1, 2 SU-021 p.2 TE-021 p.3 TE-025 p.3 TE-026 p.3 TE-027 p.3 TE-051 p.1, 3 TE-055 p.1
Colorado Department of Health (CDH)	SU-070 p.2 SU-091 p.4, 6
Completion report	TE-040 p.1, 2, 4-9, 15, 25, 27, 29, 33, 38, 46 TE-050 p.4-6
Composite sample	TE-040 p.19, 23 TE-046 p.2 TE-074 p.2, 3 TE-075 p.2, 3
Computer equipment	AD-040 p.2 SU-030 p.1-3
Computer support	AD-040 p.1, 2 SU-061 p.2, 5 SU-062 p.2, 5 TE-036 p.6
Concrete coring	TE-020 p.17
Conductivity standards	TE-060 p.12, 14
Consent for Access	SU-091 p.4, 5 TE-050 p.9

Consent Form	AD-040 p.2 SU-090 p.4 SU-091 p.4 TE-020 p.7, 19 TE-030 p.6, 10, 12, 16, 18 TE-050 p.10
Contaminated mortar and brick	TE-020 p.12
Contamination Survey Summary form	TE-025 p.1, 3, 5, 6, 11 TE-026 p.1, 4, 6, 7, 12 TE-027 p.1, 4, 8
Conversion factor	TE-020 p.18 TE-022 p.4, 6 TE-025 p.4 TE-026 p.4, 7 TE-030 p.4, 5, 12
Conversion formulas	TE-020 p.2, 11, 27 TE-030 p.1, 5, 22
Corrective Action	AD-050 p.7, 9, 10 AD-051 p.10 SU-025 p.2, 6 SU-030 p.2
Cross-check samples	SU-025 p.2
Custom software	AD-051 p.1-3, 5
D&D	AD-030 p.2, 4
Database	AD-040 p.2 SU-025 p.2, 5 SU-080 p.3 SU-091 p.3 TE-020 p.30 TE-030 p.19 TE-032 p.1, 2, 4-6, 9, 11 TE-040 p.4 TE-055 p.5
Decontamination	AD-030 p.2, 4 AD-050 p.3 TE-020 p.2, 20, 34 TE-028 p.3 TE-030 p.3 TE-031 p.2, 7 TE-040 p.21, 22, 36 TE-070 p.2 TE-073 p.1, 2 TE-074 p.1, 3

Decontamination (cont.)	TE-075 p.1 TE-077 p.2 TE-081 p.10 TE-082 p.2, 8 TE-094 p.1 TE-101 p.1 TE-102 p.1 TE-112 p.1 TE-132 p.1
Defense Decontamination and Decommissioning Program (D&D)	AD-030 p.4
Delta counter	SU-061 p.5 TE-024 p.1-3 TE-040 p.9-11, 16, 20, 22 TE-046 p.1, 3
Department of Transportation (DOT) Hazardous Materials Regulation, 49 CFR Part 172	TE-081 p.9
Detector efficiency	TE-025 p.4, 6 TE-026 p.4-6 TE-027 p.4
Dissolved oxygen	TE-060 p.1, 3, 15, 24, 25 TE-081 p.2, 15
Distance transducer calibration	TE-010 p.1, 27
Document control	AD-010 p.1 AD-040 p.1, 3 SU-040 p.2 SU-070 p.1, 3 SU-091 p.5, 6 TE-030 p.1, 3, 19
DOE Order 5480.11	TE-020 p.1, 28
Dose rate	TE-026 p.7
Dovetail properties	SU-090 p.3
Drilling log	TE-101 p.1 TE-102 p.1
Electronic distance measurement (EDM)	TE-120 p.3

EM31 geophysical instrument	TE-051 p.1, 2, 5
Environmental Restoration and Waste Management (EM)	AD-030 p.2
Environmental Restoration Program (ER)	AD-030 p.4
Extended measurements	SU-022 p.2 SU-025 p.2 TE-020 p.3, 11, 13, 17 TE-023 p.1, 5, 6 TE-030 p.3, 6, 11, 13 TE-032 p.2, 3, 6 TE-035 p.2 TE-036 p.2 TE-040 p.32, 34, 35 TE-050 p.12
External audits	AD-050 p.8, 9
Field map	SU-062 p.4 SU-090 p.3 TE-020 p.2, 7, 8, 10, 12-15, 18, 19, 35 TE-021 p.4 TE-028 p.5 TE-030 p.5, 6, 18 TE-032 p.4 TE-040 p.12, 17, 20, 23, 24, 34 TE-046 p.2, 3
Field measurement of carbonate and bicarbonate (alkalinity)	TE-060 p.18
Formerly Utilized Sites Remedial Action Program (FUSRAP)	AD-030 p.4 TE-050 p.2-4, 12, 13
FS	AD-031 p.1
Gamma Analysis Worksheet	TE-030 p.2, 6, 7, 12, 17, 18, 25
Gamma exposure rate	TE-020 p.9-12, 17, 27 TE-022 p.1 TE-026 p.7 TE-030 p.5-7, 10, 11, 22 TE-032 p.3 TE-040 p.13, 20, 21, 23, 24, 34 TE-046 p.3

Gamma scintillation detector	SU-020 p.1 TE-020 p.1, 3, 9, 27 TE-022 p.1, 4, 6 TE-032 p.2, 3 TE-040 p.9 TE-046 p.1 TE-051 p.1, 2, 4, 5
Gamma scintillometer	TE-020 p.15, 16 TE-021 p.4 TE-022 p.3 TE-030 p.5, 10 TE-040 p.18 TE-046 p.1, 3 TE-050 p.13 TE-051 p.2
Gas chromatograph	TE-078 p.2, 4 TE-080 p.1, 3
GJRAP	SU-090 p.2, 3 TE-020 p.3, 6, 7
GM counters	TE-026 p.3
GR-410 portable gamma spectrometer	TE-020 p.1, 12 TE-023 p.1, 7
Graphics	AD-030 p.2 AD-040 p.1, 2 SU-061 p.1, 2 SU-062 p.1, 2 SU-091 p.4 TE-020 p.1, 6 TE-030 p.1, 13
Grid block	TE-025 p.6 TE-026 p.67 TE-040 p.19 TE-046 p.4 TE-051 p.2-6
Grid system	TE-028 p.1-5
Groundwater	TE-060 p.2, 3, 10, 11, 14, 16, 20 TE-071 p.2, 3 TE-073 p.1 TE-081 p.1, 3, 5, 8 TE-082 p.1-3, 6 TE-090 p.1 TE-092 p.2 TE-093 p.1 TE-100 p.1, 3

Groundwater (cont.)	TE-110 p.1, 2, 5, 8 TE-111 p.1, 3
HASRD	AD-010 p.1 AD-030 p.4 AD-050 p.2, 5, 7 SU-010 p.1, 2
Hatching	SU-061 p.3, 7 SU-062 p.3, 5, 7
Health and safety	AD-010 p.1 AD-031 p.3 AD-040 p.1-3 AD-050 p.9 SU-010 p.1 TE-105 p.4
HIG	SU-061 p.5 TE-020 p.4 TE-022 p.4 TE-030 p.3, 5, 13, 16
HNU	TE-079 p.2 TE-080 p.2
HOG	SU-061 p.5 TE-020 p.4, 14, 15, 17 TE-022 p.4 TE-030 p.3, 5, 13, 16 TE-040 p.19 TE-046 p.2-4 TE-050 p.7
Horiba model U-7	TE-060 p.1, 2, 12, 16
Hot spot	TE-020 p.4, 13 TE-030 p.2, 9, 28 TE-050 p.2, 13, 14, 18
Hot spot guideline	TE-030 p.9 TE-050 p.2, 13, 14
Hot spot limits	TE-020 p.13 TE-030 p.2, 9, 28 TE-050 p.13, 14, 18
Hydraulic conductivity	TE-090 p.1-3 TE-093 p.3 TE-110 p.4, 5 TE-111 p.3, 4
Inorganic analysis	TE-070 p.3 TE-072 p.3

Installation Restoration Project (IRP)	AD-030 p.5
Internal audits	AD-050 p.8, 9
Ionic strength	TE-060 p.3, 4
IRP	AD-030 p.5
ISC	SU-061 p.1, 7, 9, 11 SU-040 p.2 SU-070 p.1-3 SU-090 p.2-4 SU-091 p.4-6 TE-030 p.2, 3, 15, 16, 17, 79 TE-035 p.2-4 TE-040 p.4, 5, 12, 13, 17, 18, 23 TE-050 p.8-12, 15, 16
IVC	SU-062 p.1, 7, 8 TE-035 p.2, 4, 6 TE-040 p.2-4, 6-8, 14, 15, 17-19, 21, 23-28, 30, 31, 33-35, 38 TE-050 p.1, 3-8, 13, 15
Jaw crusher	TE-035 p.1, 6, 10 TE-040 p.26
JMC auger	TE-040 p.11, 19, 22, 23, 35, 36
KMAN	SU-040 p.1-3 TE-032 p.9-11 TE-036 p.2-4, 6, 9 TE-040 p.4 TE-050 p.15
KRTCOM	TE-036 p.2, 3, 6
Lower limit of detection	TE-025 p.4 TE-026 p.4
Microfiche	AD-040 p.3 SU-070 p.2
Mobile Gamma Scanning Van	TE-010 p.1, 3, 6
Mobile gamma survey	SU-090 p.1
Monticello database	TE-050 p.15

MVP	TE-020 p.1, 4, 8, 13-15, 17, 20 TE-030 p.1-3, 6, 9-11, 14, 15, 42, 61, 65, 73 TE-050 p.1-3, 7, 14
Net Estimated Area-Weighted Average (NEAWA)	TE-020 p.4, 11, 12 TE-030 p.3, 6-9, 11 TE-050 p.14
Occurrence reporting system (ORS)	AD-050 p.9
OCS van	TE-055 p.1
Operation of field GC	TE-080 p.2
Organic analysis	TE-070 p.3 TE-072 p.3 TE-082 p.2, 9, 10
Organizational chart	AD-020 p.1, 2
Owner request	TE-030 p.4
Packaging and preservvation of samples for organic analyses	TE-072 p.2
Peristaltic pump	TE-081 p.3, 7 TE-111 p.2 TE-130 p.1
pH electrode	TE-060 p.1, 4-6
pH measurement	TE-060 p.3, 4, 10, 11
Photographs	AD-060 p.5 TE-010 p.6 TE-020 p.19, 20 TE-030 p.6 TE-046 p.3 TE-050 p.7 TE-074 p.4
PIC	SU-020 p.1, 3 SU-021 p.1 TE-020 p.1, 4, 11, 18 TE-022 p.1-4, 6, 7 TE-030 p.4, 5
Point source handling	TE-020 p.2, 28

Point sources	TE-020 p.5, 13, 14, 18, 28 TE-030 p.9, 10, 13 TE-040 p.12 TE-050 p.13
Portable Gamma Spectrometer	TE-020 p.1, 2, 12 TE-023 p.1, 7
Preventive maintenance	SU-030 p.2
Procedure Change Form	AD-060 p.5, 6
Procurement	AD-040 p.1, 2 AD-050 p.2, 4-6 AD-051 p.1, 2, 4 SU-030 p.3 SU-040 p.2, 3 SU-080 p.1-3, 5, 6
Proportional counter	TE-027 p.1, 3
PU5	TE-030 p.2, 4, 9, 14, 55, 63, 67
Pump-in borehole test	TE-092 p.1, 4
Pumping test	TE-093 p.1, 3-6 TE-110 p.1
PUOR	TE-030 p.2, 4, 9, 14, 53, 62, 66
Purchase requisition	SU-080 p.1, 3
Purchasing	AD-050 p.2, 5 SU-080 p.1, 4, 5
QA coordinator	AD-050 p.1, 3, 5-10
RAC	SU-070 p.2, 3 TE-030 p.3, 4, 6, 9, 27 TE-035 p.2, 4, 5 TE-040 p.1, 2-8, 11, 14-23, 25, 26, 28, 30, 31, 34, 35, 38 TE-046 p.2-4 TE-050 p.2-11, 13, 15, 16
Rad-Con	SU-022 p.4 TE-035 p.8
Radioactive sources	SU-010 p.1-5
Radiological Screening Summary form	TE-020 p.1, 19, 21, 23 TE-021 p.1, 4, 5 TE-022 p.1, 2, 5 TE-030 p.1, 5, 6, 10, 21

Radon data base operations	TE-032 p.1, 4, 9
Radon Verification Check Sheet	TE-032 p.1-5, 7
RCRA	AD-030 p.5 AD-031 p.1, 3
RDC	SU-062 p.4 TE-030 p.4, 13, 16 TE-032 p.2, 8 TE-040 p.3, 8, 13, 15, 20, 21, 24, 27, 29, 37 TE-050 p.6
Recommendation basis	SU-070 p.2 TE-030 p.14, 19 TE-040 p.8, 30
Record of Final Decision	SU-091 p.1, 4, 6, 13
Removable contamination	TE-025 p.1, 6, 9 TE-026 p.1, 7, 10
Report skeleton	TE-030 p.2, 9, 12, 30, 42, 53, 55, 59, 61-63 TE-040 p.1, 2, 27, 28, 52, 67
RFI	AD-031 p.1
RI	AD-031 p.1 TE-071 p.2
ROI	TE-010 p.13, 16, 25 TE-055 p.3
Sample identification system	TE-071 p.1
Sample label	TE-035 p.5 TE-071 p.1, 5 TE-079 p.1 TE-081 p.1, 3, 12 TE-082 p.2, 6, 12 TE-101 p.2 TE-102 p.2
Sample preparation	TE-040 p.35
Sample preservation	TE-072 p.1 TE-081 p.1, 7, 13 TE-082 p.6

Scaler/ratemeter	TE-025 p.2, 4, 5 TE-026 p.2, 5, 6
Scan van	TE-010 p.7, 16
Scintillation detector	SU-020 p.1 TE-020 p.1, 3, 9, 27 TE-022 p.1, 4, 6 TE-032 p.2, 3 TE-040 p.9 TE-046 p.1 TE-051 p.1, 2, 4, 5
SFMP	AD-030 p.3, 4 AD-040 p.1 TE-050 p.1-5, 8-10, 13, 15, 16
Significant digits	TE-030 p.7, 9, 12, 13 TE-040 p.32 TE-060 p.14
Site location map	TE-040 p.30, 32
Site Survey Information	TE-040 p.5
Smear samples	TE-025 p.6 TE-026 p.7 TE-027 p.1
Software validation	AD-051 p.2
Software verification	AD-051 p.3
Soil Analysis Worksheet	TE-030 p.2, 6, 8, 9, 13, 17, 26 TE-040 p.2, 27, 65 TE-050 p.13, 14
Soil laboratory gamma spectrometry system	SU-022 p.1 TE-036 p.1
Soil sample collection	TE-020 p.15 TE-040 p.12, 19, 34
Soil Sample Data Field Form	TE-020 p.2, 17, 19, 24 TE-030 p.1, 5, 6, 18, 23
Soil sample preparation	TE-035 p.3 TE-040 p.26
Soil sample storage	TE-035 p.2 TE-036 p.2 TE-040 p.26

Soil samples	SU-025 p.2 TE-020 p.3, 11 TE-030 p.3, 9, 19 TE-036 p.1, 2, 4 TE-040 p.2-4, 6, 18-20, 24-26, 35, 36 TE-050 p.3, 13 TE-070 p.1 TE-071 p.3 TE-072 p.3 TE-080 p.1 TE-101 p.1 TE-105 p.3, 8
Soil sampling equipment	TE-020 p.15
Soil-gas and soil-liquid sampling	TE-076 p.2
Source custodian	SU-010 p.2-4
Specific conductance	TE-060 p.3, 4, 11-15, 22
Speedy Moisture Tester	TE-055 p.5
Spillover	SU-070 p.2 SU-090 p.2-4 TE-020 p.4, 7, 8, 11, 19 TE-030 p.5, 10, 19 TE-050 p.9, 10, 16
Split spoon	TE-079 p.1 TE-100 p.2 TE-105 p.1-3, 8, 9
Split-barrel sampler	TE-101 p.1, 2
Standard reference material	SU-022 p.1, 2
Statement of work	AD-031 p.2 SU-080 p.5
Stationary receivers	TE-051 p.2, 3
Surface contamination guidelines	TE-025 p.1, 8 TE-026 p.1, 9
Surface Contamination Survey form	TE-025 p.1, 3, 5, 6, 10 TE-026 p.1, 4, 6, 7, 11 TE-027 p.1, 4, 9
Surge blocking	TE-112 p.3

Surplus Facilities Management Project (SFMP)	AD-030 p.3
Survey site information form	TE-020 p.1, 19, 22 TE-030 p.6, 10, 12, 13
T-test	SU-025 p.2, 5, 6
TAC	SU-070 p.3 SU-090 p.1, 2 SU-091 p.10 TE-030 p.4, 6, 18
Teflon bailer	TE-081 p.8 TE-082 p.2, 7
Theodolite	TE-120 p.2, 3
Time-of-flight	TE-051 p.3, 4
TLD	SU-022 p.3 TE-035 p.3 TE-036 p.2
Tracking sheet	TE-040 p.4, 18, 33
Trailer house rule	TE-020 p.13
Transmittal letter	SU-091 p.1, 3, 7
Type I verification activities	TE-040 p.7
Type I verification flow of work	TE-040 p.1, 44
Type II verification activities	TE-040 p.9
Type II Verification flow of work	TE-040 p.2, 57
U2CRT	TE-105 p.1, 10, 11
Uranium Mill Tailings Remedial Action Project (UMTRAP)	AD-030 p.2
USGS bench mark	TE-120 p.3
USRADS	TE-051 p.1-3, 8

Vicinity Properties Management and Implementation Manual (VPMIM)	AD-030 p.3 TE-030 p.1 TE-050 p.2
Victoreen	TE-021 p.1, 2
VOC analysis	TE-079 p.1
Volatile organics	TE-072 p.3, 4 TE-075 p.2, 3 TE-082 p.5, 8, 9 TE-101 p.2 TE-131 p.1
VPDMS (Vicinity Property Data Management System) Form	TE-030 p.2, 4, 15-18, 78
VPMIM	AD-030 p.3 TE-020 p.1, 5 TE-030 p.1, 7 TE-050 p.2
Well purging	TE-081 p.5 TE-082 p.3 TE-131 p.1 TE-132 p.1
Well screen	TE-081 p.5, 6, 8 TE-082 p.4, 7 TE-093 p.3, 4 TE-110 p.2-5 TE-111 p.3, 4 TE-112 p.3
"Who-done-it" map	TE-020 p.5, 7, 20
WLM method	TE-040 p.2, 14, 15, 63

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-010 Page: 1 of 42 Revision: 0 Date: 10/01/90

MOBILE GAMMA SCANNING VAN

1.0 PURPOSE

This procedure explains in detail the operation of the mobile gamma scanning van and documentation of data generated by it.

2.0 APPLICABILITY

A mobile gamma scanning van is used to survey large outdoor areas for gamma radiation anomalies. A mobile scan can identify areas of potential radioactive contamination to be surveyed with inclusion survey procedures at a later date or can eliminate suspect areas from further investigation.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: System description for the PAG radiological scanning van

3.1.2 Appendix 2: System versatility

3.1.3 Appendix 3: Useful DOS program commands accessible from scan programs dated prior to 12/20/88 and SCAN30 program code

3.1.4 Appendix 4: Data handling and system startup

3.1.5 Appendix 5: Scan program modifications

3.1.6 Appendix 6: Gamma scanning program directory

3.1.7 Appendix 7: Instrument calibration

3.1.8 Appendix 8: Distance transducer calibration check data

Approved by:

Jon Jack K. Holford 9/26/90 (Date)

C.A. Little 9/26/90 (Date)

3.1.9 Appendix 9: Background scan CRT display

3.1.10 Appendix 10: Background mode CRT display

3.1.11 Appendix 11: Background mode operation

3.1.12 Appendix 12: Scan mode operation

3.1.13 Appendix 13: Identification mode CRT display

3.1.14 Appendix 14: Identification mode operation

3.1.15 Appendix 15: Data dump mode operation

3.1.16 Appendix 16: File list mode operation

3.2 EXHIBITS

3.2.1 Exhibit 1: Operator console area

3.2.2 Exhibit 2: CBM Model 8032 computer

3.2.3 Exhibit 3: CBM Model 8050 disk drive

3.2.4 Exhibit 4: Interface unit and NIM electronics

4.0 PREPARATION OF MOBILE GAMMA SCANNING SURVEY PLAN

This procedure provides guidelines for the preparation of mobile gamma scanning survey plans.

4.1 DEVELOPMENT OF MOBILE SCANNING SURVEY PLAN

Obtain, review, and assess information provided by previous aerial survey and mobile scan data, if available. Based on the available information, develop the survey plan following the steps below:

4.1.1 Define the scope or boundaries of the survey by outlining on a map of the general survey area, (a) the areas of known contamination as indicated by any previous aerial survey results, and (b) the extent of any previous mobile gamma scans.

4.1.2 Using the outline established in the previous step, develop a street-by-street scanning plan for the area. Note from the aerial survey or previous mobile scan information the specific areas of high radiation

levels that require special attention. This plan will normally identify the specific sections of town to be surveyed; or, if the entire city is to be scanned, define the outer limits of the survey.

4.1.3 Estimate the length of time required to complete the mobile gamma scan and develop a schedule for the survey. Provide a tentative date for start of the survey. This date is subject to the project manager's or funding agency approval.

4.1.4 Prepare the survey plan for submittal to the appropriate personnel for review. The plan should include the following:

a. An introduction summarizing the information on the site obtained from previous aerial surveys and mobile scans, as applicable,

b. The scope of the present planned survey, including (1) a ground level follow-up of the aerial survey, and (2) the plan for the street-by-street mobile scan; when available, include a map showing the areas and boundaries of the proposed survey plan, and

c. A schedule for the survey activities showing estimated survey start date, duration, end date, and date on which a report will be submitted.

4.2 PLAN SUBMITTAL, REVIEW, AND APPROVAL

The completed survey plan is submitted to the reviewers. Upon completion of the review, a final version of the plan is submitted for approval to appropriate administrative personnel and funding agency.

5.0 EQUIPMENT AND SUPPLIES

The mobile gamma scanning van and support systems consist of a modified Dodge Model 300 van that has a built-in, gasoline-powered electric generator and associated instrumentation, lead storage batteries, battery charger, inverter and associated instrumentation, field office supplies, distance transducer, support equipment, and supplies.

5.1 EQUIPMENT

The gamma scanning instrumentation consists of the following:

1. Three 4 x 4 x 16 in. NaI(Tl) Polyscin Log Crystals having integral 3.5-in. photomultiplier tubes mounted on a lead-shielded, hydraulically operated carriage;

2. ORNL designed interface unit;
3. Commodore CBM Model 8032 Computer;
4. Commodore CBM 8050 Dual Floppy Disk Drive;
5. Commodore Model 4022 Tractor Printer;
6. Tracor Northern Display Unit TN 1314;
7. Tracor Northern Pulse Height Analyzer, TN 1706;
8. ORTEC Model 113 Preamplifier;
9. ORTEC AMP & SCA, Model 490B;
10. ORTEC LOG/LIN Rate Meter, Model 449;
11. ORTEC High Voltage Power Supply, Model 456, 0-3kV;
12. TENNELEC TENNEBIN 3, Bin Power Supply;
13. Distance transducer;
14. Audio alarm system;
15. ^{208}Tl Source, no specifications;
16. ^{60}Co Source, 14182.5, 11.00 uCi (1-1-74) Isotope Products Laboratories;
17. ^{137}Cs Source, 7286-5, 12.0 uCi (11-1-79) Isotope Products Laboratories;
18. Lead pig for ^{60}Co and ^{137}Cs sources; and
19. Floppy Disk Scan Program, 4/8/83 and more recent modified scan programs (SCAN30 1/25/89).

5.2 SUPPLIES

The mobile scanning van support equipment and supplies consist of the following:

5.2.1 Office supplies:

a. Stapler and staples,

b. Three-hole paper punch,

c. Paper clips,

d. Tape, masking and transparent,

e. Pens, pencils, colored pencils, and

f. 3-ring binders with inserts.

5.2.2 **Van accessories:**

a. Tire wrench,

b. First aid emergency kit,

c. Quart of oil,

d. Two-ton hydraulic jack,

e. Tire pressure gauge, to 100 psi,

f. Waste basket,

g. Road map,

h. Slow-moving-vehicle sign, and

i. Fire extinguisher.

5.2.3 **Electronic tools:**

a. Voltmeter (VOM),

b. Tool kit (pliers, cutter, soldering iron, screw driver),

c. ORTEC Model 448 Research Pulser, and

d. Frequency counter.

5.2.4 **Scanning supplies and backup equipment:**

a. Tractor printer paper, and

b. Blank diskettes.

c. Backup electronics components:

1. ORTEC High voltage Power Supply Model 456, 0-3kV,
2. ORTEC AMP & SCA, Model 490B,
3. ORTEC LOG/LIN RATEMETER, Model 449,
4. ORTEC Model 113 Preamplifier, and
5. Tracor Northern Multichannel Analyzer 1706 and Model 1314 CRT.

5.3 EQUIPMENT SETUP

The detectors, computer and peripherals, pulse height analyzer components, and support systems are all interconnected and ready for operation. If, for some reason, component disconnect or reconnect is necessary, the mobile scan team leader may contact an instrument technologist from the Instrumentation and Controls Division at ORNL/OR or electronics technician at ORNL/GJ and obtain the necessary information to reconnect the system.

6.0 GENERAL PROCEDURE

Photographs of the mobile gamma scanning van system are provided as Exhibits 1 through 4.

For background information, a system description of the mobile scanning van is included as Appendix 1. Appendix 3 presents the useful DOS computer commands available for the on-board computer system.

6.1 Because the data analysis method employed on the van is based on computations involving background count rates in various energy regions, these background levels must first be established. To establish background, the city to be scanned is divided into small areas which the mobile scan team leader has determined to represent the areas for which an associated background level will be determined.

6.2 In each of these areas, a scan is made at normal driving speed traversing a representative area of the streets included in the section. At the end of this scan, the average count rates and associated standard deviation for each of the energy windows are computed, the average Ra/Th ratio and its standard deviation determined, and the data stored for later use.

6.3 After the background level for the survey area has been established, the street-by-street scans of each area can begin. For each street to be scanned, a storage file is opened on the floppy disk system and the file identified by the name of the street and any other descriptive title. Scanning is conducted at a maximum speed of 10 ft/sec, and an audio alarm system alerts the driver if this maximum is exceeded. Distance between the van and the property is also maintained at a minimum (i.e., next to the curb unless obstructions such as parked cars prevent it). During the scan, the detectors are secured in the full up position (approximately 6 ft above ground surface) to maximize the field-of-view and minimize the influence of street-side obstructions.

6.4 As the scan proceeds, permanent landmarks (house numbers, cross streets) are systematically input to the computer to be stored along with the rest of the scan data for cross reference. If during the scan, a property is passed that exhibits gamma radiation levels exceeding preset hit criteria, an alarm is sounded and special notation appears on the computer monitor. This alarm continues to sound until the anomaly has been passed. At the end of the scan, the data file is closed and computer analysis of the data begins. This analysis results in the printout of a list of all anomalies identified by the scan and provides exact location information in terms of net distance from the input comments (permanent landmarks). To further define the locations and to gain additional information, a second scan in the identification mode of each anomaly can be performed at an even slower speed to better define the area of concern and allow for detailed description of property (i.e., house address, or if unavailable, a description of the property location). If desired at this time, a detailed spectrum analysis can be undertaken utilizing the on-board multichannel analyzer system.

6.5 After one side of a street has been analyzed, the other side is scanned in the opposite direction. In addition, all accessible parking areas, alley-ways,and other public thoroughfares would be scanned within the survey section. When all the scanning has been completed, the complete set of raw data for the entire surveyed area can be printed out for future reference.

6.6 To maintain accurate and complete records of the scanning activities, the ORNL scanning system provides for data recording and storage. The primary data storage system is the floppy disk. This system maintains a continuous permanent record of all raw data obtained during the scan. Retrieval of this data occurs (1) at the end of each scan in the form of the computer-analyzed summary of the anomaly locations or (2) on command at a later time for a complete listing of the raw data or listing of the reduced data used in comparison with the hit criteria. A printed copy of all scan files is kept in a project logbook (3-ring notebook). Also, data disks once filled

are stored outside of the scan van to minimize the chance of losing the scan data.

6.7 An event marker is also used to identify the location of the permanent landmarks input by the operator into the computer for additional cross-correlation with the data printout.

6.8 To ensure that no loss of data occurs when the detector system experiences an unexpected power loss because of generator malfunction or other problem, the van has been provided with an uninterruptable battery power supply for the data handling and storage system. In the event of a detector system shutdown, the previously stored data is adequately protected and can be retrieved without concern of data deletion.

7.0 INSTRUMENT POWER SUPPLY STARTUP

7.1 After checking oil level and securely replacing oil fill/check cap, start the generator by turning on the generator start switch located on the right driver overhead panel. Starting the generator will also activate the clock counter, which will register the number of hours the generator has operated. This counter will be checked by the garage to determine when maintenance is needed.

7.2 To monitor the condition of the batteries, check the battery charge indicator on the overhead panel above the driver's position and dash ammeter.

7.3 After generator engine has stabilized (warmed-up for 2 to 3 minutes), turn on the inverter switch located on a panel below the computer. This is the top left switch on the panel.

7.4 Monitor the voltmeter and ensure that the power supply has stabilized at approximately 115 V before turning on the instrumentation.

7.5 Watch the voltmeter and frequency meter after generator startup. The voltmeter should indicate 115 V and the frequency meter should indicate 60 Hz (cycles per second). Notify the mobile scan team leader if the readings are abnormal when the generator is under load. The ammeter will indicate the load placed on the system.

7.6 To ventilate the inverter compartment, turn on the blower switch (toggle) located below small vent hole in panel.

7.7 When the scanning activities for the day are completed, turn off electronic equipment, power, inverter, and generator, in that order.

8.0 GAMMA SCANNING SYSTEM STARTUP

8.1 Start instrument power supply.

8.2 Turn on instrument bin power.

8.3 Turn on interface unit power and push "reset" on the interface unit.

8.4 Turn on high-voltage power supply and raise to 1000 V in 500-V increments. Pause for 5 to 20 s at 500 V before increasing to 1000 V.

8.5 Raise the detectors to the full "up" position by pressing the top button on the hydraulic controller. The hydraulic controller is located on the wall just below the right-rear window of the scanning van. When the full "up" position is reached, a limit switch will stop the pump.

8.6 Insert the two safety pins into the detector frame (this may require using one or both of the hydraulic control buttons to position the holes so the pins can be inserted).

8.7 When the safety pins are inserted, push the down button of the controller to release the pressure from the hydraulic system.

9.0 INSTRUMENT CALIBRATION

The scanning instrumentation is calibrated daily during scanning after system electronics and van working area have been warmed/cooled to room temperature and before any scanning is performed. If the system has been calibrated, proceed to any of the other program modes. The calibration procedure is detailed in Appendix 7.

10.0 DISTANCE TRANSDUCER CALIBRATION

10.1 Check tire pressures; each tire should have 75 psi. Record the tire pressure in the scanning van calibration log book.

10.2 Lay out a stretch of road or street a minimum of 500 ft long. Mark the beginning and the end of the stretch along the curb and each 50-ft increment in between.

10.3 Drive the van to the starting point.

10.4 Mount the slow-moving-vehicle sign and turn on emergency flashers.

10.5 Set the computer system on Identification mode.

10.6 When the operator signals ready, drive the van slowly toward the end point of the calibrated stretch.

10.7 Carefully stop the van at the end point of the stretch.

10.8 The operator reads the distance from the computer display.

10.9 Repeat this check procedure three to five times. If the computer display is $\pm$ 3% of the true value (500 ft), the distance transducer is ready to be used.

10.10 If the readings are outside the range, the mobile scan team leader will notify the instrument technician for further adjustments.

10.11 Document the results of the calibration check for the distance transducer in the Scanning Van Calibration Logbook. For each calibration check, enter the information indicated in Appendix 8.

10.12 An alternative check of the distance transducer can be made in either the Scan or Identification program mode when traveling along a public highway which has mile marker signs. This check will easily give results which indicate qualitatively if a detailed calibration of the distance transducer is required when distance is > $\pm$ 50 ft in one mile.

11.0 BACKGROUND MODE

The background mode of the scan program is accessed when determining the background radiation level to be used in establishing the "hit" criteria for an area to be scanned. Background radiation levels may be new (to be acquired) or old (previously determined). These two options are addressed in Appendices 10 and 11.

12.0 SCAN MODE

The scan mode of the scanning program is used to scan properties for anomalies. The procedure for scan mode operation is detailed in Appendix 12.

13.0 IDENTIFICATION MODE

The identification mode detailed in Appendix 14 is used to verify or obtain the exact location of hits. No data storage is provided for this mode of operation.

14.0 DATA DUMP MODE

This program mode (detailed in Appendix 15) allows for the printing of all recorded raw data obtained during scanning from the disk in drive 1. No computer analysis of the data is performed.

15.0 FILE LIST MODE

The file list program mode detailed in Appendix 16 will print out the computer analyzed data on a file basis for the disk in disk drive 1. This program mode has three options:

15.1 The scan data can be compared with the hit criteria that were used during the scan, resulting in a printout of the same summary that was provided from the scan mode. This option is accessed by typing U ("Use Stored Hit Criteria");

15.2 The scan data can be compared with new hit criteria input by the operator, resulting in a different analysis and summary of data. To access this option, type I ("Input New Hit Criteria") and input the appropriate new hit criteria when called for; and

15.3 All the scan data, including the data on properties where a hit did not occur, are printed. This option can be accessed by typing N and entering 0 and pressing the RETURN key for each of the needed criteria.

16.0 SYSTEM SHUTDOWN

16.1 Remove disks from disk drive 0 and 1.

16.2 Turn off floppy disk system.

16.3 Turn off computer.

16.4 Turn off the interface unit power.

16.5 Decrease high-voltage by 500 V increments to 0 V.

16.6 Turn off high-voltage power supply.

16.7 Turn off instrument bin power.

16.8 If travel over public roads is more than to a local office or temporary office (i.e. motel) or if project is complete, remove safety pins under detector

frame (may require use of hydraulic system controls to position detector). If project is incomplete go to 10.

16.9 Lower detectors to the lowest position, making sure that detector cables are free of obstructions (push in and hold the down button on the hydraulic controller).

16.10 Turn off the power inverter.

16.11 Turn off the generator.

17.0 DOCUMENTATION

Documentation of the gamma scanning operation is mainly provided by the computer system and floppy disk systems. Data analysis is also provided by the computer system with hard copy printout. The printout and any notes are filed as part of the gamma scanning operation records. Printouts are attached to the scanning van logbook.

Appendix 1. System description for the PAG radiological scanning van

BASIC SYSTEM DESCRIPTION

The gamma-ray detection system employed in the scanning van consists of three 4 x 4 x 16-in. NaI(Tl) Polyscin log crystals, each having an integral 3.5-in. photomultiplier tube. The crystals are housed in a partially lead-shielded steel frame to provide a 304 in^2 of unshielded surface area for acceptance of gamma rays through the right side and from beneath the survey van. Detector and shield height can be changed by use of a hydraulic lift mechanism to optimize the detector field-of-view.

Detector output is transferred to a computer-controlled interface designed and fabricated at ORNL. This unit provides for continuous analysis of data inputs for correlation of system location with count rate information. Six separate energy regions-of-interest (ROI) are analyzed and a ^{226}Ra-specific algorithm is employed to identify locations containing residual radium-bearing materials. Data on other naturally occurring radionuclides (such as ^{40}K and ^{232}Th) are obtained for comparison as part of the analysis. Multichannel analysis capabilities are included in the system for additional qualitative radionuclide identification.

The system is operator-controlled through keyboard instructions to an on-board computer. Data output is provided on the computer video screen and a printer. Data storage is provided by a dual floppy disk system.

DATA ANALYSIS TECHNIQUE

The algorithm employed for continuous analysis of the scan data was developed from techniques used for aerial scanning of radiologically contaminated areas. In this analysis, comparison is made between the observed count rates arising from naturally occurring radionuclides (^{232}Th daughters in our case) and residual radioactive materials (^{226}Ra daughters). Where the observed ratio of these count rates (Ra/Th) is determined to be significantly different from a normal background range, the location is identified as a radiation anomaly.

In the ORNL system, three ROI for ^{226}Ra are continuously analyzed (the 0.609 MeV, 1.120 MeV, and 1.764 MeV energy peaks of ^{214}Bi) and one for ^{232}Th (the 2.614 MeV energy peak of ^{208}Tl). Based on the observed count rates in these energy regions in a background area, an average background radium-to-thorium ratio ($\overline{R}$) can be determined as follows:

$$\overline{R} = Ra/Th = \frac{(0.609\ MeV + 1.120\ MeV + 1.764\ MeV)}{(2.614\ MeV)}$$

Appendix 1. (continued)

Associated with this average ratio is a standard deviation that is dependent upon the variation of the individual Ra and Th components.

$$\sigma_{\bar{R}} = \bar{R}\left(\left[\frac{\sigma_{Th}}{\bar{X}_{Th}}\right]^2 + \left[\frac{\sigma_{Ra}}{\bar{X}_{Ra}}\right]^2\right)^{1/2}$$

where

$\sigma_{\bar{R}}$ = standard deviation of the Ra/Th ratio,

$\bar{R}$ = average Ra/Th ratio in background area,

σ_{Th} = standard deviation of the Th energy region (2.614 MeV),

$\bar{X}_{Th}$ = average Th count rate in background area,

$\bar{X}_{Ra}$ = average Ra count rate in background area,

σ_{Ra} = standard deviation of the Ra energy regions (0.609 MeV + 1.120 MeV + 1.764 MeV).

Thus, for any area to be scanned, some background Ra/Th ratio can be computed $R \pm k\sigma_{\bar{R}}$ (where k is the specified 2-sided confidence level) that can be used for comparison with the scan data obtained each second in the scan mode.

In identifying locations containing residual ^{226}Ra-bearing materials, the ORNL system uses three criteria (hit criteria), all based on the observed background Ra and Th count rates and the computed Ra/Th ratio. The first criterion that must be met involves the determination of a minimum count rate in the Ra energy regions that results in a detectable change in the observed Ra/Th ratio. The mathematical expression for this criterion is as follows:

$$C_m = 2k\left[\bar{X}_{Ra}\left(\bar{R} + 1\right)\right]^{1/2} + k^2,$$

where

C_m = minimum Ra count rate above background,

k = specified 2-sided confidence level,

$\bar{X}_{Ra}$ = average Ra count rate in background area,

Appendix 1. Continued

$\bar{R}$ = average Ra/Th ratio in background area.

For a detected count rate to pass this first hit criterion, the total count rate in the three Ra energy windows must exceed $\bar{X}_{Ra} + C_m$.

The second and third hit criteria, either of which must be met before a location is considered an anomaly, are based on comparison of the observed Ra/Th ratio with the computed background ratio. In the second criterion, the observed and background ratios are directly compared, and if the observed Ra/Th > $\bar{R} \pm k\sigma_{\bar{R}}$, the location is considered to have exceeded the criterion and the analysis moves to the third criterion. In the third criterion (called the difference techniques), a mathematical difference is computed.

$$\text{difference} = \text{observed Ra} - [\text{observed Th } (\bar{R} + k\sigma_{\bar{R}})].$$

When this difference is positive, the observed count rate is considered above the criterion.

The second and third criteria, although based on the same background ratio, provide different degrees of sensitivity, depending on the magnitude of the observed count rates in the energy windows. Their combined use provides for a reduction in the incidence of false hits as follows:

1. The identification of properties containing radiation anomalies when actually no anomaly is present; and,

2. Identification of properties as having ^{226}Ra-bearing material (tailings) when only natural variations in background are present due to changes in counting geometry as is possible when passing close to a masonry wall or rock outcrop.

An index field is also calculated as a subjective indication of the anomaly strengths and is calculated as follows:

$$\text{Index} = \frac{\text{observed Ra (cps)/calculated Ra/Th ratio}}{\text{hit criteria Ra (cps)/hit criteria Ra/Th ratio}}$$

Appendix 2

SYSTEM VERSATILITY

The ORNL scanning van system has been optimized to look for locations containing ^{226}Ra-bearing materials. However if desired, system modifications could be made to allow for the analysis of other radionuclides. For instance, if the 0.662 MeV energy peak of ^{137}Cs was set as a region-of-interest (ROI) the scan van could be used as an emergency response vehicle in the event of a fission product leak at a nuclear power plant. The scan van might be utilized to quickly establish perimeter zones around the site.

In addition, the system is presently configured so that if the Ra/Th ratio is suppressed due to an increase in ^{232}Th (^{208}Tl), a low ratio hit criteria is displayed on the CRT and listed on the file printout. This is utilized to identify both ^{232}Th contamination and also to identify Th background variations due to causes such as some igneous rocks found in the natural environment or used in building materials.

Appendix 3. Useful DOS program commands accessible from scan programs dated prior to 12/20/88 and SCAN30 program code.

GENERAL

Command	Function
Place program disk in Drive 0 and press SHIFT and RUN/STOP keys.	This loads the DOS program. Once the DOS has been loaded, all communications with the disk can be obtained by the use of the following commands.
>$D	Will display the directory of the disk drive indicated by D. D must be either 0 or 1.
>iD	Will initialize the disk drive D (D is either 0 or 1).
↑Program Name	Will load and run the program (for scanning enter ↑scan).
↑Program Name	Will load but will not run the program.
>ND:Name,XX	Will format a disk in drive D. The name can be no more than 24 characters and must be followed by a two-digit (XX) identification number.
>c1 = 0	Will copy the files on drive 0 to drive 1.
> press RETURN key	Will print the error message and clear the error channel.
Load "$D",8	Loads the directory from drive D.
Open 4,4:CMD4:LIST	Opens the communication channel to the printer and lists the directory.
Print #4:Close4	Closes the communication channel to the printer to print disk directory[b].

[a]The EXIT key is the CTRL-HOME key on the computer keyboard.
[b]This will erase all programs in the computer RAM except the DOS program.

Appendix 4. Data handling and system startup.

Technologist action	CRT display	Function or comment
1. Turn on computer (switch is located on rear lower left corner).	**COMMODORE BASIC 4.0** 31743 bytes free READY	
2. Turn on floppy disk system (switch is located on rear lower left corner).		Center green light will appear when system is ready.
3. Insert scan program disk into the floppy disk drive 0.		Disk title is "CBM Model 8050 Scan Program, 4/3/83".
4. Press SHIFT and RUN/STOP keys to load the computer/disk support programs (DOS Support using programs dated prior to 1/25/89).		Disk drive 0 green light will come on while information is being transferred.
	READY	DOS Support is loaded.
5. Insert blank disk into drive.		To format the blank disk for data storage.

Appendix 4. (continued)

6. Type >n1:disk name,XX		To format a new disk. Disk name is any appropriate identifying name of not more than 26 characters. XX is a sequential number from 00 to 99, you use when multiple disks are used on site. Disk Drive 1 green light will appear for 3 to 4 min. and disappear when formatting is complete.
7. Remove the disk from drive 1 and use a felt tip pen to write on the disk the name typed in Step 6 above.		Disk should be removed and reinserted to ensure that the disk is registered properly when formatted.
8. Type ↑scan and press RETURN key.	Input your name	Will load scan program from disk 0.
9. Enter your name. Press RETURN key.	Input date (e.g. 2/10/89)	After the log-on sequence, the program will automatically address the background program mode. If other modes are desired, go to step 11.
10. Enter date. Press RETURN key.		

Appendix 4. (concluded)

11. Press EXIT key.	CRT will display the six program modes that can be accessed (see Appendix 6)	Computer will return to the program mode directory. Any of the six program modes can now be accessed by typing the first letter of any program mode.

Appendix 5

SCAN PROGRAM MODIFICATIONS

Five software modifications have been initiated in the scan program in order to eliminate operational problems or to track scan project progress. All of the modifications were made between November 4, 1988 and January 25, 1989.

Scan program modifications include; (1) printing the total distance scanned on each scan file printout, (2) printing a directory of the current data disk files on scan file printouts, (3) locking out the Exit key and replace its function with the Esc key, (4) eliminating program crashes if to long a comment string is input during a scan and, (5) allowing the system to automatically escape from the scan program before the data disk currently in use runs out of storage capacity.

The modified scan program (SCAN30 dated 1/25/89) has to be loaded into the computer without the "UNIVERSAL WEDGE" (DOS) program as it was with earlier versions of the scan program. This is necessary in order for the SCAN30 program to print the directory of the data disk at the end of each scan file. If the DOS, "UNIVERSAL WEDGE", functions are needed such as in the case of formatting data disks the computer must be shut-off to remove the SCAN30 program from memory. The "UNIVERSAL WEDGE" program (included on all scan program disks dated prior to 12/20/88) can then be loaded when DOS functions are needed. Unless noted the following procedures describe the SCAN30 Program functions after it has been inserted into floppy disk drive 0 and loaded into the computer by pressing the SHIFT and RUN/STOP keys.

Appendix 6. Gamma scanning program directory.[a]

Program	Function
Scan	Records all street survey data (scan data)
Background	Defines background for areas to be scanned
Calibration	Used for system checkout
Data Dump	Prints all stored raw data
File List	Prints data above hit criteria
Identification	Pinpoints anomaly location

[a]Enter only the first letter of the desire program mode.

Appendix 7. Instrument calibration.

Technologist action	CRT display	Function or Comment
1. At main program directory, Press C key.	The CRT will display the calibration/instrument settings.	C is the first letter of the calibration program.
2. With the CRT display as a guide, check the discriminator window settings on the interface unit. Use the values under UPPER and LOWER columns of the display for the appropriate windows (A1 through A4 and B1 through B4).		
3. Remove the ^{137}Cs source from the lead pig and place it in the source holder on the power strip in front of the detector support frame.		
4. Push the acquire button on the MCA and observe the dead-time meter; it should be less than 10 percent.		
5. Move MCA cursor to Channel 111.		
6. Observe ^{137}Cs 0.662 MeV photopeak. If it falls in Channel 111 $\pm$ 1, do nothing. If not, adjust the fine gain on amplifier until the peak falls within the channel range.		When adjusting fine gain, always clear the acquired data to minimize confusion on the location of the photopeak.
7. Record the ^{137}Cs photopeak channel number in the scanning van calibration logbook, and amplifier gain setting. Include calibrator's name, date of calibration, and location of calibration.		

Appendix 7. (continued)

8. Replace the ^{137}Cs source with a ^{60}Co source. Clear data. Again observe the dead time (should be $\leq$ 10%).

9. Move the MCA cursor to the center of the 1.17 MeV photopeak (approximately at channel 195).

10. If photopeak is $\pm$ 3 channels of channel 195, go to step 11 below. If not, go back to step 3 above. If the problem cannot be resolved, go to step 21.

11. Record the ^{60}Co 1.17 MeV photopeak channel number in the scanning van calibration logbook.

12. Move the MCA cursor to the center of the 1.33 MeV ^{60}Co photopeak (approximately channel 221).

13. If photopeak is $\pm$ 3 channels of channel 221, go to step 15. If not, return to step 3.

14. If problem cannot be resolved, go to step 21.

15. Record the ^{60}Co 1.33 MeV photopeak in the scanning van calibration logbook.

16. Remove the ^{60}Co source and store in the lead pig. Place the ^{208}Tl source on the bracket directly in front of the detectors; observe dead time; should be less than 10%.

17. Move the MCA cursor to the center of the 2.61 MeV ^{208}Tl photopeak (approximately channel 425).

Appendix 7. (continued)

18. If the center of the photopeak is ± 5 channels of channel 425, go to step 19. If not, go back to step 3. If the problem cannot be resolved, go to step 21.

19. Record the photopeak channel number in the scanning van calibration logbook.

20. Return ^{208}Tl source to the source drawer.

21. If the MCA cannot be calibrated to the required tolerances, the scanning team leader may contact an instrument technologist at ORNL/OR or ORNL/GJ for further adjustments or repairs.

22. Type any character on the keyboard and observe on the display unit the count rates in the appropriate discriminator regions-of-interest (ROI).

23. Observe the "average count rate" in the Ra (0.609 MeV) region with no source present. (Allow time for average values to stabilize approximately 40 s). Record the average background count rate in the scanning van calibration logbook.

24. Remove the ^{137}Cs source from the lead pig and place it at the same location as when calibrating.

25. Observe the average count rate in the Ra (0.609 MeV) region associated with the ^{137}Cs source (allow approximately 40 s for count rate to stabilize). Record the average source count rate in the scanning van calibration logbook.

Appendix 7. (concluded)

26. Subtract the count rate in step (23) from that in step (25) and record the net count rate in the scanning van calibration logbook.

27. If the net count rate is within ± 5% of the previous calibration (see the logbook), the detector sensitivity is considered unchanged and property scanning can begin. If the net count rate is outside the tolerance range, inform the mobile scan team leader who will contact the appropriate instrument technologist for repairs.

28. Replace the ^{137}Cs source in the lead pig.

29. Press ESC key to return to the program mode directory.

Calibration is complete, and another program mode may be accessed.

Appendix 8. Distance transducer calibration check data.

Date: _____
Technologist: _____
Other members: _____
_____
Tire pressure: _____psi

Distance measurements:

1. _____ ft ____% error
2. _____ ft ____% error
3. _____ ft ____% error
4. _____ ft ____% error
5. _____ ft ____% error

Average_____ ft

$$\% \ error = \frac{500 - reading}{500} \times 100^{*}$$

---

*If % error >3% notify Mobile Scan Team Leader.

Appendix 9. Background scan CRT display.

BACKGROUND SCAN

Scan of area should be obtained at normal driving speed

Max length of file name is 16 characters

Use the Esc key to close the background file and
return to program directory.

Appendix 10. Background mode CRT display.

APPROPRIATE BACKGROUND DATA MUST BE ENTERED

PRIOR TO ACCESSING ANY OTHER PROGRAM MODE

BACKGROUND DATA FOR AREA TO BE SCANNED CAN BE OBTAINED FROM

NEW FILE: BACKGROUND SCAN AREA

OLD FILE: DATA FROM PREVIOUS BACKGROUND FILE

ENTER ONLY THE FIRST LETTER OF THE DESIRED PROGRAM MODE

Appendix 11. Background mode operation.

Technologist action	CRT display	Function or comment
1. At scan program directory, press B key.	See Appendix 6	This will access the background mode of the scan program.
2. If a new file is to be established for background of the area, press N key. If data from a previous background file are to be used, go to step 6.	See Appendix 10 Input background filename	
3. Type in filename. Press RETURN key (only when ready to accumulate data).		Filename must be less than 16 characters.
4. Drive the vehicle at normal driving speed to cover a representative % of the accessible streets to establish the background; the mobile scan team leader has the responsibility of determining if variations in the local geology and/or land use warrant the acquisition of a new background throughout the project.	Accumulated background data and distance	Normal driving speed is the posted speed limit at the particular location being scanned.

Appendix 11. (continued)

5. When sufficient coverage has been obtained, press ESC key to close data acquisition.	CRT will display the program directory.	The computer will analyze the accumulated data and print out the results.
6. If a background has been established for the area to be scanned, press "O" (for old) key.	Input total Ra counts (mean)	
7. Enter total Ra counts (mean) from a previous background measurement. Push RETURN key.	Input Ra/Th Ratio (mean)	
8. Enter Ra/Th ratio (mean) from a previous background measurement. Push RETURN key.	Input Ra/Th ratio (std dev)	
9. Enter the Ra/Th ratio standard deviation from previous background measurement. Push RETURN key directory.	Computer will display the new hit criteria for a few seconds and return to the program.	

Appendix 12. Scan mode operation.

Technologist action	CRT display	Function or comment
1. Position the gamma scanning van at an identifiable permanent landmark in an area to be scanned.		Landmarks can be cross streets, house number and street, etc.
2. Type S.	Computer will give specifications for filename and an example. INPUT FILENAME	
3. Type filename.	Filename typed	Filename should be less than 16 characters.
4. When ready, press RETURN key.	Computer will display the accumulated data at 1-s intervals for the total distance, total Ra counts, Ra/Th ratio, and the sign of the positive difference analysis algorithm.	Green light on disk drive 1 will appear.
5. Type start landmark and press RETURN key.		Start landmark is usually a street or house number and street.
6. Drive the scanning van at 10 ft/sec or approx. 6 mph and as close as possible to the street curb.		Audio alarm will sound if 10 ft/sec speed is exceeded.

Appendix 12 (continued)

7. Type in landmarks and press RETURN key at regular intervals as the scan proceeds.	These landmarks will serve as check points when anomalies are detected. When entering house and/or business numbers, press return when detector crystals pass the main entrance of the building.
8. After all accessible roads within the area have been scanned, press ESC key to close the file and begin computer analysis of the data.	When the computer has completed analysis of the data, the printer will print out the locations where hits occurred. It will also provide location information (distance from last identifiable landmark), appropriate count rate data in the Ra channels, the Ra/Th ratio, and the magnitude of the computer positive difference. A remarks column is also provided for any comments the technologist wants to make.

Appendix 13. Identification mode CRT display.

IDENTIFICATION PROGRAM

THIS PROGRAM IS TO PINPOINT THE EXACT LOCATION OF THE ANOMALIES

The data is not stored in this program. If a permanent record is needed then return to the scan program

TO RESET DISTANCE, DEPRESS 0
TO EXIT PROGRAM, DEPRESS ESC KEY
DEPRESS ANY KEY TO START THE PROGRAM

Appendix 14. Identification mode operation.

Technologist action	CRT display	Function or comment
1. Type I to access the program mode; then follow instructions on CRT - press any key.	See Appendix 6	No data storage is provided in this mode of scanning. Also, the distance can be reset to zero at any time by typing 0.
2. Referring to the scan mode printout, find the location of the hit, and drive the van to the vicinity of the hit location.		
3. Reset the distance at the positions of the nearest landmark.		
4. Start scanning toward the location of the hit. Drive the van very slowly. Compare CRT displayed distance to that recorded on summary sheet obtained.	Similar information as in scan mode data	
5. Stop the vehicle at the hit location and identify the property where the hit occurred.		Identification may be by house number and street or other property descriptions.
6. Record the identification information under the remarks column of the summary data sheet.		

Appendix 14. (continued)

7. When all hit properties have been identified, press ESC key to end the identification mode and return to the program mode directory.	Program mode directory. (Appendix 6)

Appendix 15. Data dump mode operation.

Technologist action	CRT display	Function or comment
1. Type D.	Filenames of all files on the disk	Computer will read the file directory on the disk in drive 1. The filenames are numbered sequentially as they appear on the disk. To dump data from a single file, type the number of that file. To dump data from the entire disk, press RETURN key.
2. After obtaining the desired data, press ESC key to return to the program mode directory.		

Appendix 16. File list mode operation.

Technologist action	CRT display	Function or comment
1. Type F.	File names of all files on the disk	Computer will read the file directory of the disk. The files are numbered sequentially as they appear on the disk.
2. Choose the option desired as discussed at the beginning of this section.		
3. Select the number assigned to the desired file, enter it, and press RETURN.		
4. When the needed data are printed, press the ESC key to return to the program mode directory.		

Exhibit 1. Operator console area.

ORNL PHOTO-371-91

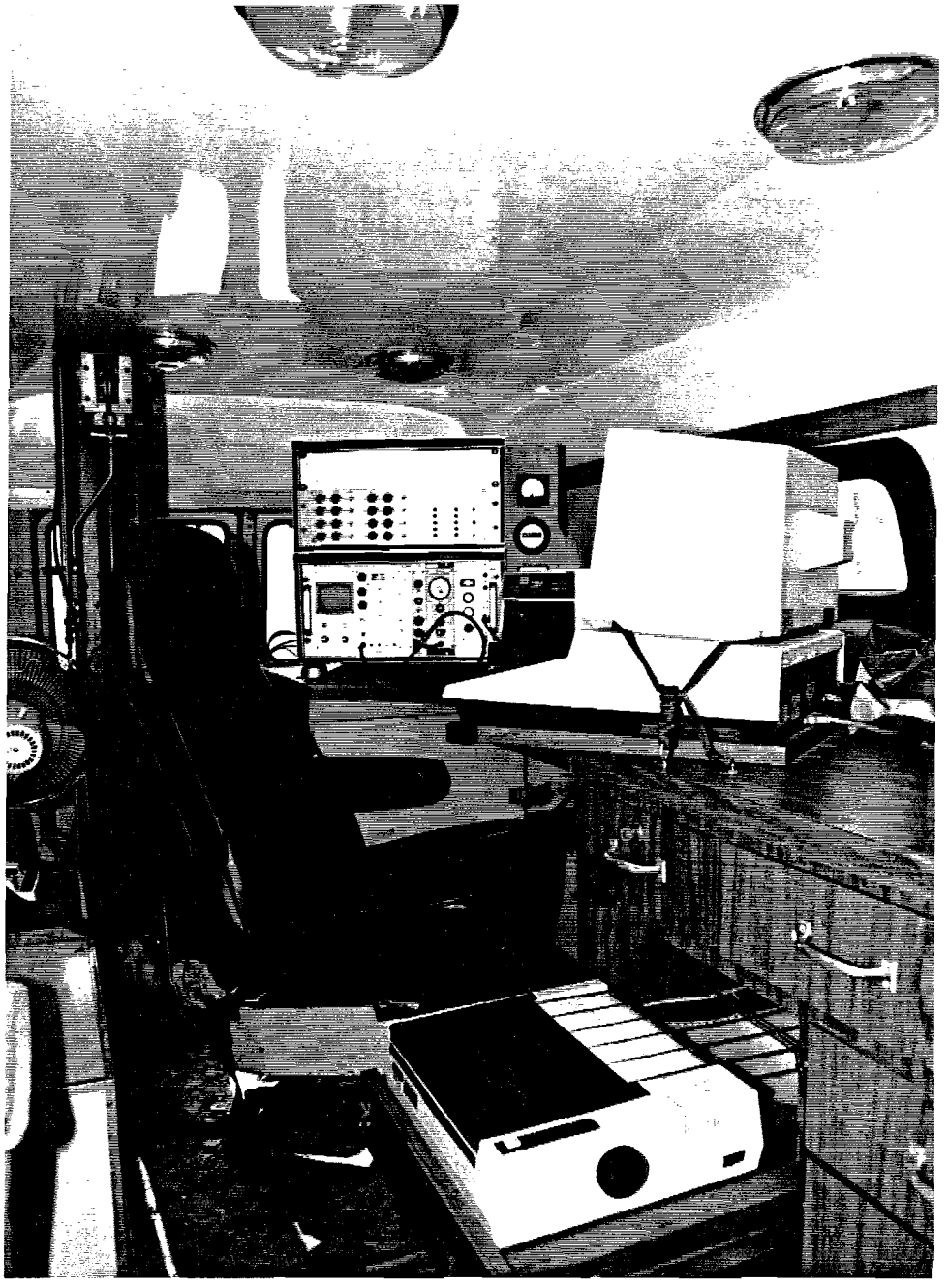


Exhibit 2. CBM Model 8032 computer.

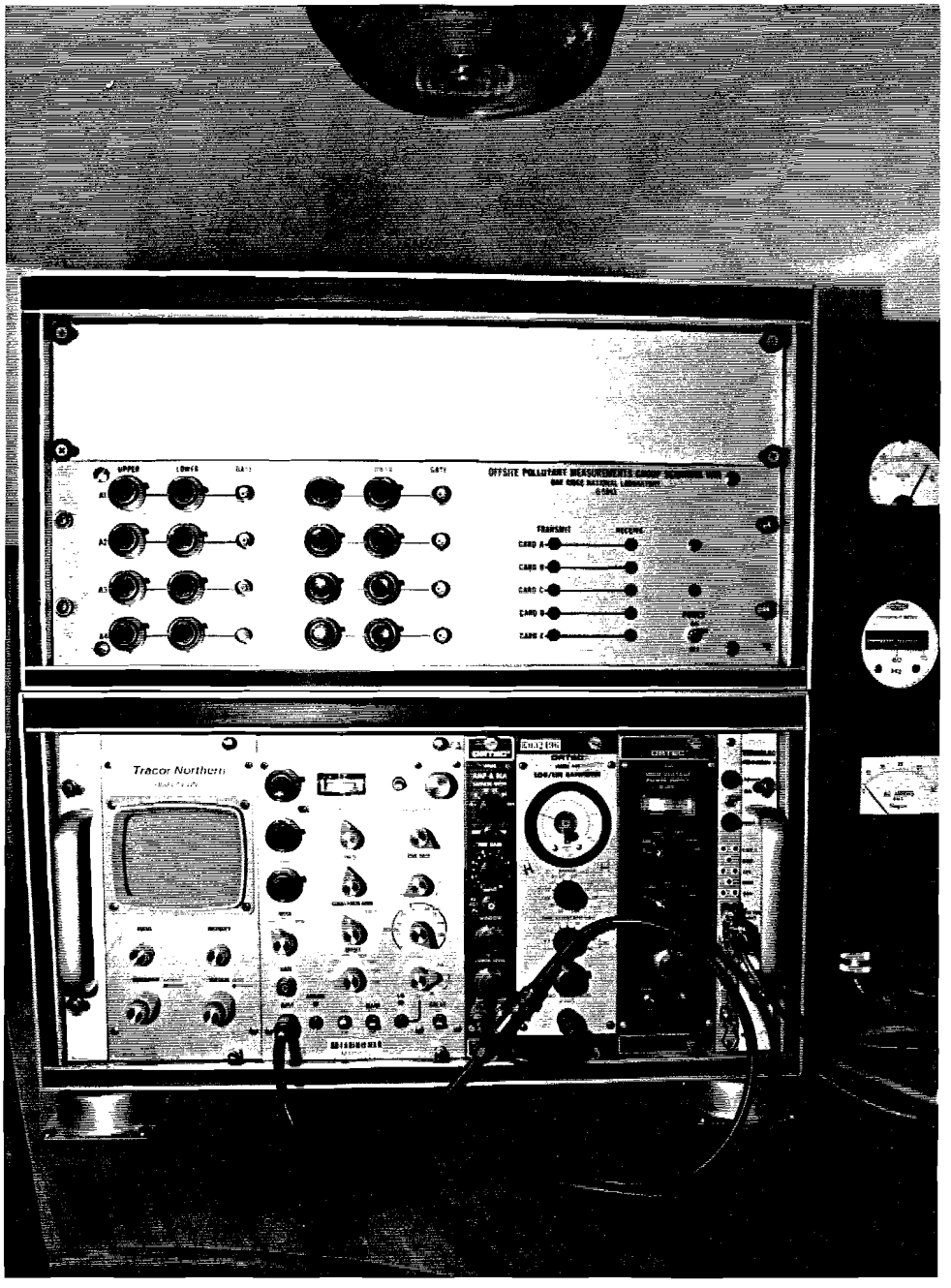
ORNL PHOTO-372-91

Exhibit 3. CBM Model 8050 disk drive.

ORNL PHOTO-373-91

Exhibit 4. Interface unit and NIM electronics.

ORNL PHOTO-374-91



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-020 Page: 1 of 35 Revision: 1 Date: 02/03/92

INCLUSION SURVEY ACTIVITIES

1.0 PURPOSE

This procedure describes inclusion survey field measurement activities and data recording.

2.0 APPLICABILITY

This procedure applies to all gamma inclusion surveys performed for the Uranium Mill Tailings Remedial Action (UMTRA) Project and the Monticello Vicinity Properties (MVP) Project.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Vicinity Property Management and Implementation Manual* (VPMIM), UMTRA-DOE/AL-050601.
3.1.2 Procedure TE-120, Physical Survey.
3.1.3 Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties.
3.1.4 Procedure TE-025, Alpha Radiation Measurement.
3.1.5 Procedure TE-026, Beta-gamma Radiation Measurement.
3.1.6 Procedure TE-021, Gamma Scintillation Detector Operation.
3.1.7 Procedure TE-032, Alpha-Track Radon Detector Placement and Retrieval.
3.1.8 Procedure TE-023, GR-410 Portable Gamma Spectrometer Operation.
3.1.9 Procedure TE-030, Post-inclusion Survey Activities.
3.1.10 Procedure TE-022, Pressurized Ionization Chamber (PIC) Operation.
3.1.11 Procedure TE-034, Chain of Sample Custody for In-House Analysis.
3.1.12 DOE Order 5480.11, "Radiation Protection for Occupational Workers," December 21, 1988.

3.2 APPENDICES

3.2.1 Appendix 1: Survey Site Information
3.2.2 Appendix 2: Radiological Screening Summary

Approved by:

2/3/92 (Date)

C.A. Little (Date)

3.2.3 Appendix 3: Soil Sample Data Field Form
3.2.4 Appendix 4: Chain of Sample Custody/Soil Sample Analysis Form
3.2.5 Appendix 5: Guidelines to the Extent of Inclusion Surveys
3.2.6 Appendix 6: Conversion Formulas
3.2.7 Appendix 7: Point Source Handling Guidelines Calculations

3.3 EXHIBITS

3.3.1 Exhibit 1: Probe Measurement in Sample Holes
3.3.2 Exhibit 2: Methods of Locating Windblown Samples
3.3.3 Exhibit 3: Sampling Equipment
3.3.4 Exhibit 4: Decontamination of Sample Collection Equipment
3.3.5 Exhibit 5: Example of Field Map

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Gamma scintillation detectors, one for each member of the survey team, plus one back-up
4.1.2 30-ft measuring tape
4.1.3 100-ft measuring tape
4.1.4 Survey flags, or other marking devices
4.1.5 Posthole digger
4.1.6 Trowel
4.1.7 Dandelion digger
4.1.8 Breaker bar
4.1.9 Weedsprayer with clean water
4.1.10 Wire brush
4.1.11 Hammer
4.1.12 Safety glasses
4.1.13 Shoe or boot coverings
4.1.14 Camera
4.1.15 Calculator
4.1.16 Surveying equipment
4.1.17 Brunton compass
4.1.18 Engineering scale
4.1.19 "Peg Leg" drawing platform
4.1.20 Portable gamma spectrometer
4.1.21 Eberline GJ140 alpha probe

4.2 SUPPLIES

4.2.1 Field data forms (Appendices 1, 2, and 3)
4.2.2 Chain of Sample Custody/Soil Sample Analysis Form

4.2.3 3 by 3 ft plastic sheets
4.2.4 Sample cans
4.2.5 Plastic sample can lids
4.2.6 Small plastic bags
4.2.7 Large plastic bags (turkey bags)
4.2.8 Black ball-point pens
4.2.9 Black felt-tip pens
4.2.10 Paper towels
4.2.11 Gridded drawing paper
4.2.12 Drawing pencils

5.0 RESPONSIBILITY

5.1 The team leader is responsible for delegating inclusion survey tasks, recording field data, ensuring that all team members adhere to survey procedures, and making any field decisions relevant to the inclusion survey. The team leader is the point of contact with the property owner and usually surveys the interior areas. He or she may also assist the team members in the exterior scan or in mapping the property.

5.2 Team members are responsible for performing the exterior gamma scanning of the property, taking soil samples as directed by the team leader, and assisting the team leader in mapping and defining any regions of contamination. A team member may map the vicinity property prior to or during the survey and assist the team leader in the interior scan.

5.3 The technical assistant is responsible for documenting and ensuring implementation of changes in inclusion survey procedures.

6.0 DEFINITIONS

6.1 **Cpm:** counts per minute.

6.2 **Extended measurements**: soil sampling and/or radon measurements performed during or after a radiological survey to determine if radiological contamination exceeds applicable standards.

6.3 **Gamma scan**: a measure of the gamma radiation level of surfaces using a portable gamma scintillation detector.

6.4 **GJRAP**: Grand Junction Remedial Action Project.

6.5 **GM tube**: Geiger-Mueller counter; a radiation detection device which utilizes an ionization chamber to measure the pulses of energy released by radioactive material.

6.6 **Habitable structure**: a permanent building enclosed on all four sides and having a ceiling and floor and either currently inhabited or potentially inhabitable. A detached garage is generally considered uninhabitable unless it is used frequently or for long periods of time, as for a workshop. Mobile homes are not considered permanent structures.

6.7 **HIG**: high indoor gamma reading.

6.8 **HOG**: high outdoor gamma reading.

6.9 **Hot spot**: an area of radiological contamination 25 m^2 or less.

6.10 **Inclusion survey**: a radiological survey conducted on a vicinity property to determine if radiological contamination is present and exceeds applicable standards and whether the property should be recommended for inclusion to or exclusion from the appropriate remedial action project.

6.11 **Kcpm**: thousand counts per minute.

6.12 **μR/h**: micro Roentgen per hour or micro R per hour, a unit of radioactive exposure.

6.13 **MVP Project**: Monticello Vicinity Properties Project.

6.14 **NEAWA**: net estimated area-weighted average.

6.15 **PIC**: pressurized ionization chamber.

6.16 **Progeny**: in radioactivity, this refers to the product nuclei or atoms resulting from decay of the precursor or parent.

6.17 **Spillover**: a deposit that extends from one vicinity property (parent property) boundary to another vicinity property (daughter property).

6.18 **Subsurface soil sample**: soil sample taken from a depth greater than 15 cm below the soil surface.

6.19 **Surface soil sample**: soil sample taken from a depth of 0-15 cm below the surface.

6.20 **UMTRA Project**: Uranium Mill Tailings Remedial Action Project.

6.21 **Vicinity property**: a public or private property in the vicinity of a mill site covered under the UMTRA Project or Monticello remedial action program.

6.22 **VPMIM**: Vicinity Properties Management Implementation Manual.

6.23 **"Who-done-it" map**: a map indicating areas surveyed by individual team members.

6.24 **50-ft centers**: the lines technicians walk, 50 ft apart, during a gamma scan of large disturbed areas greater than 5 acres.

7.0 SAFETY

7.1 Always wear gloves when handling radioactive materials, for example, when sampling elevated regions and when handling point sources.

7.2 When handling a point source, adhere to the following guidelines:

7.2.1 Minimize handling time.

7.2.2 Do not carry the source next to the body.

7.2.3 Shield the source if left in the van for an extended period of time.

7.2.4 Alternate turns when handling point sources to lower the individual hand dose.

7.3 After handling radioactive materials, wash hands before eating or drinking.

7.4 If alpha contamination is suspected on body and/or clothes, use the Eberline GJ140 alpha probe in the soils laboratory for self monitoring.

7.4.1 Use the instrument carefully because the mylar cover on the probe is very fragile.

7.4.2 If contamination in excess of 160 cpm is detected, remove the contaminated clothing, place it in a plastic bag, and take it to a designated laundry for cleaning.

7.4.3 If contamination is detected on skin, wash or shower immediately.

a. Repeat self monitoring and washing until no evidence of contamination remains.

8.0 PROCEDURE

Inclusion survey activities follow guidelines laid out in Reference 3.1.1.

8.1 PROPERTY SKETCH

8.1.1 Obtain a legal description of the property from the Mesa County tax assessor's files or from the plat maps maintained in the public relations department at ORNL/PAG.

a. For a property outside Mesa County, obtain the legal description by normal title search methods at the appropriate courthouse.

8.1.2 Sketch the property either prior to or at the time of the survey.

a. Using measuring tapes, a Brunton compass, or surveying equipment in the case of large properties, map boundary lines, buildings, concrete areas, fences, roads, and other major features of the property.

b. Sketch the property on gridded drawing paper using an engineering scale. Use as large a scale as appropriate, accurate to the nearest foot.

c. Procedures for using survey equipment are described in TE-120, Physical Survey.

8.1.3 Following the visit, produce an accurate drawing of the property on AutoCAD.

a. See Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties, for specific standards for base maps.

8.2 EXTENT OF INCLUSION SURVEY

The extent of an inclusion survey is guided by a decision matrix based on the EPA (Environmental Protection Agency) standards; it is designed to minimize the effort necessary to make a defensible inclusion/exclusion recommendation. In general, when an includable deposit is discovered on a property, further survey activities are not required. (See Appendix 5, Guidelines to the Extent of Inclusion Surveys.)

8.2.1 GJRAP Properties

a. Prior to scanning a Grand Junction UMTRA property, the team leader must determine whether or not the property has been remediated under GJRAP by examining the GJRAP folder which accompanies the file.

b. A property that was assessed under GJRAP but not remediated under the program must be given a complete gamma survey, including all indoor areas.

c. No indoor survey is conducted on GJRAP-remediated properties; however, an outdoor survey is performed.

8.2.2 Large Areas

a. Survey large undisturbed lands, greater than 5 acres, only in access areas (e.g. roads, driveways, and frontage roads), structures, pavements, and any other items or regions believed to be manmade (e.g., drainage areas, and rubble piles). Survey access roads by walking along both sides of the road, with stops to investigate elevated readings. Note scanned areas on the field map and on the "who-done-it" map.

b. Survey large disturbed lands, greater than 5 acres, by walking over the property on 50-ft centers. This is done in one direction (e.g., north-south) without crosswise surveying, unless areas likely to have contaminated deposits (i.e., obvious fill areas, dirt piles, debris, improvements, and landscaping) are not on the 50-ft scan pattern. Investigate any anomalous readings to ensure that a deposit is not present. Note scanned areas on the field map and on the "who-done-it" map.

c. Survey large areas with unusual radiologic conditions using smaller centers and more detailed investigation to provide sufficient documentation for exclusion.

8.2.3 Spillovers

a. After a signed consent form has been obtained, survey the daughter property of a nonincludable spillover deposit according to standard inclusion survey procedures. The property is not includable if the spillover deposit in its entirety is not includable unless another deposit on the property exceeds EPA standards.

b. If the spillover deposit is known to exceed standards based on data from the parent property alone, a brief scan to verify that the deposit spills over onto the daughter property is adequate to make an inclusion recommendation.

c. Monticello spillover daughter properties must be sampled to ensure that elevated gamma readings are due to actual contamination and are not just emanation from the parent property.

d. Contaminated city sidewalks are never considered spillover deposits; the area of contamination is considered to end at the property line. Contaminated sidewalks of adjacent properties should be noted on the field map. However, do not include these sidewalks when calculating contaminated areas for the parent property.

8.2.4 Roads

a. For properties with adjacent paved roads, survey only to the edge of the curb or pavement.

b. For properties with adjacent unpaved roads and alleys, survey only to the midpoint of the road or alley.

c. For MVP unpaved roads and/or alleys, the inclusion boundary extends from the boundary of the block and/or the individual residence to the midpoint of the road.

8.2.5 Perimeters

To conclusively rule out any spillover contamination from adjoining properties, survey the perimeter of all properties, even if the survey has been terminated because it exceeds EPA inclusion criteria.

a. Large (>5 acres) undisturbed properties are excepted from this requirement.

8.2.6 Mobile Homes

Do not survey the interior of mobile homes because they are not considered permanent structures.

8.2.7 Alpha and Beta Radiation Contamination

On occasion, the call for determining alpha and/or beta contamination may arise. Use Procedures TE-025 and TE-026 to measure these types of contamination and report results on field sheets.

8.3 GAMMA SCREENING

8.3.1 Conduct a gamma scan of the property using gamma scintillation detectors as described in Procedure TE-021, Gamma Scintillation Detector Operation.

a. The team leader or designated team member scans the lowest habitable level of the structures.

b. For UMTRA properties, a verbal refusal occurs when the owner denies access to any structure. No data is collected for the property. Obtain a signed refusal if possible in this case.

c. At the discretion of the team leader, team members either scan outdoors simultaneously with the interior scan or wait until the interior scan is completed.

8.3.2 The team leader makes a recommendation for exclusion with no further measurements under the following conditions:

a. the entire property has been scanned;

b. no area (see below) produces exposure rate averages greater than background rate plus 20%;

outdoors: 100 m^2
indoors: a room or 9.3 m^2.

8.4 DEPOSIT DEFINITION

Define the deposits of radioactive contamination in the following manner:

8.4.1 Note any region which exceeds the highest value of the representative background rate range by 1000 cpm on the base map and mark its boundary with flags or other appropriate markers.

8.4.2 Determine a gamma rate range and a field average for the deposit.

a. The field average gamma exposure rate is an estimate of the most frequently measured gamma exposure rate.

b. The gamma rate range should not exceed 50 kcpm. If the range for a particular deposit exceeds this maximum value, break the deposit into smaller regions to facilitate averaging of values found.

NOTE: It is possible to have a deposit with a determined gamma rate range that contains spots of contamination [<0.5 m^2] exceeding the highest range value. The spots must be discrete and few.

c. Record the ranges, averages, and any extraordinary notes on the field data sheets and on the field map.

8.4.3 Measure the area of the deposit.

a. For deposits <930 m^2 (100 by 100 ft), stretch a measuring tape across the surface of the deposit in varying directions as often as deemed necessary by the team leader to obtain accurate measurements of the deposit.

b. For deposits >930 m^2, measure the deposit as above or pace off.

c. Pace off the deposit in as many directions as necessary to obtain an accurate shape of the deposit.

d. Record the shape, location, and areal extent of the deposit to scale on the field map.

8.4.4 For indoor regions of elevated exposure rates, determine gamma rate ranges, average gamma rates, and deposit measurements by the same methods used for outdoor deposits. A "room" may be any room (regardless of size) or an interior area large enough to be partitioned from a larger area to make a room (9.3 m^2 or 10 by 10 ft).

8.4.5 Doubling Gamma Exposure Rates Beneath Concrete and Asphalt

To determine whether contamination exists beneath a slab of concrete, asphalt, or other impenetrable material, or within the slab itself, dig a hole, as specified by the team leader, adjacent to the slab and as close to the highest reading as possible.

a. If visible tailings are discovered beneath the slab, double the gamma exposure rate for the area beneath the slab because the cover material (i.e., concrete, asphalt) will shield some of the gamma exposure. Calculate by doubling the counts per minute and then converting to μR/h. Base calculations for sampling decisions or inclusion/exclusion recommendations on the doubled gamma exposure rate.

b. If tailings are not visible beneath the slab or the area of contamination is inaccessible, the gamma exposure rate remains as measured. If the net estimated area weighted average gamma exposure rate exceeds background plus 20%, take a concrete sample and/or a sub-slab soil sample, if possible. If samples are inaccessible, the team leader refers the property to the extended measurements coordinator for coring.

8.4.6 Calculate the net estimated area-weighted average (NEAWA) gamma exposure rates for all regions of contamination:

a. Convert all gamma readings from kcpm to μR/h by using the appropriate conversion formula ($y = mx + b$) or PIC measurements. Appendix 6 contains the known conversion formulas for UMTRA sites and Monticello.

b. Subtract the average background gamma exposure rate from the average gamma exposure rate of the contaminated region. The result is the net gamma exposure rate.

c. Calculate the area of contamination in m^2 by multiplying the area in ft^2 by 0.0929. If the area exceeds 100 m^2, round to 100 m^2.

d. Multiply the net gamma exposure rate by the area in m^2 and divide by 100 m^2. The result is the NEAWA gamma exposure rate.

8.4.7 If any 100 m^2 outdoor area averages more than 25 μR/h above background or if any room or 9.3 m^2 indoor area of a building averages more than 20 μR/h above background, the team leader makes a recommendation for inclusion and ends the survey.

a. Under these circumstances, it is not necessary to perform a gamma scan of the entire property. However, perform a perimeter scan to ensure there is no spillover contamination.

8.4.8 For UMTRA properties, extended measurements are required if gamma exposure rates exceed 20% above background averaged over 100 m^2 outdoors or 9.3 m^2 indoors or if the team leader is not satisfied with the adequacy of the data to make a recommendation.

a. Take soil samples from outdoor deposits.

b. The team leader refers the file for radon daughter concentration sampling if an indoor region has a NEAWA gamma exposure rate exceeding 20% of background. See Procedure TE-032.

8.4.9 Normally, floor plans of the structures are not included in property sketches. However, when an indoor region of contamination is detected, add floor plans of the affected structures to the field map at the time of the site survey.

8.4.10 If the outlying boundaries of the deposit are difficult to define, measure posthole and subsurface gamma rates to identify the extent of the contamination. The team leader determines the spacing and depth of the postholes. Reclaim postholes in the same manner as soil sample locations. Indicate the locations of the postholes on the field map.

8.4.11 Contaminated Mortar and Brick

a. Area Determination

To determine the area of contamination in a standard brick wall or fireplace, first determine which is elevated, the mortar or the brick. Slide the scintillometer probe slowly parallel to the surface of the area. The meter will show a slight increase when placed directly against the contaminated area. Calculate the total surface area of the wall or fireplace (length times height), and multiply the product by 0.33 if the mortar is contaminated or by 0.77 if the brick is contaminated. As mortar volume varies from brick to brick, a conservative estimate is incorporated into the multiplication factor for standard brick walls. For material other than brick (e.g., cobble on cinder block walls), modify the multiplication factor if necessary.

b. Calculate the NEAWA gamma exposure rate as described above.

c. Gamma Spectrometer Data

Use the portable gamma spectrometer to determine if the elevated brick or mortar is contaminated with man-made or naturally occurring radioactive materials (see Procedure TE-023, GR-410 Portable Gamma Spectrometer Operation). A radium/thorium ratio greater than 2.5:1 (applies only to Mesa County, Colorado) indicates excess radium from uranium mill tailings. Conversely, a radium/thorium ratio less than 2.5:1 indicates that elevated gamma exposure rates are a result of the

natural radiation within the building material. Therefore, extended measurements are not required.

d. Sampling

If the team leader requires further data, take a brick and/or mortar sample from a discrete location with the property owner's permission and analyze for a conclusive determination of brick or mortar contamination.

8.4.12 Trailer House Rule

When several small deposits can be included in a 14 by 70 ft rectangle (the size of a trailer house), the deposits may be combined as one region of contamination for calculation and sampling purposes. The rectangle cannot overlap a structure.

8.4.13 For Monticello properties, defining the deposit includes asking the owner for information regarding the source of contamination.

8.5 POINT SOURCES

8.5.1 For UMTRA, regions exhibiting elevated gamma rate ranges that are generally <1.0 m^2 in area and/or contain radioactive material that is not mill-related (i.e., ore, petrified wood and dinosaur bones) or is of undetermined type, are deemed point sources.

8.5.2 For MVP, point sources are defined the same as for UMTRA except that a point source is considered mill-related unless proven otherwise.

a. Contamination includes tailings, ore, radioactive mill equipment pieces, etc.

b. A property in Monticello can, therefore, be included on a point source using the hot spot limits described in Procedure TE-030.

c. Sample ore point sources but not petrified wood, bone, or other obvious collector's pieces.

8.5.3 A point source is represented on the field map with an asterisk (*) and its associated gamma rate.

8.5.4 A point source is never considered to be the site HOG and should not be recorded as such.

8.5.5 Make a reasonable effort to uncover the point source to document its type and exposure rate.

8.5.6 For MVP, remove point sources after obtaining permission from the site owner. UMTRA point sources do not need to be removed.

8.5.7 The following limits for handling point sources apply to uranium ore, mill tailings, slag, etc., only; they do not apply to other radionuclide sources or radium salts. For other types of radioactive contamination, another dose limit must be calculated. Calculations and assumptions for the handling guidelines below are described in Appendix 7.

a. Point sources <800 kcpm or <1400 μR/h may be removed in the following way:

1. note the exposure rate on the appropriate field data sheet;

2. indicate on the field map the location of removal and the exposure rate;

3. double-bag the point source(s) and label as sample excess with site number, address, and date;

4. for point sources within Mesa County, take the point source to the soils laboratory;

5. for point sources outside Mesa County, contact appropriate waste disposal authorities if the point source is not needed for analysis;

6. for MVP, take the point source to the repository if not needed for analysis.

8.5.8 Remove point sources >800 kcpm or >1400 μR/h in the following way:

a. these point sources are <u>outside</u> gamma scintillation range and should be dealt with carefully;

1. pregnant women and small children should not be allowed in the region of the point source;

b. note the general location of the point source and notify the team leader;

c. if the property owner requests that the point source be removed, the team leader uses a GM tube (from the electronics technician) to continue the investigation until the source is located;

d. note the location and exposure rate on the field map and appropriate field sheets;

e. if the source measures <50 mR/h, handle it double-bagged;

f. if the team is working in Mesa County and the surrounding area, take the source directly to the compound for evaluation and appropriate storage;

g. if the team is working outside the Mesa County area, contact appropriate waste disposal authorities regarding disposal;

h. for MVP, take the point source to the repository;

i. if the source measures >50 mR/h, it should not be handled; consult the project manager before taking further action.

8.6 SOIL SAMPLE COLLECTION

8.6.1 After the gamma scan is completed, the team leader specifies the sampling locations and notes these on the field map.

8.6.2 Soil sampling equipment consists of simple implements such as gardening trowels, posthole digger, or any implement that can be used for this purpose. See Exhibit 3, Sampling Equipment.

8.6.3 Take one sample and one subsurface sample (if necessary) at the HOG.

NOTE: For an MVP property with no elevated readings, take one sample at the highest background reading.

a. Take a gamma scintillometer measurement on the surface and record on the field data sheets prior to sampling.

b. Remove 15 cm (6 in.) of soil with a posthole digger, place on a plastic sheet and blend with a trowel or other tool.

c. Fill an aluminum sample can with sample representative of the entire interval, and cover with a plastic lid.

d. Take a gamma scintillometer measurement at each subsequent 15-cm (6-in.) depth.

e. If the gamma scintillometer measurement increases by more than 20%, continue sampling at subsequent 15-cm (6-in.) depths until measurement stabilizes or decreases.

f. Before the sample hole is reclaimed, insert the probe in the hole and note the thickness and depth of contaminated layer(s) on field data sheets. See Exhibit 1, Probe Measurement in Sample Holes.

8.6.4 Write the address, sample identification number, date, sampler's initials, and sample depth on the lid.

a. Assign each sample a unique alphanumeric identification:

ab01234-S1 (sample 1, surface only)
ab01234-S2 (sample 2, same property, surface only)

or

ab01234-S1A (0-15 cm)
ab01234-S1B (15-30 cm)
ab01234-S1C, etc. (30-45 cm)
ab01234-S1Z (indicates concrete sample)
ab01234-S1U (indicates sample taken under a slab)

where:

ab - area location code
01234 - location number
S1 (or S2) - sample number
A - sample depth, 0-15 cm
B - sample depth, 15-30 cm
C - sample depth, etc.

8.6.5 Place each sample in a small sample bag.

a. Put all sample bags for one survey site in a larger plastic bag (turkey bag).

8.6.6 Record the appropriate data on the Soil Sample Data Field Form (Appendix 3).

8.6.7 Take a second sample at the next highest gamma exposure rate location (at least 1.5 m away), again recording scintillometer measurements.

a. For MVP, sample a deposit that is <1.5 m^2 only once.

8.6.8 Take additional samples the team leader deems necessary for complete deposit definition.

8.6.9 If tailings are suspected to be within concrete, take a sample of the concrete as discreetly as possible.

a. Samples collected from under sidewalks, concrete slabs, and other impermeable surfaces should follow the same guidelines as for other samples, although sampling exactly at the HOG is often impossible.

b. Sample as close to the HOG as possible.

c. Note the thickness of the slab and the depth interval of the sample on the Soil Sample Data Field Form (Appendix 3).

d. If the team leader deems necessary, refer the property to the extended measurements team for concrete coring.

e. Site owner permission should precede concrete slab sampling.

8.6.10 In areas of suspected windblown contamination, the team leader specifies at least two samples to represent each 100 m^2 area.

a. See Exhibit 2, Methods of Locating Windblown Samples, for guidelines to locating windblown sample locations.

b. Always consider driplines and areas next to structures obstructing the wind direction for sampling.

c. Separate the surface sample into a 0- to 2.5-cm sample and a 2.5 to 15-cm sample to confirm the presence of windblown contamination.

8.6.11 Once samples have been collected, restore the area to as close to its original state as possible.

a. If a grass lawn is present, remove a top grass "plug" before taking samples and save for replacement.

b. Fill dirt may be required to replace soil collected as sample material.

8.7 MEASUREMENTS IN UNCONTAMINATED AREAS

8.7.1 Once the entire survey site has been gamma scanned, record the background exposure rates on the field data sheets and indicate the locations on the field map.

a. If the entire property exhibits elevated count rates, obtain a representative value from a previously surveyed and uncontaminated property in the area.

8.7.2 For those sites with no established conversion tables, obtain a direct conversion factor with a PIC. (See Procedure TE-022, Pressurized Ionization Chamber Operation.)

a. The team leader selects the PIC location as distant from any elevated gamma readings as is conveniently possible.

8.8 DATA RECORDING

8.8.1 Record all data collected at an inclusion survey site on the three field data sheets and the field map.

a. Complete all appropriate entries before the team leaves the site.

b. Record the site location number and the survey date in the space provided at the top of all three field data sheets.

8.8.2 Field Map, see Exhibit 5.

a. Illustrate the locations of tailings deposits and point sources, indicate gamma radiation measurements at appropriate locations, and provide any other pertinent information on the field map.

b. Note background ranges indoors and outdoors and sample locations.

c. All regions must have an identifier, rate range, and average noted on the map.

d. Clearly indicate on the field map which portions of the property were surveyed.

8.8.3 Survey Site Information, see Appendix 1.

a. Owner data

Normally, the scheduler completes this section after making an appointment for the site survey. Complete the required information from the consent form and/or from the site owner contact.

1. Monticello zip code is 84535.

2. Monticello telephone area code and prefix are (801) 587-.

b. Land use

Complete this section during the inclusion survey. Describe each structure located on the survey site to aid in report writing. Entries in this section are self-explanatory.

c. Photographs

Complete this section after survey site photograph(s) have been taken. Do not complete the film roll and frame numbers for Polaroid camera pictures.

d. Spillover

If any deposit continues onto an adjacent property(ies), note it as "spillover" in this section. Record the address of the adjacent property in the space provided.

8.8.4 Radiological Screening Summary, see Appendix 2.

a. Enter survey team initials in the appropriate spaces.

b. The remaining entries on page two are self-explanatory.

8.8.5 Soil Sample Data Field Form, see Appendix 3.

a. Describe each sample location adequately. When possible, use measurements from easily relocatable points.

b. "Area Rep:" refers to total measured surface area that the collected sample represents. The remaining categories on this page are self-explanatory.

c. Normally, the "gamma, μR/h" blanks are filled in as part of the team leader prereport activities. The "Ra^{226}, pCi/g" blanks are completed by the soils lab technician once the respective sample has been analyzed.

8.8.6 Chain of Sample Custody/Soil Sample Analysis Form, see Appendix 4.

a. This form should be completed at the time of sample collection. See Procedure TE-034.

8.8.7 A site photograph is taken before the team leaves the survey site.

a. Photograph general outdoor views of the property from a vantage point that provides a reasonable understanding of the property including relative size, structures, and terrain.

1. Take two photographs for UMTRA properties.

2. Take only one photograph for MVP.

b. A front view of the property is most commonly taken.

c. Subsequent photographs (i.e., indoor photographs) are not needed unless property is exceptionally large or is in some way peculiar.

d. After the photograph(s) is developed, label it with the location number and date surveyed and place in the vicinity property file.

8.8.8 Each team member indicates the portions of the property he or she surveyed on a copy of the property map called the "who-done-it" map.

a. Complete this map in black ink and indicate with initials or graphic symbols the portions of the property each individual scanned.

8.9 INSPECTION AND DECONTAMINATION OF EQUIPMENT AND PERSONNEL

8.9.1 Inspect sample collection equipment for visible contamination after collecting each sample.

a. Remove visible contamination using a brush, paper towels, and/or water before returning the equipment to the survey vehicle. See Exhibit 4.

8.9.2 Inspect gamma detection equipment for visible contamination after surveying each property. Decontaminate if necessary.

8.9.3 Following the completion of each inclusion survey, personnel will inspect themselves for visible contamination.

a. Remove visible contamination using a brush, paper towels, and/or water.

b. When field conditions are muddy, use shoe or boot coverings.

c. Following an inclusion survey during muddy conditions, wash shoes, boots, and/or coverings free of visible contamination using water, paper towels, or a brush, as appropriate.

d. Following sample handling or field work, wash hands before smoking, eating, or drinking.

8.9.4 After the team inspects and decontaminates all equipment and themselves at the end of each inclusion survey, the team leader marks the appropriate space on the Radiological Screening Summary form.

Appendix 1. Survey Site Information

OAK RIDGE NATIONAL LABORATORY SITE#_____

SURVEY SITE INFORMATION SURVEY DATE_____

OWNER DATA:

NAME:_____ LOCATION:_____
ADDRESS:_____ _____
_____ TENANT:_____
PHONE:_____ PHONE:_____

LAND USE

RESIDENTIAL___: SINGLE FAMILY___ COMMERCIAL___ RETAIL STORE___
MULTI-FAMILY ___ OFFICE ___
MANUFACTURE ___
MOTEL, HOTEL ___

PUBLIC BLDG.___: SCHOOL___
CHURCH___ VACANT LOT___
OPEN LAND ___

OTHER_____ DESCRIPTION_____
_____ _____

NUMBER OF STRUCTURES:_____

TYPE OF CONSTRUCTION: (# of levels, frame/masonry, basement /crawl/space/slab-on-grade, etc.)

Bldg. #1: _____
Bldg. #2: _____
Bldg. #3: _____
Bldg. #4: _____

PHOTOGRAPH(S): FILM ROLL #_____

	(compass direction)	(description)
FRAME #_____	LOOKING:_____	AT_____
_____	LOOKING:_____	AT_____
_____	LOOKING:_____	AT_____
_____	LOOKING:_____	AT_____

SPILLOVER:___ NO ___ YES

ADJACENT PROPERTIES:_____
_____

Appendix 2. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h
_____
_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION PIC(uR/h) ---- (cpm x 1000)
LOCATION PIC(uR/h) GAMMA-RATE METER - 6" CONVERSION(cpm/uR/h)

_____ _____ _____ _____
_____ _____ _____ _____
_____ _____ _____ _____

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE: INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2

NoH-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location_____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Appendix 3. Soil Sample Data Field Form

OAK RIDGE NATIONAL LABORATORY SITE #_____

SOIL SAMPLE DATA FIELD FORM SURVEY DATE_____

	VISIBLE TAILING	SAMPLE NUMBER	DEPTH (M)	GAMMA kcpm	GAMMA μR/h	^{226}Ra pCi/g
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____

UCN17198 (9/90)

Appendix 4. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

_____

_____

1. Project No. 6R0004-180 2. Project Name Monticello Vicinity Properties ISC & IVC

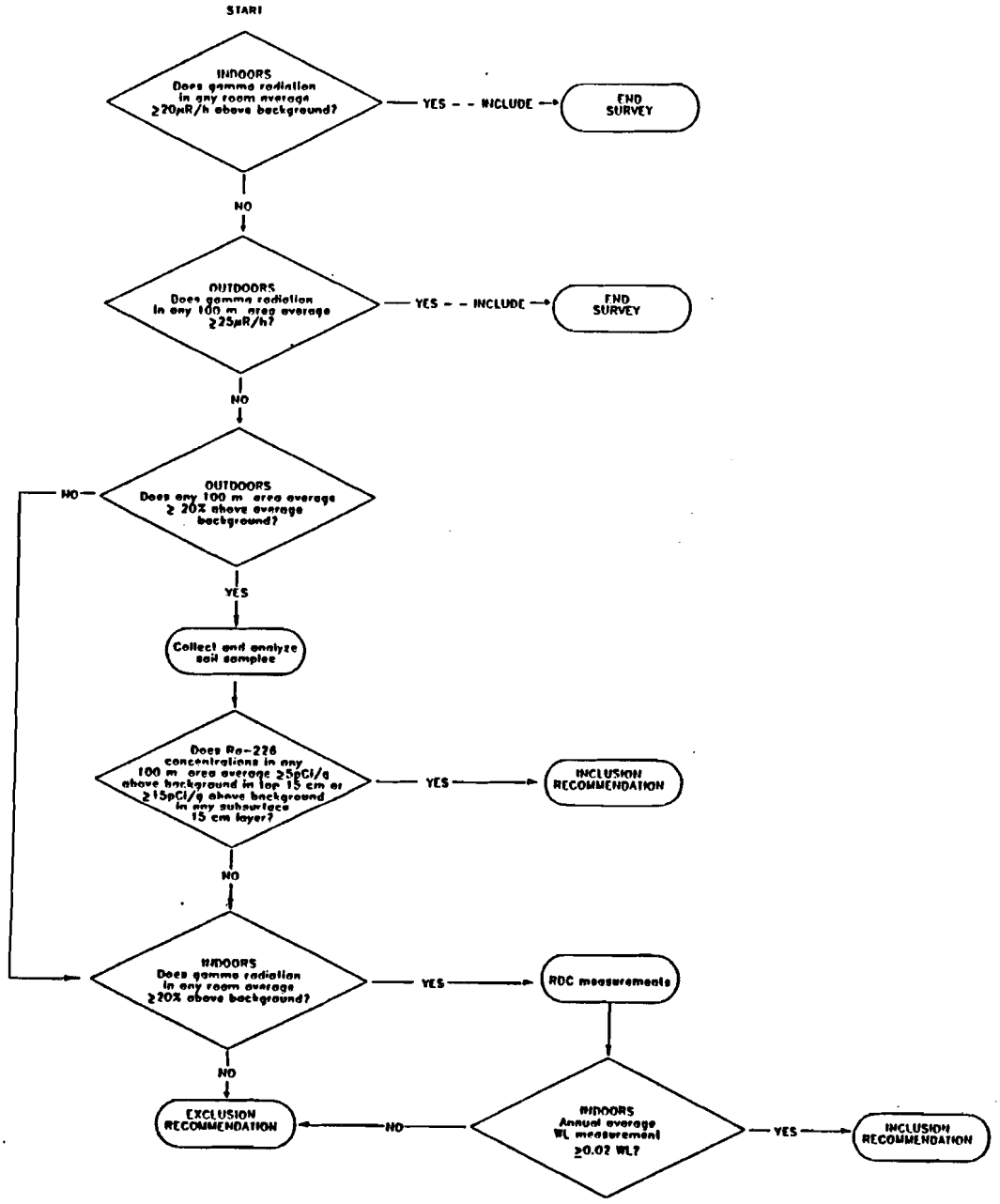
LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pCi/g)	SBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345A (1/91)

Appendix 5. Guidelines to the Extent of Inclusion Surveys



Appendix 6. Conversion Formulas

Grand Junction: $y = 1.69x + 3.45$

Durango: $y = 1.55x + 5.28$

Lowman: $y = 1.98x + 5.92$

Green River: $y = 1.60x + 7.34$

Gunnison: $y = 1.47x + 10.33$

Naturita, Nucla, Slickrock, and Vancorum: $y = 1.80x + 5.64$

Rifle: $y = 1.56x + 6.89$

Monticello: $y = 1.46x + 7.2$

y = gamma exposure rate in μR/h

x = gamma exposure rate detected by gamma scintillation detector in kcpm

Appendix 7. Point Source Handling Guideline Calculations

DOE Order 5480.11 (Reference 3.1.12) allows the following dose limits for radiation workers:

1. 5 rem (annual effective dose equivalent) for stochastic effects (equivalent to whole body irradiated uniformly);

2. 50 rem (annual dose equivalent) for non-stochastic effects to the extremities.

The dose limit which would be reached first (hand or whole body) and thus be limiting for the occupational worker was determined using the Microshield computer code.

Case 1: the ore was located in the workers hand.
The exposure rate in air at a point 0.1 cm from the source was determined to be 3.436×10^5 mR/hr.

Case 2: the dose was received from the ore located 30 cm away (whole body).
The exposure rate in air at a point 30 cm from the source was determined to be 6.811×10^5 mR/hr.

Limiting Organ Calculation:

DOE Order 5480.11 allows an effective dose equivalent (EDE) of 5 rem/year and an extremity annual dose equivalent (ADE) of 50 rem. The ratio of the allowable 50 rem ADE extremity dose to the whole body EDE dose is a factor of 10. The ratio of Case 1 to Case 2 is:

$$\frac{\text{Case 1}}{\text{Case 2}} = \frac{3.436\text{E}05 \text{ mR/h}}{6.811\text{E}03 \text{ mR/h}} = 50$$

This ratio is 5 times (i.e., 50 divided by 10) that allowed by DOE Order 5480.11. This indicates that the extremity dose of 50 rem ADE will be achieved before the whole body reaches 5 rem EDE when handling uranium ore point sources. Therefore, the extremity dose of 50 rem ADE is limiting for hand held uranium ore.

Appendix 7. (continued)

Allowable Ore Exposure Rate:

The allowable exposure rate was determined by use of the extremity dose limit of 50 rem ADE since it was found to be the limiting dose.

The extremity dose was decreased by a factor of 10 to add conservatism to the calculation and to prevent the worker from reaching the maximum allowable exposure.

$$\frac{50 \text{ rem}}{10 \text{ hrs}} = 5 \text{ rem ADE}$$

The reduced extremity dose was then used to determine the allowable ore exposure rate:

$$\frac{5 \text{ rem}}{100 \text{ h}} = 50 \text{ mrem/h} = 50 \text{ mR/h}^{*} \text{ (i.e., measured on contact)}$$

* For gamma radiation - 1 R is approximately 1 rem in soft tissue

Assumptions in Calculation:

The following assumptions are inherent in the calculations:

1. Ore consists of ^{238}U and progeny in equilibrium.

2. Ore sample is assumed to have a radius of 6 cm and consist of SiO_2 with an effective density of 2.65 g/cm^3.

3. Only gamma radiation is considered.

4 Gamma contributions from branching decay progeny ^{234}Pa (0.13%), ^{218}At (0.02%), ^{210}Tl (0.02%) and ^{206}Tl (0.00013%) are ignored.

5. Contributions from ^{235}U and progeny are ignored due to the low natural percentage of ^{235}U in ore.

Appendix 7. (continued)

6. Emanation loss of ^{222}Rn is ignored.

7. The worker handles uranium ore an average of 100 h per year.

8. A conservative extremity dose is used

The inclusion of beta radiation dose to the hand can create considerable difficulty in calculations due to the energy distribution of beta particles and the large energy ranges encountered for the U-238 chain. While computer codes are available which will compute the beta dose, the database of these codes generally requires considerable additions to simulate the whole ^{238}U decay chain. Therefore, a representative set of radionuclides (^{90}Sr and ^{90}Y) was chosen to show the effect of a thin protective layer such as a glove in reducing the beta dose. ^{90}Sr has a 0.544 MeV maximum beta, while ^{90}Y has a 2.245 MeV maximum beta. Computer runs were made for skin thickness of 0.007 cm and 0.1 cm, respectively. The data indicated that a glove of approximately 0.1 cm thickness would decrease the beta dose to the hand by 80%.

Exhibit 1. Probe Measurement in Sample Holes

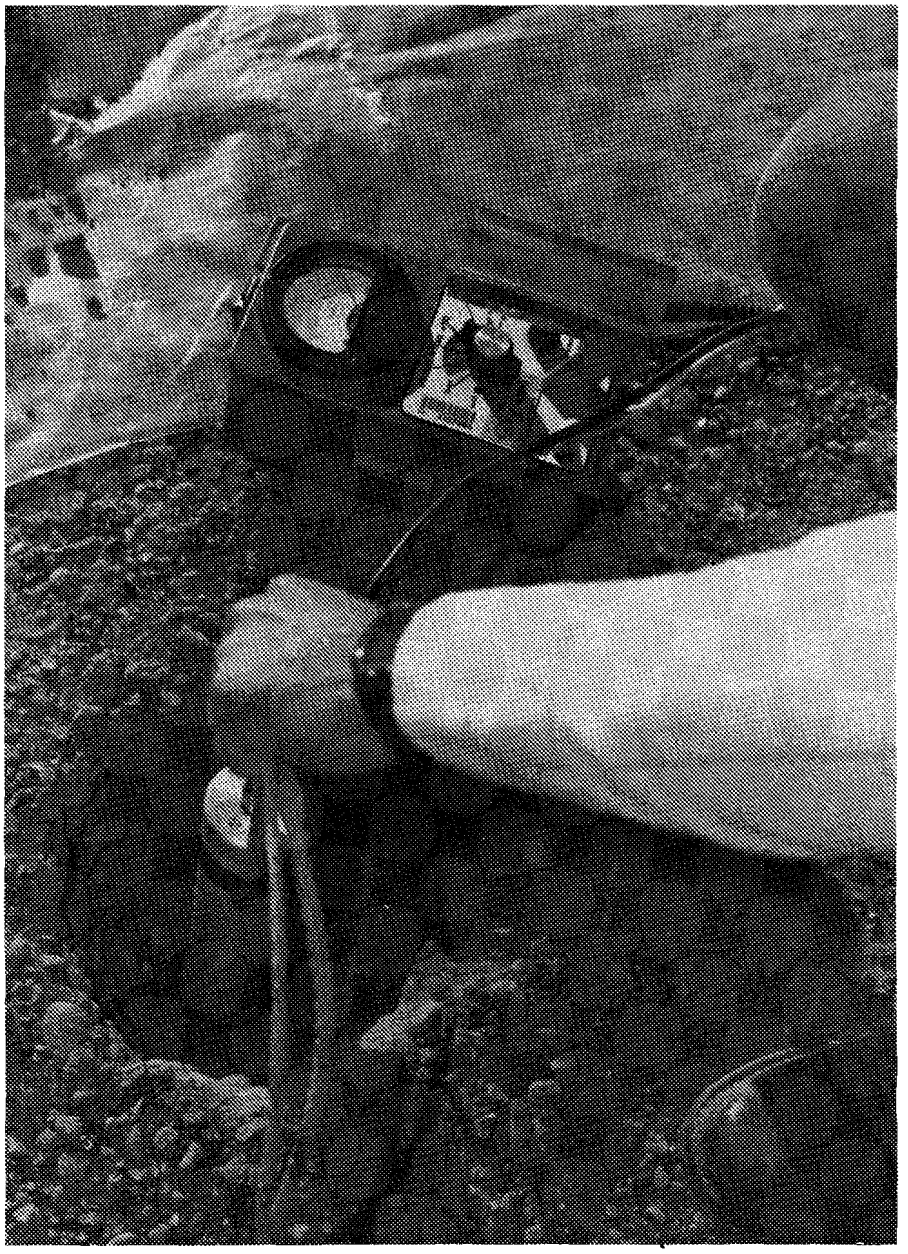


Exhibit 2. Methods of Locating Windblown Samples

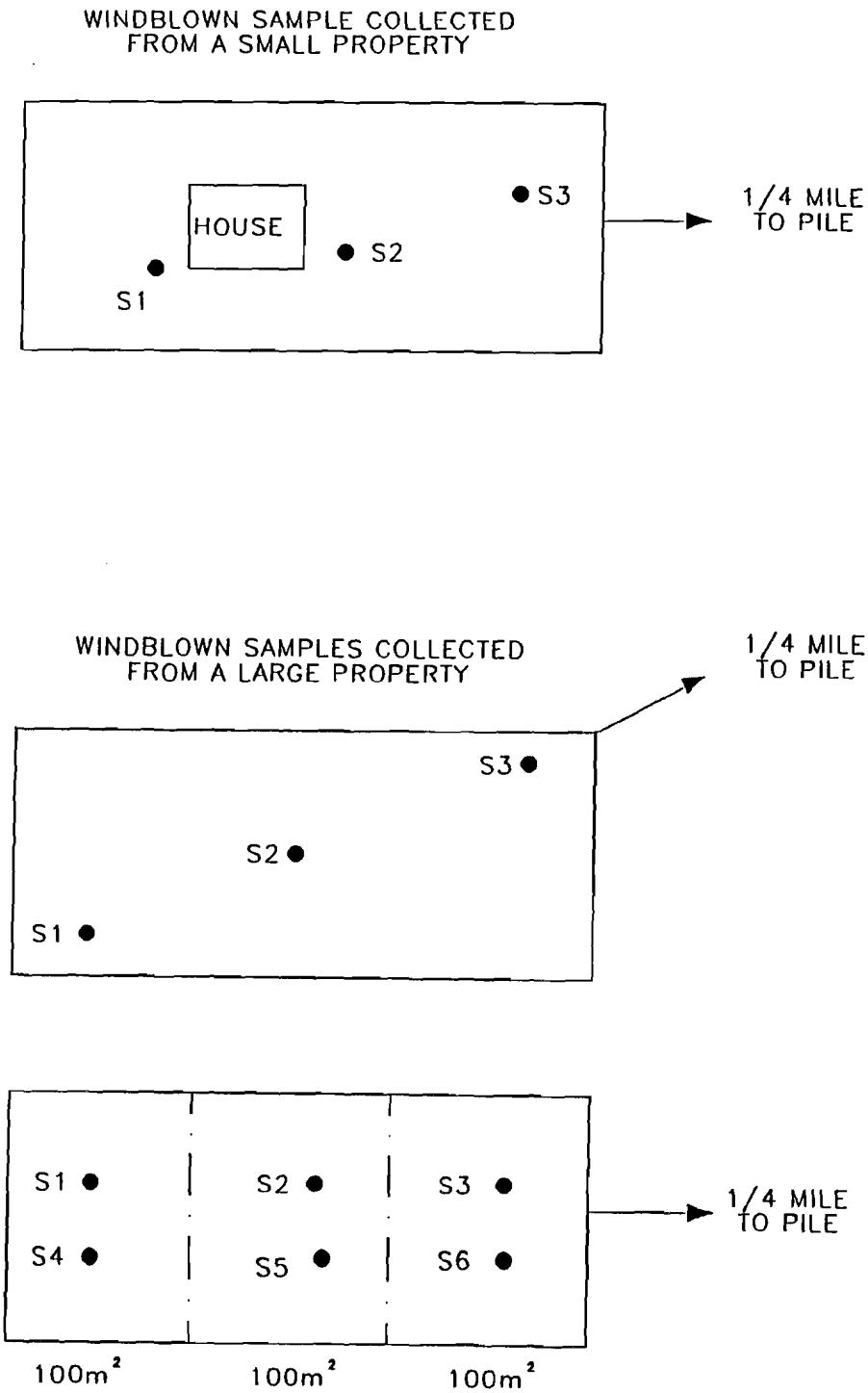


Exhibit 3. Sampling Equipment

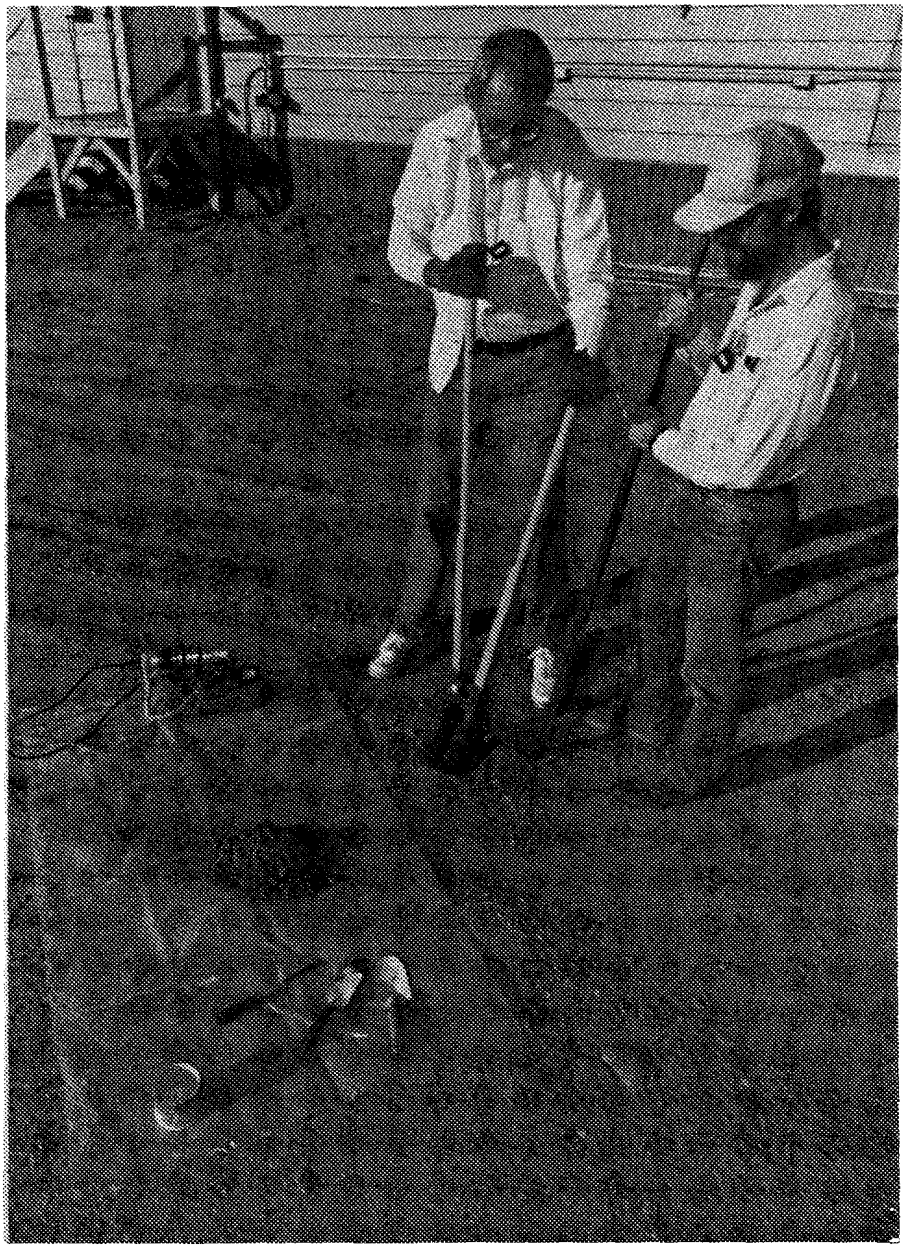


Exhibit 4. Decontamination of Sample Collection Equipment

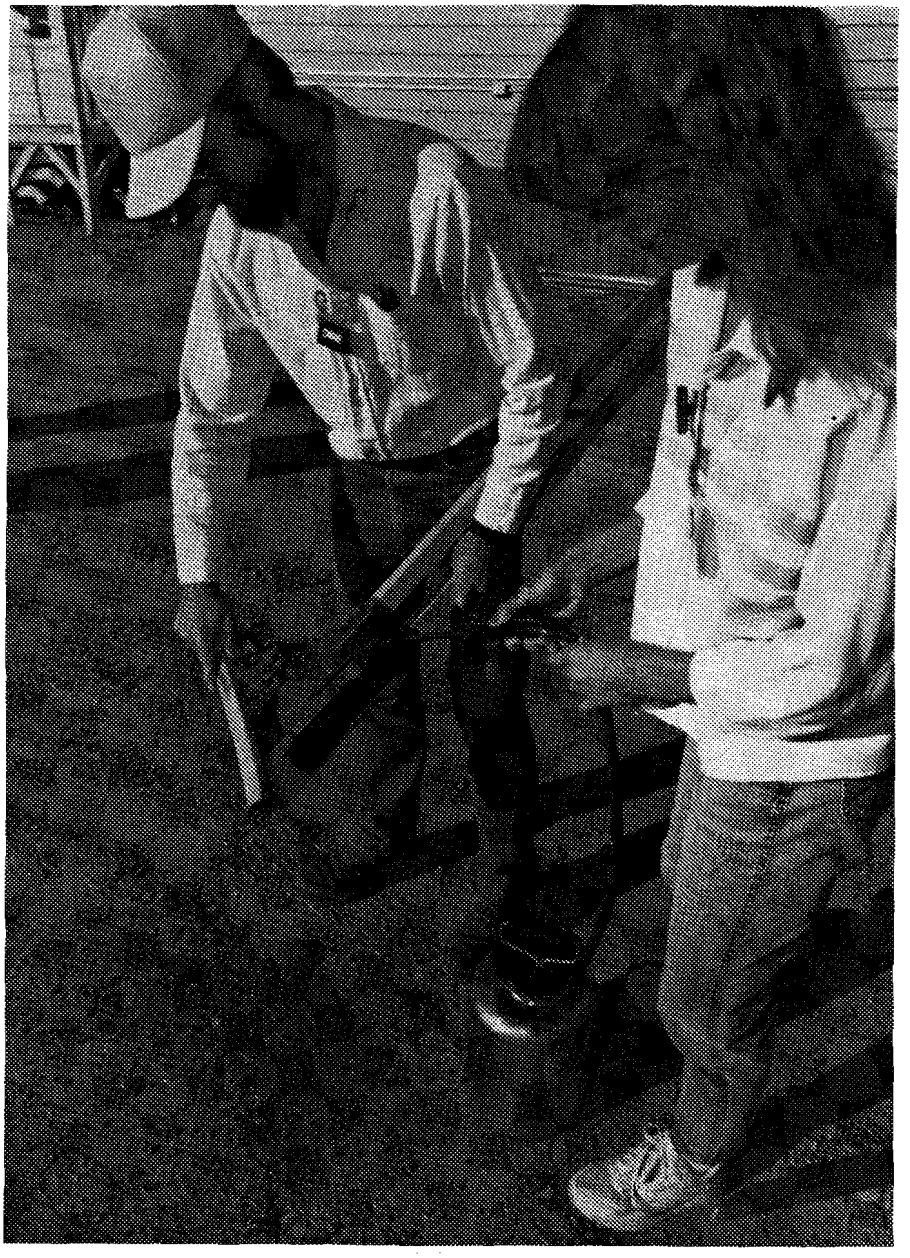


Exhibit 5. Example of Field Map

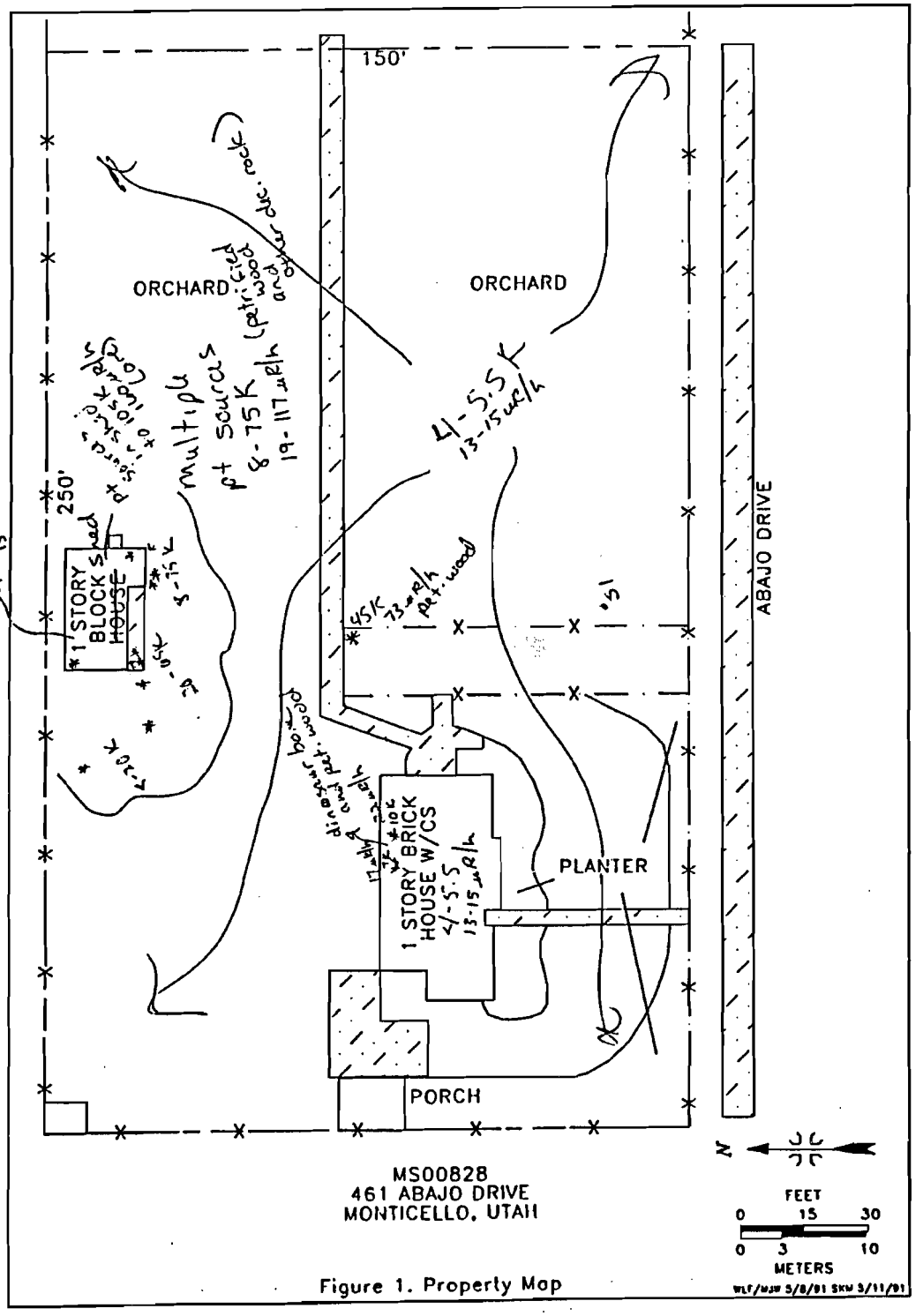


Figure 1. Property Map

GAMMA SCINTILLATION DETECTOR OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of gamma scintillation detectors. For more detailed information about the instrument, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to scintillation survey instruments used for detecting gamma radiation.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Instrumentation Manual for Model 490, THYAC III*, Victoreen, Inc., Cleveland, OH.

3.2 APPENDICES

3.2.1 Appendix 1: Radiological Screening Summary

3.3 EXHIBITS

3.3.1 Exhibit 1: Survey Method

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Victoreen portable ratemeter, Model 490, THYAC III, 0-800; 0-8,000; 0-80,000; 0-800,000 counts per minute (cpm); Victoreen Instrument Company

4.1.2 Battery: two (2) D-cell batteries, NEDA Type 13

4.1.3 Gamma scintillation probe, Model 489-55 [1.25 in. by 1.50 in.

Approved by:

Wayne K. Hilford 3/19/91 (Date)

Craig Little 3/20/91
C.A. Little (Date)

sodium iodide (thallium activated) scintillation crystal], Victoreen Instrument Company, to match corresponding ratemeter

4.1.4 Headphone set that attaches to ratemeter

4.1.5 A 6-ft nylon cord (or equivalent) attached to the top of the scintillation probe for use in handling the probe while surveying

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader ensures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 FREQUENCY

Perform the field check prior to the first field survey of each day.

7.0 PROCEDURE

7.1 EQUIPMENT SET UP

7.1.1 Remove the ratemeter and corresponding probe from storage in the survey vehicle and visually check for physical damage. If physically damaged, do not use; report damage to the instrument technician.

7.1.2 Attach the headphone set to the phone connector on the ratemeter. The headphone provides an audio indication of gamma radiation intensity.

7.1.3 Initially set the range at the highest level (x 1000). If the meter reading is less than 10% of full scale, switch to the next lower level (x 100). Repeat this procedure until the reading is over 10% of full scale.

7.1.4 The Model 490 Ratemeter has three response times designated slow, medium, or fast, which correspond to approximately 15 s, 5 s, and 1.5 s, respectively. The medium response is used for the majority of the readings.

7.2 FIELD CHECK

7.2.1 Check the battery condition by setting the Range switch to the "BAT" position and observing the THYAC III meter. The indicator should be in the "Battery Check" region or battery replacement is mandatory. (See the instruction manual for Model 490, THYAC III).

7.2.2 Enter in the field van logbook the instrument number, battery check, date, location at which the field check is made, and initials of person making the check.

7.2.3 Set the Response switch to the "MEDIUM" position and the Range switch to the appropriate position (the maximum upscale deflection without going off scale).

7.2.4 Determine the background level and record the background cpm in the field van logbook. This is usually done at a reference site for the area to be surveyed.

7.2.5 Place the probe in contact with the depleted uranium check source and read the gross cpm. Record the gross cpm in the field van logbook.

7.2.6 Calculate the net cpm by subtracting the background cpm from the gross cpm. Record the net cpm in the logbook. The net cpm reading must be within laboratory accepted limits (approximately ±20% of the reading taken during the previous field check).

7.2.7 If the net cpm is within the acceptable range, the instrument is now ready for use. If the net cpm is out of the acceptable range, change batteries and repeat steps 7.2.5 through 7.2.6. If the reading is still out of the acceptable range, return the instrument to the PAG electronics technician for repair and recalibration.

7.3 DISCRETE MEASUREMENTS (GAMMA SCINTILLOMETER)

7.3.1 Place the scintillometer probe against or at a specified distance from the surface to be surveyed.

7.3.2 Observe the count rate as displayed on the rate meter. Note the average value in cpm and record it on the radiological screening summary page of the field data sheets (Appendix 1).

7.3.3 When the survey is complete, turn the instrument off.

7.4 FIELD SCAN SURVEY PROCEDURES

7.4.1 Traverse the property to be surveyed by following parallel, adjacent but slightly overlapping, 3- to 4-ft wide paths. While traversing the property, the surveyor should move the detector from side to side (covering a 3- to 4-ft wide area) while holding it as close to the ground as possible (less than 6 in.); see Exhibit 1, Survey Method. The presence of rocks and other objects may not permit holding the detector at a constant height.

7.4.2 Use the detector's audio response to identify areas of anomalous radiation levels. Periodically observe the meter response to obtain an estimate of the average levels measured.

7.4.3 Note average background levels and their locations and readings at all locations with elevated radioactivity. Enter the observed detector response (cpm) on the radiological screening summary and on the field map for the appropriate surveyed site.

7.4.4 When the entire survey site has been scanned, turn the instrument off.

7.5 EQUIPMENT USE DURING INCLEMENT CONDITIONS

During inclement weather, cover each probe and ratemeter with a plastic sample bag and secure at the open end with tape; use the instrument as indicated in Sect. 7.4. Remove the bags prior to prolonged storage to prevent damage from condensation.

Appendix 1. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h
_____
_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000) GAMMA-RATE METER - 6"	CONVERSION(cpm/uR/h)
LOCATION	PIC(uR/h)		

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE:

INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

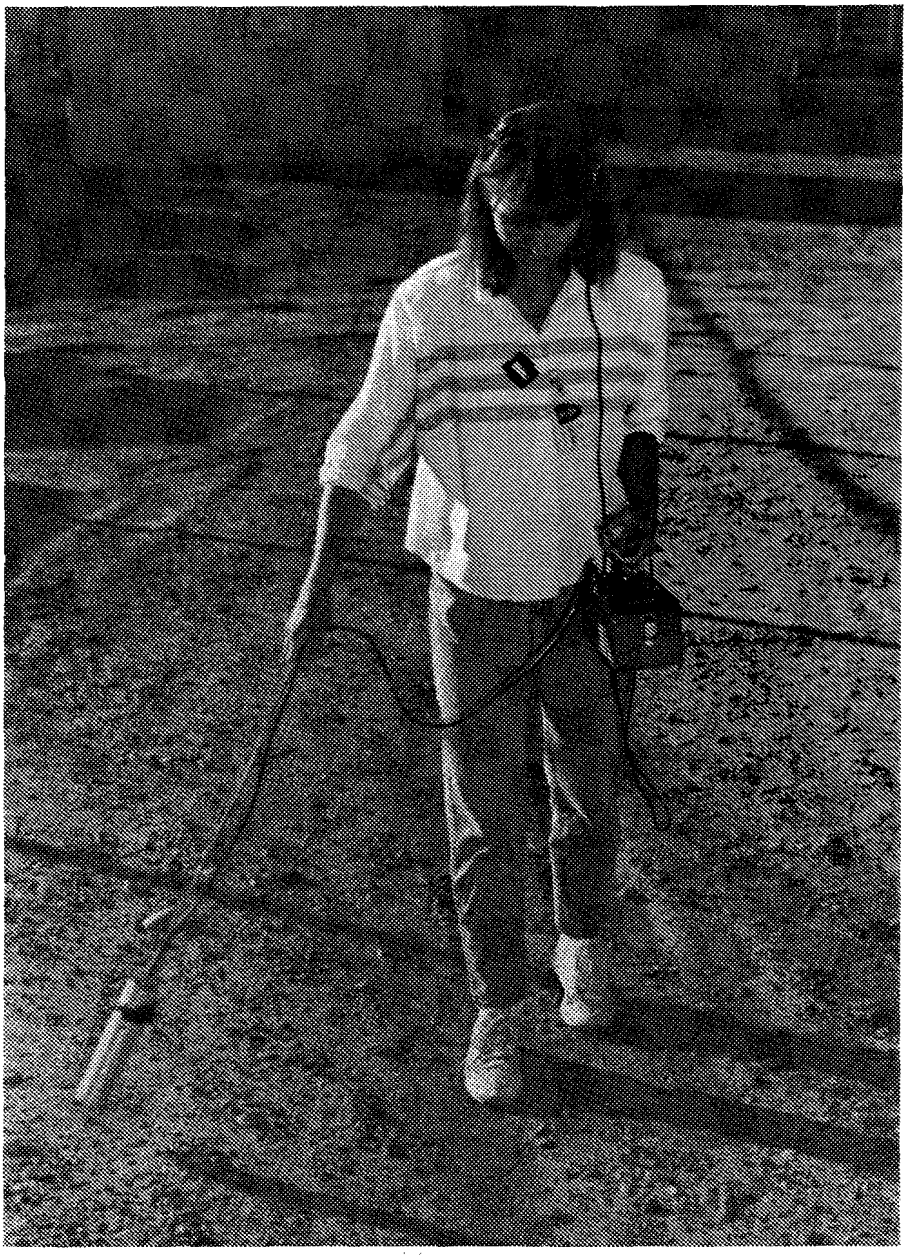
Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location_____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Exhibit 1. Survey Method



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-022 Page: 1 of 7 Revision: 0 Date: 03/25/91

PRESSURIZED IONIZATION CHAMBER (PIC) OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of the pressurized ionization chamber (PIC). For more detailed information about the instrument, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to the operation of the PIC, which is used to convert the gamma exposure rate reading measured by the gamma scintillation detector expressed in kcpm to gamma exposure rate expressed in μR/h.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Operational Manual RS-111 Area Monitor System*, Second Printing, Reuter Stokes Inc., Cleveland, OH.
3.1.2 SU-021, Calibration of Pressurized Ionization Chamber.

3.2 APPENDICES

3.2.1 Appendix 1: Radiological Screening Summary
3.2.2 Appendix 2: Correlation between PIC Readings and Gamma Scintillation Detector Measurements

3.3 EXHIBITS

3.3.1 Exhibit 1: Pressurized Ionization Chamber (PIC)

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

Reuter Stokes Portable Environmental Radiation Monitor Model RSS-111. This system includes the following:

Approved by:

Jas K. Halford 3/19/91 (Date)

C.A. Little 3/20/91 (Date)

4.1.1 Monitor
4.1.2 Digital display
4.1.3 Auto-disconnect battery pack with batteries
4.1.4 Integrating digital readout apparatus with timer (see Exhibit 1)

4.2 MATERIALS

4.2.1 Radiological screening summary (Appendix 1)

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader ensures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician. The team leader is responsible for selection of PIC data collection locations and recording the data correctly.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use. Team members are responsible for taking PIC readings and assisting the team leader in documentation of field data.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 DEFINITIONS

6.1 PIC: pressurized ionization chamber.

7.0 PROCEDURE

7.1 CHECKOUT PROCEDURE

7.1.1 Place the sensor head directly on the surface to be measured with handle facing upward.

7.1.2 Make sure all switches are OFF.

7.1.3 Connect all cables... 12VDC, V/F, ints. to the head.

7.1.4 Turn the ELECTROMETER switch to ZERO.

7.1.5 Turn the MODE switch to BATT.

7.1.6 Turn the DISPLAY/RECORDER switch to ON.

7.1.7 Simultaneously depress the μR/h switch and the 300 V switch.

a. Display will give the % of full charge for the 300 V battery.

b. This battery should be replaced when the charge degrades to 85% or less.

c. -14V, +14V, and +12 V checks must be in white or recharge.

7.2 OPERATING PROCEDURE

7.2.1 The DISPLAY/RECORDER switch may be turned off unless the LED readout on the instrument is needed.

7.2.2 Turn the ELECTROMETER switch to READ when it has been on ZERO for about 60 s to allow the transients to die.

7.2.3 Take several 9-s readings until stabilized.

7.2.4 Use the 180-s setting for readings.

7.2.5 When through, turn OFF all switches before disconnecting the cables.

7.2.6 Field check: See SU-021, Calibration of Pressurized Ionization Chambers.

7.3 FIELD PROCEDURE

7.3.1 After the entire survey site has been scanned with the gamma scintillometer, place the PIC sensor head on an average background region as assigned by the survey site team leader. The head faces are numbered 1-4. Always place face #1 in the general direction of north.

7.3.2 Read and record the PIC measurement.

7.3.3 Remove the sensor head and place the scintillometer probe 15 cm above the surface of the assigned sensor head location; read and record the scintillometer measurement.

7.3.4 Repeat as indicated by the team leader on the HOG, HIG, and any other desired anomalies and/or background activity locations.

7.3.5 When all desired measurements have been taken, turn off the instrument.

7.4 EQUIPMENT USE DURING INCLEMENT CONDITIONS

7.4.1 Cover each sensor head and the monitor with large plastic storage bags.

7.4.2 Secure the bag at the open end with tape.

7.4.3 Use the instrument as indicated in Sect. 7.2

7.4.4 Remove the bags prior to prolonged storage.

7.5 DATA CONVERSION

Convert gamma scintillator data to μR/h using a conversion factor as determined in Appendix 2, Correlation between PIC Readings and Gamma Scintillation Detector Measurements.

Appendix 1. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h
_____
_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION PIC(uR/h) --- (cpm x 1000)
LOCATION PIC(uR/h) GAMMA-RATE METER - 6" CONVERSION(cpm/uR/h)

_____ _____ _____ _____
_____ _____ _____ _____
_____ _____ _____ _____

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE:

INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location_____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Appendix 2. Correlation between PIC Readings and Gamma Scintillation Detector Measurements

Readings are taken with both the gamma scintillation detector and the PIC to determine a conversion factor for each study area, until a conversion equation has been determined by linear regression.

Calculate a conversion factor (CF) as follows:

$$CF = G_1/P_1$$

where:

G_1 = gamma scintillation detector reading in kcpm at Location 1

P_1 = PIC reading in μR/h at Location 1

Calculate a separate conversion factor for representative and contaminated areas, and where there are grossly different gamma range readings for individual contaminated regions.

Correlation between the PIC and the scintillometer is assumed to be linear according to the equation:

$$Y = X/CF$$

where:

Y = μR/h
X = scintillometer data in kcpm
CF = conversion factor

Exhibit 1. Pressurized Ionization Chamber (PIC)

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-023 Page: 1 of 7 Revision: 0 Date: 02/03/92

GR-410 PORTABLE GAMMA SPECTROMETER OPERATION

1.0 PURPOSE

This procedure describes the operation of the GR-410 portable gamma spectrometer. For more detailed information, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to the operation of the GR-410 portable gamma spectrometer used for differentiating the source of gamma radiation.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Technical Manual for Portable Gamma Ray Spectrometer*, V3342, V. 1 and 2, Geometrics/Exploranium Corporation Canada, Ltd., 1977.

3.1.2 Procedure TE-020, Inclusion Survey Activities.

3.2 APPENDICES

3.2.1 Appendix 1: Extended Measurements Data Form

3.3 EXHIBITS

3.3.1 Exhibit 1: GR-410 Portable Gamma Spectrometer

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Model GR-410 Portable Gamma Ray Spectrometer, GeoMetrics, Inc.
4.1.2 Portable Detector GPX-21, GeoMetrics, Inc.
4.1.3 Interface cable
4.1.4 Field pack for carrying instrument

Approved by:

Jay K. Holford 2/3/92 (Date)

Craig A. Little 2/4/92
C.A. Little (Date)

4.2 MATERIALS

4.2.1 Twelve D-cell batteries

5.0 RESPONSIBILITY

5.1 The team leader is responsible for the following:

5.1.1 Ensures that instruments are available and are returned from the field each day,

5.1.2 Reports instrument nonconformance to the electronics technician,

5.1.3 Selects data collection locations, and

5.1.4 Ensures that the data is recorded correctly.

5.2 Team members are responsible for the following:

5.2.1 Preventing loss of or damage to instruments,

5.2.2 Cleaning and decontaminating instruments after field use,

5.2.3 Taking gamma spectrometer readings, and

5.2.4 Assisting the team leader in field data documentation.

5.3 The electronics technician is responsible for the following:

5.3.1 Keeping inventories of field instruments and

5.3.2 Repairing inoperable instruments or transferring them to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 PROCEDURE

6.1 Set up the instrument for operation.

6.1.1 Remove the outer casing of the instrument package.

6.1.2 Check that the three dials on the right side are at the following settings, left to right:

a. Th = 8.68
b. U = 5.82
c. K = 4.42

6.1.3 Reset any incorrect dials by rotating the cylinder through the hole on the top above the dial.

6.1.4 Check battery charge.

a. Turn the FUNCTION selector to BT where the meter needle should be within the green triangle designated BATT.

b. If the needle is to the left of the triangle, the batteries need to be replaced.

6.1.5 The messages in the message indicator window have the following meanings:

Message	Meaning
1*	Total counts are being displayed (all energies between 0.5 and 3.0 MeV)
2*	K counts are being displayed (window peak is 1.46 MeV)
3*	U (Ra) counts are being displayed
4*	Th counts are being displayed
A	Instrument is counting (accumulating)
C (flashing)	Unit requires gain calibration
L (flashing)	Battery charge too low; replace batteries

* Flashing indicates an overflow in channel; a shorter counting period is required.

NOTE: K window peak is 1.46 MeV.
U (Ra) window peak (^{214}Bi) is 1.76 MeV.
Th window peak (^{208}Tl) is 2.61 MeV.

6.2 Measure gamma radiation.

6.2.1 Turn the FUNCTION selector to GM.

a. Check that the meter needle is centered between the two green triangles marked -E and +E.

b. If not, unlock the GAIN selector by moving the black peg (next to the dial) up.

c. Rotate the dial until the needle is centered between the two triangles.

d. Lock the GAIN selector by moving the black peg back down.

6.2.2 Turn the FUNCTION selector to MIN (minutes).

6.2.3 Turn the SAMPLE PERIOD selector to the desired period.

a. Select a time period to give a minimum Th count of about 100, approximately 10 min in background areas.

b. Three 1-min interval readings give a good range of results to average when measuring a region of elevated gamma.

6.2.4 Press the READ button momentarily to turn the power on.

a. A flashing "C" appears in the message indicator for about 5 s as the system gain stabilizes.

b. If the "C" continues to flash, recalibrate the gain as described above.

6.2.5 Place the detector head against the material to be measured.

a. This should preferably be a flat surface.

6.2.6 After the flashing "C" has disappeared, press the READ button once more.

a. The message indicator displays an "A"; this indicates that the system is counting.

b. At the end of the counting period, the "A" disappears and an alarm sounds.

6.2.7 Press the READ button a third time.

a. The unit displays the accumulated counts for each of the four channels for 4 s in the following order: total counts, K, Ra, and Th.

b. A flashing number in the message indicator window during the display of the accumulated counts indicates that an overflow has occurred in that channel and a shorter counting period is required.

c. During the display of total counts, a red light flashes next to the message indicator, indicating that the displayed results should be multiplied by 10.

6.3 Record data.

6.3.1 Record gamma spectrometer data on the Extended Measurements Data Form. See Appendix 1.

6.3.2 Calculate and record the Ra:Th ratio using the average of the Ra and Th counts.

a. This ratio is used during inclusion survey activities to determine if the source of gamma radiation is mill tailings related. See Procedure TE-020.

6.3.3 A gamma spectral readout may accompany concrete and asphalt coring and radon monitoring.

Appendix 1. Extended Measurements Data Form

EXTENDED MEASUREMENTS DATA FORM

Date:

Location Number:	Exposure Rates Kcpm:						
Address:	uR/h:						
	Gamma Spec Data Time Intervals:						Ave
Source Code:	Total Cts:						
Source Def. & Sample Location:	K Cts:						
	Ra Cts:						
Sample Number:	Th Cts:						
Sample Depth Interval:	Ra/Th Ratio						

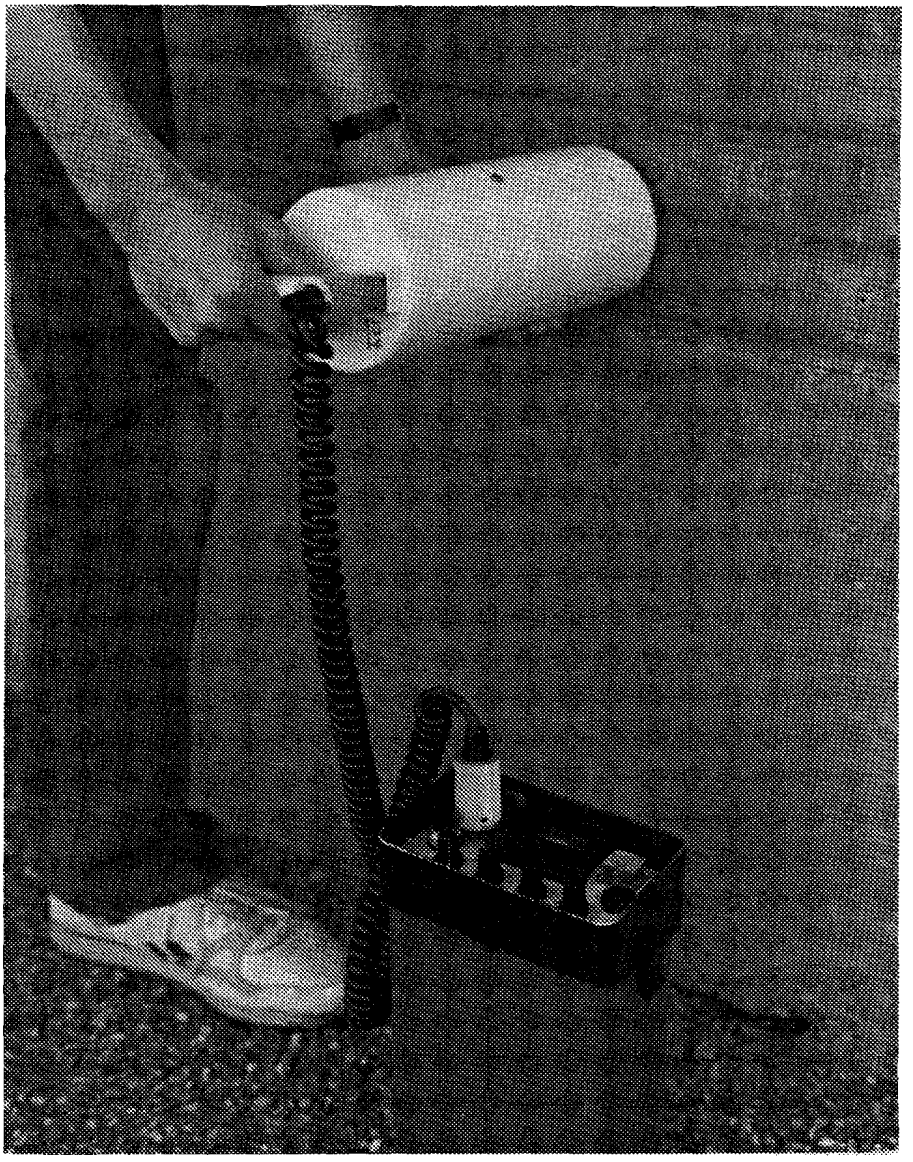
Remarks:

Date:

Location Number:	Exposure Rates Kcpm:						
Address:	uR/h:						
	Gamma Spec Data Time Intervals:						Ave
Source Code:	Total Cts:						
Source Def. & Sample Location:	K Cts:						
	Ra Cts:						
Sample Number:	Th Cts:						
Sample Depth Interval:	Ra/Th Ratio						

Remarks:

Exhibit 1. GR-410 Portable Gamma Spectrometer



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-024 Page: 1 of 5 Revision: 0 Date: 03/25/91

DELTA COUNTER OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of the delta counter.

2.0 APPLICABILITY

This procedure applies to the operation of the delta counter used to determine the difference (or delta) between the amount of gamma radiation emanating from adjacent sources of radiation and the amount of gamma radiation emanating from directly beneath the delta counter.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Delta Gamma Field Data

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Bendix-designed delta counter EL-0018 or EL-0018a
4.1.2 Field check jig BFEC-EL0012 or equivalent

4.2 MATERIALS

4.2.1 Radium source BFEC 10027-2 or equivalent for the Bendix EL-0018 with front mounted detector or BFEC RA-32b2 or equivalent for the Bendix EL-0018a
4.2.2 Metal shield
4.2.3 Delta gamma field data sheet (Appendix 1)
4.2.4 Delta calibration logbook

Approved by:

Jon Jack K. Hilford 3/19/91
(Date)

Craig Little 3/20/91
C.A. Little (Date)

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader ensures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician. The team leader is responsible for selecting the appropriate measurement locations and for recording data accurately.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use. Team members are responsible for taking delta counter readings and assisting the team leader in field data documentation.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 FREQUENCY

The field check for the delta counter is performed prior to the field survey by the team members.

7.0 PROCEDURE

7.1 DELTA COUNTER FIELD CHECK

7.1.1 Turn the power switch ON.

7.1.2 If the batteries are low, an arrow and colons will appear in the display; batteries should be replaced if these indicators appear.

7.1.3 Select the proper counting interval of 5 min.

7.1.4 Remove the metal shield from the base of the instrument.

7.1.5 Match the plastic source jig GJ# to the GJ# on the delta counter. Place the Ra-226 source with the matching GJ# in the source jig.

7.1.6 Press the START button to begin the UP (total) count (the UP and DOWN counts are both initiated by pressing the START button).

7.1.7 Verify that the count is increasing. The RESTART switch can be used to initiate counting at any point.

7.1.8 After 5 min, the delta counter emits an audible signal. Record the total count in the verification field calibration logbook.

7.1.9 Insert the metal shield into the base of the counter.

7.1.10 Push the START button and verify that the count is decreasing. Count DOWN for 5 min.

7.1.11 Record the difference, or delta count, in the delta calibration logbook.

7.1.12 If the delta count is not within the range stipulated, the measurement must be repeated. If the second delta count is also outside the range, the instrument cannot be used. Report the instrument's failure to the electronics technician and obtain a replacement delta counter.

7.2 FIELD MEASUREMENTS WITH DELTA COUNTER

7.2.1 Position the instrument on the surface to be measured. A plastic bag may be placed between the detector and the soil to protect it from contamination or dampness as needed.

NOTE: If possible, the instrument should not be moved during the sequence of unfiltered and filtered measurements.

7.2.2 Turn the instrument on and set the counting interval at 2 min.

7.2.3 With the metal shield removed, depress the START button to initiate the total count. Make sure the count is increasing; if not, RESET the instrument and start again.

7.2.4 At the end of the counting interval, record the total count on the delta gamma field data sheet.

7.2.5 Place the metal shield into the slot beneath the detector without moving the detector, if possible.

7.2.5 Place the metal shield into the slot beneath the detector without moving the detector, if possible.

7.2.6 Depress the START button and verify that the count is decreasing. If not, RESET and start again.

7.2.7 At the end of the counting interval record the difference, or delta count, on the delta gamma field data sheet.

7.3 DATA REDUCTION OF DELTA COUNTS

Reduction of the delta counts per second to equivalent-radium (^{226}Ra) concentrations is accomplished by a program in Quick Basic Clipper. The program is called DELTA10.EXE and is started with a batch file called DELTA.BAT. The team leader and electronics technician can assist team members in locating and running the program.

Appendix 1. Delta Gamma Field Data

VICINITY PROPERTY INDEPENDENT VERIFICATION

DELTA GAMMA FIELD DATA SHEET

PROPERTY ADDRESS:_____ LOCATION NUMBER_____

_____ INSTRUMENT GJAO #_____

_____ CALIBRATION EXPIRES_____

TECHNICIAN NAME :_____ DATE _____

RESULTS CALCULATED BY:_____

****

ALL COUNT TIMES ARE 120 SECONDS UNLESS NOTED OTHERWISE

SAMPLE LOCATION	TOTAL COUNT	DELTA COUNT	%UNCERTAINTY (<15%)	Ra-226 pCi/g	DEPTH cm	COMMENTS (OPTIONAL)

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-025 Page: 1 of 12 Revision: 1 Date: 02/03/92

ALPHA RADIATION MEASUREMENT

1.0 PURPOSE

This procedure describes the method for measuring total alpha radiation levels on surfaces that are potentially contaminated with alpha-emitting radionuclides.

2.0 APPLICABILITY

When contamination is suspected, levels of alpha contamination must be determined according to criteria set forth for specific sites. This procedure applies to measuring total contamination, before removable contamination has been sampled. See Appendix 1 for surface contamination limits for radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Field Instrument Logbook.
3.1.2 PAG Procedure TE-027, Determination of Removable Contamination.

3.2 APPENDICES

3.2.1 Appendix 1: Surface Contamination Guidelines, DOE Order 5400.5
3.2.2 Appendix 2: Surface Contamination Survey
3.2.3 Appendix 3: Contamination Survey Summary

3.3 EXHIBITS

3.3.1 Exhibit 1: Counting for Alpha Activity

4.0 EQUIPMENT AND MATERIALS

4.1 Alpha scintillation probe:

4.1.1 Bicron Analyst A50 Alpha Probe
4.1.2 Bicron Analyst A100 Alpha Probe

Approved by:

David K. Halford 2/3/92 (Date)

Craig Little 2/4/92 (Date)
C.A. Little

4.1.3 Ludlum 43-65 Alpha Probe

4.2 Scaler/ratemeter:

4.2.1 Ludlum 2221
4.2.2 Bicron Analyst
4.2.3 Eberline ESP-2

4.3 Cable
4.4 Alpha check sources
4.5 Paint or grease pencil

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for alpha contamination.

6.0 PROCEDURE

6.1 Perform an operational check on the alpha probe.

NOTE: The following scaler/ratemeter instructions are for the Ludlum 2221, specifically. For instructions when using other scaler/ratemeters, see the electronics technician.

6.1.1 Obtain alpha check sources from the electronics technician.

a. The specific source to be used is listed on the side of the instrument.

6.1.2 Attach alpha probe to scaler/ratemeter.

6.1.3 Turn on scaler/ratemeter.

6.1.4 Check battery (should be >4.5 V).

a. Turn instrument switch to OFF when changing batteries or cables.

6.1.5 Set "IN WIN OUT" switch to "OUT".

6.1.6 Check calibration sticker to ensure that calibration date is current.

6.1.7 Collect background count by placing the probe face up on a clean surface and counting for 1 min.

6.1.8 Check instrument response by counting for 1 min using a check source.

6.1.9 Compare net count (gross count minus background count) to the 3- sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the above steps, acquiring a new background count and gross count.

c. If the net count rate still does not fall within the 3-sigma range, check with the electronics technician.

6.1.10 Enter the following data in the field instrument logbook:

a. Surveyor's initials
b. Date
c. Instrument number
d. Background counts
e. Gross counts
f. Net counts
g. Battery check
h. 3-sigma rate range
i. Instrument efficiency (listed on side of instrument)
j. Comments

6.2 Determine field background.

6.2.1 Set ratemeter in scaler mode.

6.2.2 Set count time to 1 min.

6.2.3 Press "Count" to initiate counting.

6.2.4 After counting is completed, repeat for a total of two background readings.

6.2.5 Record the following information on both the Surface Contamination Survey form (Appendix 2) and the Contamination Survey Summary (Appendix 3):

a. the average of the two background readings;

b. the instrument number;

c. instrument efficiency (the reciprocal of the conversion factor);

d. probe geometry (active probe area, cm^2, divided by 100).

6.3 Determine the Lower Limit of Detection (LLD) for the area to be surveyed:

$$LLD = \frac{2.71 + 4.66\sqrt{\frac{B}{T}}}{E \times G}$$

Where

LLD = lower limit of detection, dpm/100 cm^2
B = background, counts
T = count time, min
E = detector efficiency, counts per disintegration
G = probe area, cm^2, divided by 100

6.3.1 In order for the instrument to be adequately sensitive, the LLD must be < 50% of the applicable guideline.

6.3.2 Enter the LLD value on the appropriate field sheet.

6.4 Determine action level.

$$AL = (SC \times E \times G) + B$$

Where

AL = action level, cpm
SC = site criteria, dpm/100 cm^2
B = background, cpm
E = detector efficiency, counts per disintegration
G = probe area, cm^2, divided by 100

6.4.1 A field count at or above this value indicates that further investigation is needed at this location.

6.5 Scan for alpha activity.

6.5.1 Switch scaler/ratemeter into "DIG. RATE", ratemeter mode.

6.5.2 Set "RESP", response time switch, to "S" for slow response.

6.5.3 Set range selection switch to "X 1" for 500 cpm (counts per minute) full scale or to "X 10" for 5,000 cpm full scale.

6.5.4 Pass the detector slowly over the surface of interest.

a. Do not touch the surface with the probe in order to avoid contamination of the probe itself.

b. The speed of probe movement will vary depending upon the experience of the surveyor but is typically 10-20 cm/s.

c. Because the probe face is very fragile, take care to avoid damage by rough surfaces or sharp objects.

6.5.5 Note increases in count rates as indicated by the audible meter output.

a. Typically, count rates 5-10 times the background rate are indicative of contamination or radionuclide concentrations exceeding allowable levels.

b. Circle areas of increased count rate using paint or grease pencil.

6.5.6 Continue traversing the area at close intervals.

a. Due to the relatively short range of the particles and the directional dependence of the scanning, intervals usually overlap.

6.5.7 For individual grid blocks, record range results on a separate Surface Contamination Survey form for each block. See Appendix 2.

6.5.8 For other scans, record results on the Contamination Survey Summary form. See Appendix 3.

6.5.9 Take systematic point measurements for all areas of increased activity as described below.

6.6 Make systematic point measurements.

6.6.1 Place scaler/ratemeter in "SCALER" mode.

6.6.2 Using "MINUTES" switch, set count time to 1 min.

6.6.3 Place probe above point to be read. See Exhibit 1.

a. Grid blocks selected for systemic measurements require a predetermined number of readings, usually 5 per grid block.

b. For the first reading, place probe on point A, as shown on the Surface Contamination Survey form (Appendix 2).

6.6.4 Press "COUNT" button to count for 1 min.

6.6.5 Record the number of counts on the Surface Contamination Survey form.

6.6.6 For grid blocks, repeat this counting and recording procedure at each of the four other points (B, C, D, and E) as shown on the form.

a. When required, take a duplicate reading every 10th reading and indicate this on the form.

b. Average the cpm for the five readings and record.

c. Calculate the alpha activity average from the cpm average.

6.7 If removable contamination is suspected, collect smear samples according to TE-027, Determination of Removable Contamination.

6.8 After the area has been scanned and/or counted, calculate alpha dpm/100 cm^2 by subtracting background and applying appropriate time, detector efficiency, and effective area factors to the net counting rate.

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

Where

N = net counts
T = count time, min.
E = detector efficiency, counts per disintegration
G = probe area, cm^2, divided by 100

6.9 After the systematic survey has been completed, transfer the data from the Surface Contamination Survey sheet to the Contamination Survey Summary form (Appendix 3) by entering the following information:

a. Area identifier (where or what is being surveyed)
b. Building number
c. Room number

d. Date
e. Surveyor's initials
f. Direct radiation measurement average results.

Appendix 1. Surface Contamination Guidelines
DOE Order 5400.5 2-8-90

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1]		
	Average[3][4]	Maximum[4][5]	Removable[4][6]
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	RESERVED	RESERVED	RESERVED
Th-Natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
U-Natural, ^{235}U, ^{238}U, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above.[7]	5,000	15,000	1,000

[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.

Appendix 1. (continued)

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

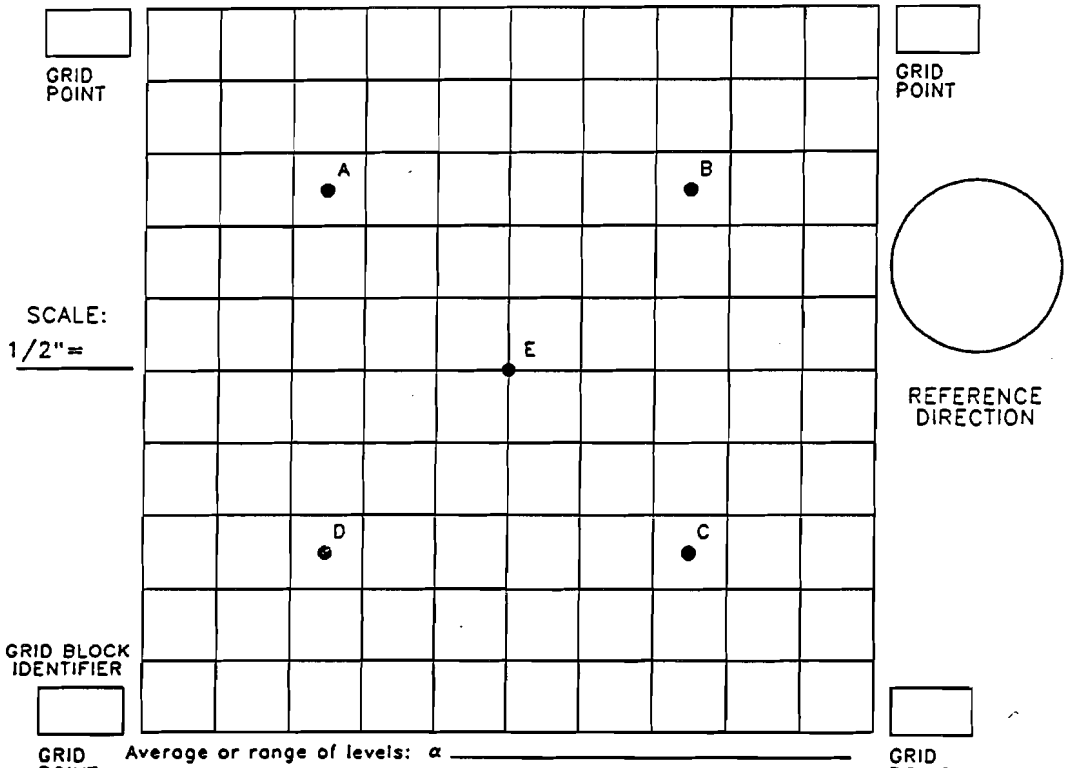
7/ This category of radionuclides includes mixed fission products, including the ^{90}Sr which has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

Appendix 2. Surface Contamination Survey

DATE: _____
PHASE: _____
ROOM: _____
BUILDING: _____
TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		bcpm				
α		bcpm				



Average or range of levels: α _____ β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS						DOSE RATE	SMEAR #
	ALPHA		$\beta\gamma$ DOWN		$\beta\gamma$ UP			
	cpm	dpm/100cm2	cpm	dpm/100cm2	cpm	dpm/100cm2		
A								
B								
C								
D								
E								
AVE								

Comments: _____

UCN-17231
(3 Rev. 5/91)

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA–GAMMA		cpm				
GAMMA		kcpm				

Item/ Grid Block	Point	DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
		Alpha		Beta–Gamma					Gamma		Smear #	Alpha		Beta–Gamma	
		cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	μR/h @ 1 meter		cpm	dpm/ 100cm 2	cpm	dpm/ 100cm 2

Comments: _____

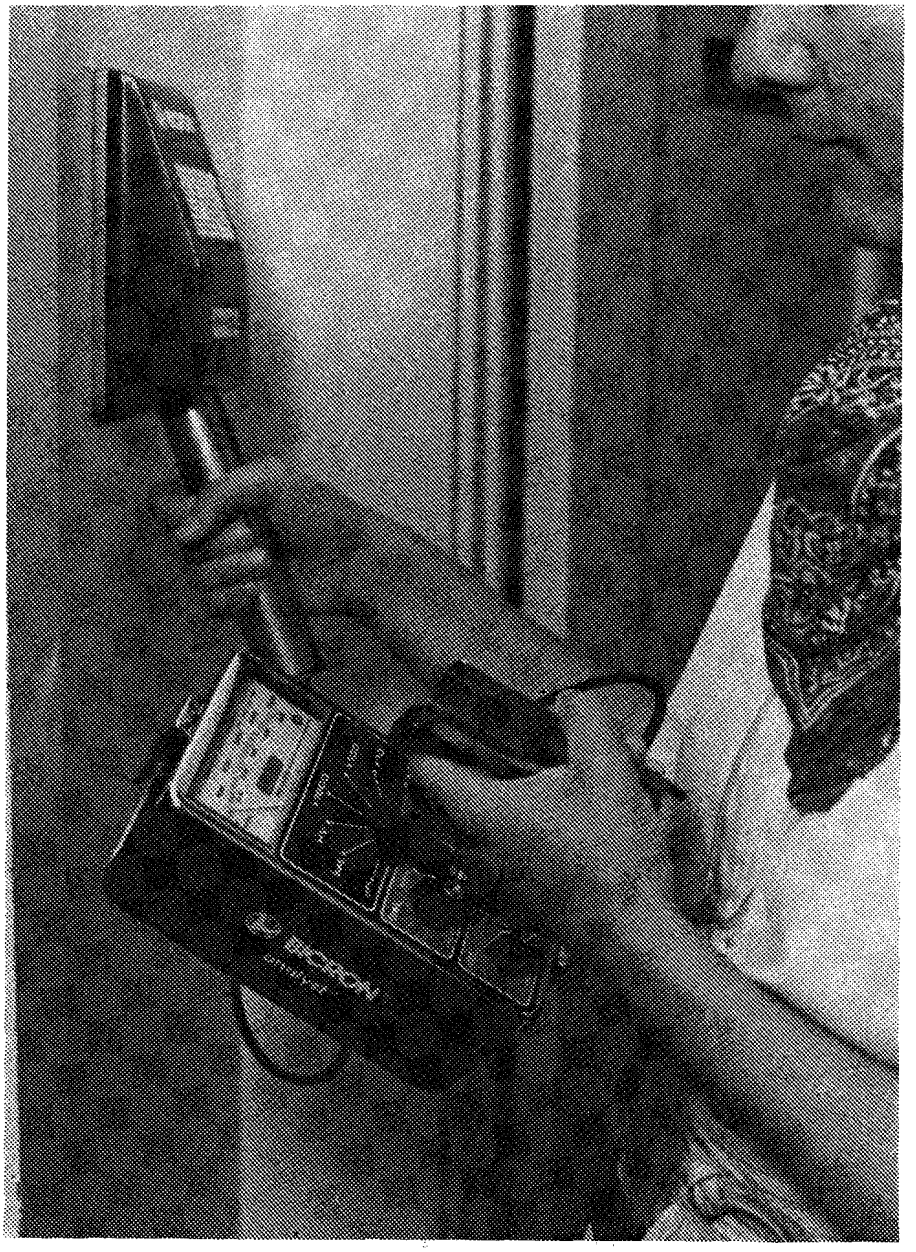
UCN – 17230
(3 Rev. 5/91)

Appendix 3. Contamination Survey Summary

ALPHA RADIATION MEASUREMENT

Number: TE-025
Page: 11 of 12

Exhibit 1. Counting for Alpha Activity



BETA-GAMMA RADIATION MEASUREMENT

1.0 PURPOSE

This procedure describes the method for measuring beta-gamma radiation on surfaces that are potentially contaminated with beta-emitting radionuclides.

2.0 APPLICABILITY

When contamination is suspected, levels of beta-gamma contamination must be determined according to criteria set forth for specific sites. This procedure applies to measuring total contamination, before removable contamination has been sampled. See Appendix 1 for surface contamination limits as applied to radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Field Instrument Logbook.
3.1.2 PAG Procedure TE-027, Determination of Removable Contamination.

3.2 APPENDICES

3.2.1 Appendix 1: Surface Contamination Guidelines, DOE Order 5400.5.
3.2.2 Appendix 2: Surface Contamination Survey
3.2.3 Appendix 3: Contamination Survey Summary
3.2.4 Appendix 4: Area Scan & Radiation Level Survey

3.3 EXHIBITS

3.3.1 Exhibit 1: Counting for Beta-gammma Activity

4.0 EQUIPMENT AND MATERIALS

4.1 Beta-gamma probe:

Approved by:

Jack K. Hafford 2/3/92 (Date)

Craig Little 2/4/92 C.A. Little (Date)

4.1.1 Ludlum 44-9 Beta-gamma Probe
4.1.2 Bicron Analyst PGM Beta-gamma Probe
4.1.3 Eberline HP-260 Beta-gamma Probe

4.2 Scaler/ratemeter:

4.2.1 Ludlum 2221
4.2.2 Bicron Analyst
4.2.3 Eberline ESP-2

4.3 Cable
4.4 Beta check sources.

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for beta-gamma activity.

6.0 PROCEDURE

6.1 Perform an operational check on the beta-gamma probe.

NOTE: The following scaler/ratemeter instructions are for the Ludlum 2221, specifically. For instructions on using other scaler/ratemeters, see the electronics technician.

6.1.1 Obtain beta-check sources from the electronics technician.

a. The specific source to be used is listed on the side of the instrument.

6.1.2 Attach beta-gamma probe to scaler/ratemeter.

6.1.3 Turn on scaler/ratemeter.

6.1.4 Check battery (should be >4.5 V).

a. Turn instrument switch to OFF when changing batteries or cables.

6.1.5 Set "IN WIN OUT" switch to "OUT".

6.1.6 Check calibration sticker to ensure that calibration date is current.

6.1.7 Collect background count by placing the probe face up on a clean surface and counting for 1 min.

6.1.8 Check instrument response by counting for 1 min using a check source.

6.1.9 Compare net count (gross counts minus background counts) to the 3-sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the above steps, acquiring a new background count and gross count.

c. If the net count rate still does not fall within the 3-sigma range, check with the electronics technician.

6.1.10 Enter the following data in the field instrument logbook:

a. Instrument number
b. Battery check
c. Background counts
d. Gross counts
e. Net counts
f. 3-sigma rate range
g. Instrument efficiency (listed on side of instrument)
h. Surveyor's initials
i. Date
j. Comments

6.1.11 GM counters have several limitations that can lead to erroneous results unless the user is aware of them.

a. Slow recovery of the counter at high radiation levels causes a decreased response to radiation events; at extremely high levels, the response may no longer increase with increased radiation. In certain cases, the response may decrease or go to zero at very high levels.

b. At extreme temperatures, the instrument may respond erratically or not at all. Under these conditions, a check source is needed to ensure reliable behavior.

c. The GM tube is delicate and sensitive to damage if dropped or exposed to significant changes in air pressure. If a rattling sound is heard when the user blows air across the probe face, it is likely that the tube has broken. To avoid a common means of tube breakage, do not ship the probe in an unpressurized airplane.

d. Beta-gamma probes respond to gamma radiation, which makes direct contamination monitoring difficult in areas of high gamma background or where gamma emitting contamination is present.

6.2 Determine field background.

6.2.1 Set ratemeter in scaler mode.

6.2.2 Set count time to 1 min.

6.2.3 Press "Count" to initiate counting.

6.2.4 After counting is completed, repeat for a total of two background readings.

6.2.5 For indoor scanning, record the following information on both the Surface Contamination Survey form (Appendix 2) and the Contamination Survey Summary (Appendix 3):

a. the average of the two background readings;

b. the instrument number;

c. instrument efficiency (the reciprocal of the conversion factor);

d. probe geometry (active probe area, cm^2, divided by 100).

6.2.6 For outdoor scanning, record the above information on the Area Scan and Radiation Level Survey form (Appendix 4).

6.3 Determine the Lower Limit of Detection (LLD) for the area to be surveyed:

$$LLD = \frac{2.71 + 4.66\sqrt{\frac{B}{T}}}{E \times G}$$

Where

LLD = lower limit of detection, dpm/100 cm^2
B = background, counts
T = count time, min
E = detector efficiency, counts per disintegration
G = probe area, cm^2, divided by 100

6.3.1 In order for the instrument to be adequately sensitive, the LLD must be < 50% of the applicable guideline.

6.3.2 Enter the LLD value on the appropriate field sheet.

6.4 Determine action level.

$$AL = (SC \times E \times G) + B$$

Where

AL = action level, cpm
SC = site criteria, dpm/100 cm^2
B = background, cpm
E = detector efficiency, counts per disintegration
G = probe area, cm^2, divided by 100

6.4.1 A field count at or above this value indicates that further investigation is needed at this location.

6.5 Scan for beta-gamma activity.

6.5.1 Switch scaler/ratemeter into "DIG. RATE", ratemeter mode.

6.5.2 Set "RESP", response time switch, to "S" for slow response.

6.5.3 Set range selection switch to "X 1" for 500 cpm (counts per minute) full scale or to "X 10" for 5,000 cpm full scale.

6.5.4 If alpha activity is suspected, shield the probe with a piece of paper or similar material.

6.5.5 Pass the detector slowly over the surface of interest.

a. Maintain the smallest air gap possible between the probe and the surface to be scanned. Do <u>not</u> touch the surface with the probe in order to avoid contamination of the probe itself.

b. Scan at a rate of 1 s per width of probe.

c. Due to the short range of beta particles, scanning intervals should overlap.

d. CAUTION: Avoid placing the probe on surfaces with sharp projections which may puncture the thin detector face.

6.5.6 After the area has been scanned, calculate beta-gamma activity by subtracting background and applying appropriate time, detector efficiency, and detector area factors to the net counting rate.

$$\text{ß } dpm/100\ cm^2 = \frac{N}{T \times E \times G}$$

Where

N = net counts
T = count time, min
E = detector efficiency, counts per disintegrations
G = probe area, cm^2, divided by 100

NOTE: A SrY-90 source calibration efficiency will be about 50% greater than a Tc-99 source efficiency due to differing beta energy values.

6.5.7 For individual grid blocks, record range results on a separate Surface Contamination Survey form for each block. See Appendix 2.

6.5.8 For outdoor areas, record range results on the Area Scan and Radiation Level Survey form. See Appendix 4.

6.5.9 For other scans, record results on the Contamination Survey Summary form. See Appendix 3.

6.6 When necessary, make systematic point measurements. See Exhibit 1.

6.6.1 Place scaler/ratemeter in "SCALER" mode.

6.6.2 Using "MINUTES" switch, set count time to 1 min.

6.6.3 Place probe above point to be read.

a. Grid blocks that have been selected for systemic measurements require a predetermined number of readings, usually 5 per grid block.

b. For the first reading, place probe on point A, as shown on the Surface Contamination Survey form (Appendix 2).

6.6.4 Press "COUNT" button to count for 1 min.

6.6.5 Record the number of counts on the Surface Contamination Survey form.

6.6.6 For grid blocks, repeat this counting and recording procedure at each of the four other points (B,C,D,and E) as shown on the form.

a. When required, take a duplicate reading every 10th reading and indicate this on the form.

b. Average the cpm for the five readings and record on the form.

c. Calculate the beta-gamma activity average from the cpm average.

6.6.7 Convert cpm to beta-gamma dpm/100 cm^2.

6.6.8 If removable contamination is suspected, collect smear samples according to TE-027, Determination of Removable Contamination.

6.6.9 If it is necessary to determine beta-gamma dose rate, repeat the measurement at the same location with the probe face up.

6.6.10 Calculate the beta-gamma dose rate using the calibration factor for the instrument used:

$$DR = \frac{C_1 - C_2}{T \times CF} + (\gamma \times 0.87)$$

Where

DR = dose rate, μrad/h
C_1 = counts probe down
C_2 = counts probe up
T = count time, min
CF = conversion factor, cpm/μrad/h
γ = gamma exposure rate, μR/h
0.87 = conversion factor for exposure rate to dose rate, μrad/μR

6.6.11 After a systematic survey has been completed, transfer the data from the Surface Contamination Survey form to the Contamination Survey Summary form (Appendix 3) by entering the following information:

a. Area identifier (where or what is being surveyed)
b. Building number
c. Room number
d. Date
e. Surveyor's initials
f. Instrument identification number

g. Instrument efficiency factor
h. Direct radiation measurement average results.

Appendix 1. Surface Contamination Guidelines
DOE Order 5400.5 2-8-90

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1]		
	Average[3/4]	Maximum[4/5]	Removable[4/6]
	RESERVED	RESERVED	RESERVED
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa			
Th-Natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
U-Natural, ^{235}U, ^{238}U, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[7]	5,000	15,000	1,000

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.

Appendix 1. (continued)

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

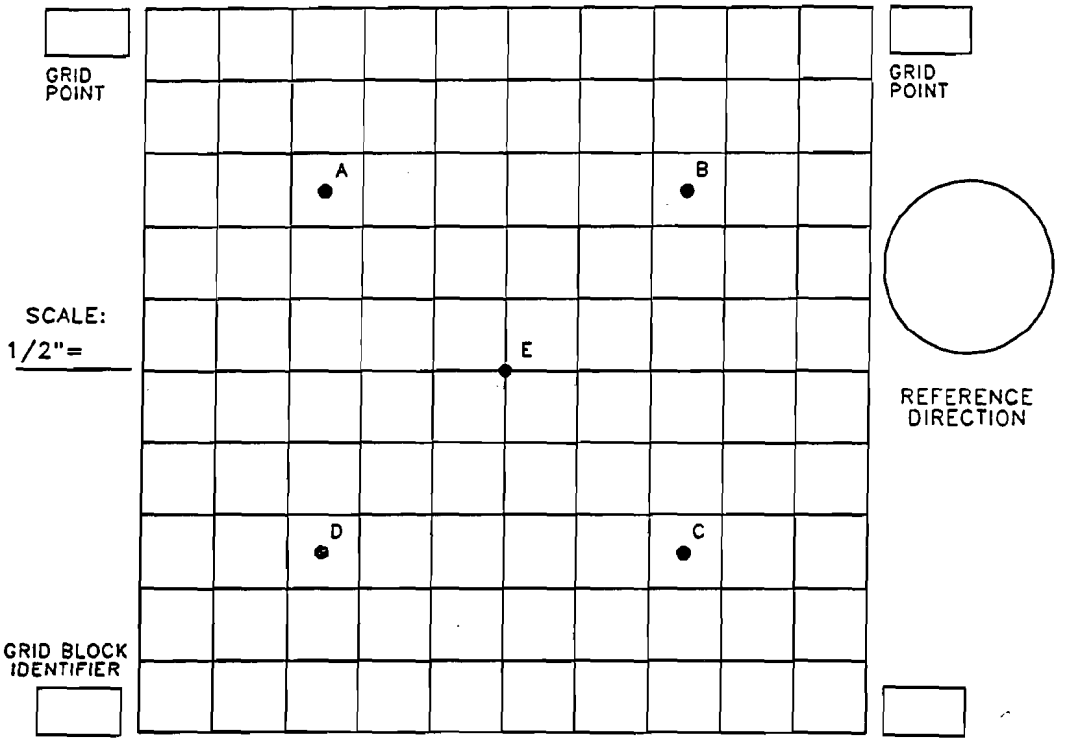
[7/] This category of radionuclides includes mixed fission products, including the ^{90}Sr which has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

Appendix 2. Surface Contamination Survey

DATE: _____
PHASE: _____
ROOM: _____
BUILDING: _____
TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		kcpm				
α		kcpm				



Average or range of levels: α _____
β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS						DOSE RATE	SMEAR #
	ALPHA		$\beta\gamma$ DOWN		$\beta\gamma$ UP			
	cpm	dpm/100cm2	cpm	dpm/100cm2	cpm	dpm/100cm2		
A								
B								
C								
D								
E								
AVE								

Comments: _____

UCN-17231
(3 Rev. 3/91)

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA–GAMMA		cpm				
GAMMA		kcpm				

		DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
		Alpha		Beta–Gamma					Gamma		Smear	Alpha		Beta–Gamma	
Item/ Grid Block	Point	cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	μR/h @ 1 meter	#	cpm	dpm/ 100cm^2	cpm	dpm/ 100cm^2

Comments: _____

UCN – 17230
(3 Rev. 5/91)

Appendix 3. Contamination Survey Summary

BETA-GAMMA RADIATION MEASUREMENT

Number: TE-026
Page: 12 of 14

Appendix 4. Area Scan and Radiation Level Survey

AREA SCAN & RADIATION LEVEL SURVEY

PHASE: _____

DATE: _____

TECHNICIANS: _____

	INST.	BKGD	EFF.	GEOM	LLD dpm/100cm²	ACTION LEVELS
γ		μR/h				
γ		μR/h				
$\beta\gamma$		CPM				

GAMMA SCAN

AREA IDENTIFIER	GAMMA RANGE		GAMMA AVERAGE	
	kcpm	μR/h	kcpm	μR/h

DELTA COUNT MEASUREMENTS

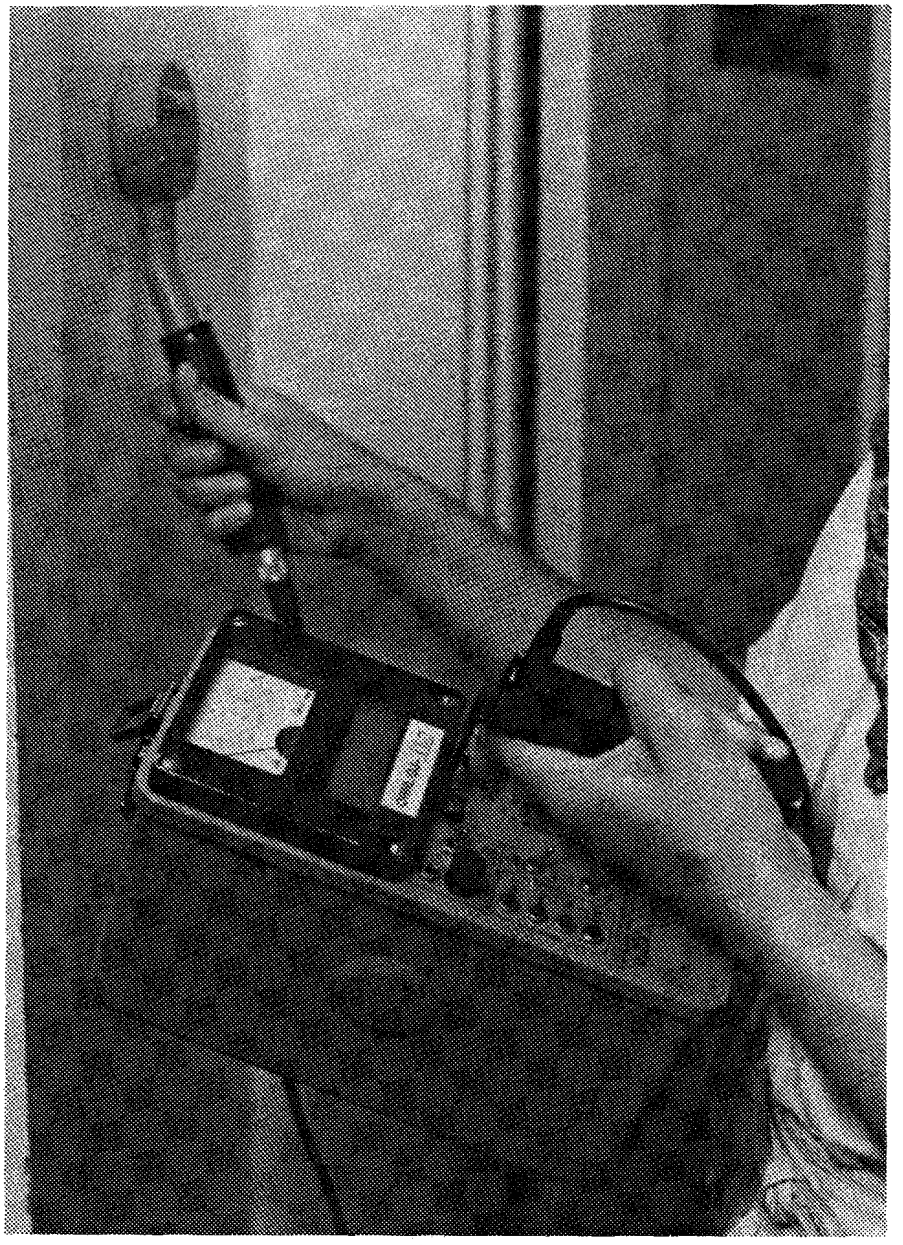
LOCATION	GROSS CNT.	DELTA CNT.	%UNCERT.	Ra-226 pCi/G

FIXED POINT MEASUREMENTS

	GAMMA				BETA-GAMMA				DOSE RATE
	SURFACE		1M		DOWN		UP		
LOCATION	kcpm	μR/h	kcpm	μR/h	cpm net	dpm 100 cm2	cpm net	dpm 100 cm2	

COMMENTS: _____

Exhibit 1. Counting for Beta-gamma Activity



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-027 Page: 1 of 10 Revision: 1 Date: 02/03/92

DETERMINATION OF REMOVABLE CONTAMINATION

1.0 PURPOSE

This procedure describes the method for measuring removable alpha and beta-gamma radioactivity on equipment and building surfaces.

2.0 APPLICABILITY

When contamination is suspected, levels of contamination on equipment and building surfaces must be determined according to criteria set forth for specific sites. This procedure applies to measuring removable contamination. See Appendix 1 for removable surface contamination limits for radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Surface Radioactivity Guides
3.1.2 Appendix 2: Lab Smear Data
3.1.3 Appendix 3: Contamination Survey Summary
3.1.4 Appendix 4: Surface Contamination Survey

3.2 EXHIBITS

3.2.1 Exhibit 1: Acquiring a Smear Sample

4.0 EQUIPMENT AND MATERIALS

4.1 Filter papers
4.2 Glassine or paper envelopes
4.3 Proportional counter

Approved by:

2/3/92 (Date)

C.A. Little 2/4/92 (Date)

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for removable radioactive contamination.

6.0 PROCEDURE

6.1 Collect sample.

6.1.1 Applying moderate pressure with two or three fingers, wipe smear (filter) paper over approximately 100 cm^2 of the surface. See Exhibit 1.

a. This area is about the size of a dollar bill.

6.1.2 Place the filter in an envelope.

6.1.3 Complete the Lab Smear Data form (see Appendix 2) by entering the following information:

a. Surveyor's initials

b. Date taken

c. Smear number.

6.1.4 If determining radon or thoron daughters or other short half-life radionuclides, smears should be counted within 1-2 h. Otherwise delay counting for at least 4 h to permit decay of short-lived radionuclides.

a. For longer half-life radionuclides, send to laboratory for counting along with the Lab Smear Data form.

6.2 Perform an operational check on the alpha and beta-gamma detectors.

Note: The following instructions are for the Ludlam 2929 Dual Channel Scaler Smear Counter. For instructions on using other smear counters, see the electronics technician.

6.2.1 Obtain alpha and beta-gamma check sources from the electronics technician.

a. The specific source to be used is listed on the top of the instrument.

6.2.2 Turn on the instrument.

a. Check calibration sticker to ensure that calibration date is current.

6.2.3 Collect ten background readings by inserting an empty chamber into the proportional counter and counting for 1 min per background count.

a. The dual scaler will give readings simultaneously for alpha and for beta-gamma.

6.2.4 Average the ten background readings each for alpha and for beta-gamma.

6.2.5 Check instrument response by counting the alpha check source for 1 min and then the beta-gamma check source for 1 min.

a. Place check source in the proportional counter facing up, insert, and lock into place.

6.2.6 Compare net count (gross counts minus background counts) to the 3-sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the check source 1-min count.

c. If still out of range, report the instrument to the electronics technician.

6.2 Count smears.

6.2.1 Remove filter paper from envelope and place in the planchet in the counter, smeared side up.

6.2.2 Count for 1 min.

a. If contamination levels are high or it is not practical to return the samples to the laboratory for analysis, portable alpha and beta-gamma meters may be used for counting.

6.2.3 Subtract background count (determined by counting blank or unused smear) and convert net count to dpm/100 cm^2 using proper time and detector efficiency values.

$$dpm/100\ cm^2 = \frac{N}{T \times E}$$

Where

N = net counts
T = count time, min
E = detector efficiency, counts per disintegration

6.2.4 If the area smeared is other than 100 cm^2, calculate an adjusted counts value and substitute it for net counts in the equation above:

$$C_a = \frac{100\ cm^2}{A} \times N$$

Where

C_a = adjusted counts
N = net counts
A = area smeared, cm^2

6.2.5 Record results on Lab Smear Data form and Contamination Survey Summary (Appendix 3).

a. For samples from individual grid blocks, record results on a separate Surface Contamination Survey form for each Block. See Appendix 4.

Appendix 1. Surface Contamination Guidelines
DOE Order 5400.5 2-8-90

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1]		
	Average[3/4]	Maximum[4/5]	Removable[4/6]
Transuranics, ^{125}I, ^{129}I, ^{226}Ra, ^{227}Ac, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	RESERVED	RESERVED	RESERVED
Th-Natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
U-Natural, ^{235}U, ^{238}U, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[7]	5,000	15,000	1,000

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.

Appendix 1. (continued)

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

7/ This category of radionuclides includes mixed fission products, including the ^{90}Sr which has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

Appendix 2. Lab Smear Data

LAB SMEAR DATA

TECHNICIAN:_____

SMEAR #	DATE / TIME TAKEN	COUNTS	EFFICIENCY	DPM / 100CM^2	DATE / TIME ANALYZED

Appendix 3. Contamination Survey Summary

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA–GAMMA		cpm				
GAMMA		kcpm				

		DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
		Alpha		Beta–Gamma					Gamma		Smear	Alpha		Beta–Gamma	
Item/ Grid Block	Point	cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	μR/h @ 1 meter	#	cpm	dpm/ 100cm^2	cpm	dpm/ 100cm^2

Comments: _____

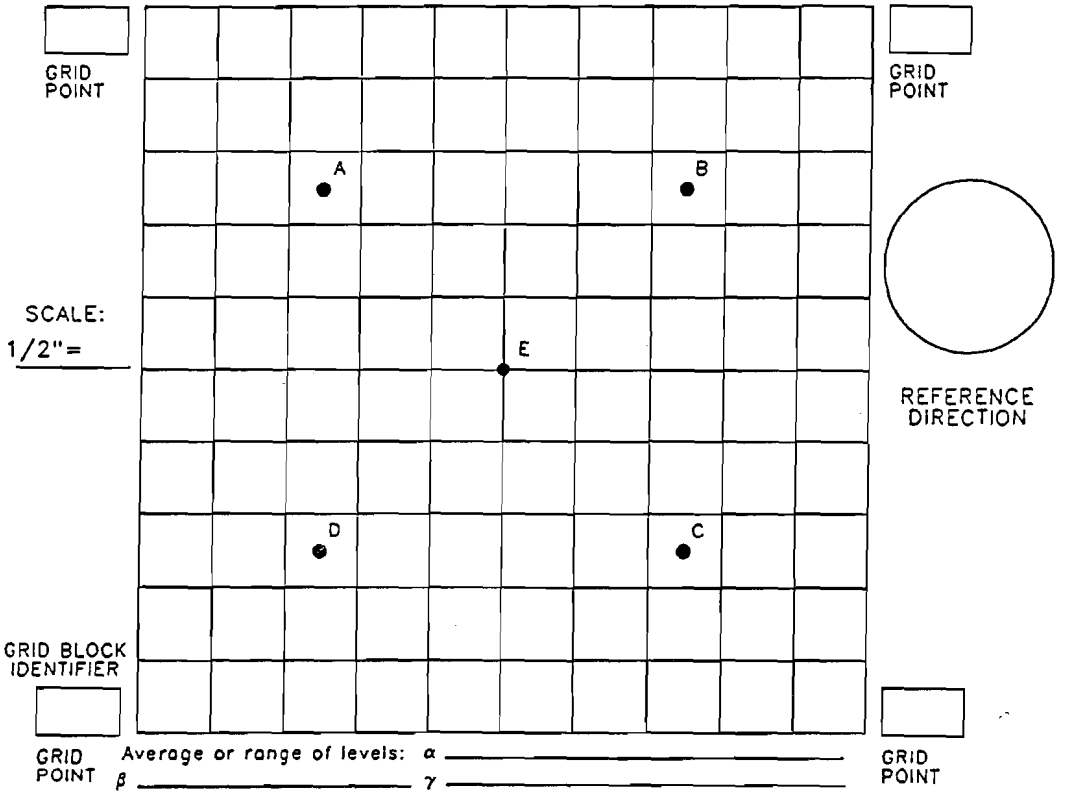
UCN – 17230
(3 Rev. 5/91)

Appendix 4. Surface Contamination Survey

DATE: _____
PHASE: _____
ROOM: _____
BUILDING: _____
TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		kcpm				
α		kcpm				



Average or range of levels: α _____
β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS						DOSE RATE	SMEAR #
	ALPHA		$\beta\gamma$ DOWN		$\beta\gamma$ UP			
	cpm	dpm/100cm2	cpm	dpm/100cm2	cpm	dpm/100cm2		
A								
B								
C								
D								
E								
AVE								

Comments: _____

UCN-17231
(3 Rev. 5/91)

Exhibit 1. Acquiring a Smear Sample

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-028 Page: 1 of 5 Revision: 0 Date: 10/01/90

SITE PREPARATION FOR RADIOLOGICAL SURVEYING

1.0 PURPOSE

This procedure describes the methods for clearing a site and establishing a grid system for referencing radiological survey activities.

2.0 APPLICABILITY

This procedure applies to all site surveying activities for which grid referencing is necessary.

3.0 OTHER DOCUMENTS

None

4.0 EQUIPMENT AND MATERIALS

4.1 Chalk

4.2 Tape

4.3 Grease pencil

4.4 Grid point markers (stakes, hubs, spikes, flags, etc.)

4.5 Moving and clearing equipment as necessary

5.0 RESPONSIBILITY

5.1 The site team leader is responsible for the following:

5.1.1 Determining the degree of clearing needed;

5.1.2 Determining the gridding requirements;

Approved by:

Douglas K. Hoffman 09/17/90 (Date)

C.A. Little 9/19/90 (Date)

5.1.3 Supervising onsite clearing and gridding activities to assure compliance with condition of survey plans and subcontract agreements.

5.2 Survey personnel are responsible for establishing indoor grids not already in place and outdoor grids of small land areas.

5.3 Gridding of open land areas will usually be performed by a professional land survey organization under subcontract arrangements.

5.4 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.

6.0 PROCEDURE

6.1 Clear indoor area.

6.1.1 Remove or relocate equipment and material which impede the radiological survey.

a. In the case of private property surveys, this should be done by the property owner when possible to avoid potential damage by the subcontractor.

b. When radiological history indicates, check all equipment and material removed for potential contamination.

6.1.2 Provide access to potentially contaminated interior surfaces such as drains, ductwork, tanks, pits, and equipment by removing covers or disassembling equipment.

6.2 Clear outdoor area if necessary.

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

a. 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.

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

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

6.2.2 Clearing includes providing access to potentially contaminated interior surfaces such as drains, tanks, pits, etc.

6.2.3 When clearing open land areas, caution must be exercised to prevent relocations of surface contamination or damage to site features such as drainage ditches, utilities, fences, and buildings.

6.3 Define indoor grid.

6.3.1 Select grid baseline, usually the longest dimension of the structure.

6.3.2 If the property has already been gridded as part of the owner's decontamination and survey activities, use this grid to provide consistency and easy comparison of measurements.

6.3.3 Determine grid dimensions based on the following:

a. Potential for contamination;

b. Providing adequate systematic measurement;

c. Providing adequate sampling points for statistical significance.

6.3.4 A minimum of 30 grid blocks is required with 60 to 100 blocks preferable.

6.3.5 Metric units are preferred for the grid, but English units may be followed if an acceptable grid system has been pre-established.

6.3.6 Use a basic grid system of 1 or 2 meters per block.

6.3.7 Mark grid blocks on the floor and lower wall (up to 2 m) using a chalk line or other appropriate marking system.

a. Use one of the inside corners of the building as the starting point for referencing the grid.

6.3.8 Mark grid points (grid line intersections) with paint, tape, or grease pencil.

a. Ask owner's permission before using paint or other markers which may deface the surface.

6.3.9 Identify grid points using an alpha-numeric system.

a. Lines perpendicular to the baseline are identified alphabetically.

b. Lines parallel to the baseline are identified by a number indicating the distance from the baseline.

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

6.3.11 If more convenient, grid each room individually in buildings containing multiple rooms.

a. This is at the discretion of the team leader.

b. Small rooms ($< 10\ m^2$) do not require gridding.

6.3.12 Upper walls and ceiling areas are not usually gridded.

a. Reference measurements on these surfaces to prominent building features or to locations corresponding to the gridded floor and lower walls.

6.8 Prepare open land grid system.

6.8.1 Use a basic grid interval of 10 m.

a. This interval may be decreased or increased depending on the total property area and the radiological history.

6.8.2 Grid points (also called grid line intersections) include points where the grid lines intersect with buildings and property boundaries.

a. These points are marked using stakes, hubs, spikes, point, flags, or survey tape, depending on the characteristics and routine uses of the surface.

6.8.3 Reference the grid using a specific grid point identified on the grid marker as point 0,0.

a. This point is generally near the center or at a corner of the property.

6.8.4 Reference the coordinates of other grid points to the 0,0 point using alpha-numeric identifiers.

a. The numeric identifier indicates the distance in meters or feet from the reference point.

b. 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).

6.8.5 Label the grid point markers with the coordinates of the grid point.

6.8.6 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.

6.8.7 The field map may be used for noting grid coordinates.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-030 Page: 1 of 80 Revision: 1 Date: 02/03/92

INCLUSION SURVEY REPORT COMPLETION

1.0 PURPOSE

The purpose of this procedure is to describe the tasks performed to complete and transmit inclusion survey reports.

2.0 APPLICABILITY

This procedure applies to the UMTRA (Uranium Mill Tailings Remedial Action) and Monticello Vicinity Properties (MVP) projects.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Vicinity Properties Management and Implementation Manual* (VPMIM), UMTRA-DOE/AL-050601.

3.1.2 *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, T. E. Myrick, B. A. Berven, and F. F. Haywood, ORNL/TM-7343.

3.1.3 EPA Standards for Remedial Action at Inactive Uranium Mill Processing Sites, Code of Federal Regulations, Sect. 40, Part 192.

3.1.4 U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Rev. 2, March 1987.

3.1.5 Procedure TE-020, Inclusion Survey Activities.

3.1.6 Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties.

3.1.7 Procedure SU-070, Document Control.

3.2 APPENDICES

3.2.1 Appendix 1: Inclusion Survey Report Flow Chart

3.2.2 Appendix 2: Radiological Screening Summary sheet

3.2.3 Appendix 3: Conversion Formulas

3.2.4 Appendix 4: Soil Sample Data Field Form

Approved by:

2/3/92 (Date)

C.A. Little 2/4/92 (Date)

3.2.5 Appendix 5: Property File Tracking Form
3.2.6 Appendix 6: Gamma Analysis Worksheet
3.2.7 Appendix 7: Soil Analysis Worksheet
3.2.8 Appendix 8: Background Concentrations of ^{226}Ra in Surface Soil
3.2.9 Appendix 9: Hot Spot Limits
3.2.10 Appendix 10: UMTRA Report Skeleton
3.2.11 Appendix 11: MVP Report Skeleton
3.2.12 Appendix 12: PUOR Report Skeleton
3.2.13 Appendix 13: PU5 Report Skeleton
3.2.14 Appendix 14: UMTRA Condensed Report Skeleton
3.2.15 Appendix 15: MVP Condensed Report Skeleton
3.2.16 Appendix 16: PUOR Condensed Report Skeleton
3.2.17 Appendix 17: PU5 Condensed Report Skeleton
3.2.18 Appendix 18: UMTRA Letter of Recommendation
3.2.19 Appendix 19: MVP Letter of Recommendation
3.2.20 Appendix 20: PUOR Letter of Recommendation
3.2.21 Appendix 21: PU5 Letter of Recommendation
3.2.22 Appendix 22: UMTRA Vicinity Property Summary Evaluation and Recommendation
3.2.23 Appendix 23: MVP Vicinity Property Summary Evaluation and Findings
3.2.24 Appendix 24: VPDMS Form
3.2.25 Appendix 25: ISC Report Review Checklist

4.0 EQUIPMENT AND MATERIALS

4.1 MATERIALS

4.1.1 Team Leader Logbook
4.1.2 Gamma Analysis Worksheet
4.1.3 Soil Analysis Worksheet
4.1.4 Report skeleton
4.1.5 Letter of recommendation (not needed for condensed reports)
4.1.6 Vicinity Property Summary Evaluation Form
4.1.7 VPDMS form (UMTRA properties only)
4.1.8 ISC Report Review Checklist
4.1.9 Vicinity property file

5.0 RESPONSIBILITY

5.1 The team leader is responsible for the following:

a. Preparing the survey report for writing;
b. Assigning the survey report for writing and review;
c. Reviewing the survey report for clarity, accuracy, and completeness; and

d. Tracking the report until ready for transmittal to the appropriate agency.

5.2 Assigned team members have the following responsibilities:

a. Performing necessary calculations and
b. Writing and reviewing the survey report.

5.3 Clerical staff are responsible for:

a. Transmitting MVP field data to the RAC and
b. Typing the draft report and letter of recommendation,
c. Typing corrections after report editing, and
d. Transmitting the report and associated documentation to the appropriate project management office.

5.4 Public relations staff are responsible for:

a. Entering property and recommendation information into the data base and
b. Submitting the property folder to Document Control for filing.

6.0 DEFINITIONS

6.1 ACAD: AutoCAD™, computer-aided drafting program.

6.2 Authorized limit: a level of residual radioactive material that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use.

6.3 Defense D & D: Defense Decontamination and Decommissioning.

6.4 Extended measurements: measurements or samples in addition to gamma radiation field surveying; soil samples and radon measurements.

6.5 HIG: high indoor gamma radiation measurement.

6.6 HOG: high outdoor gamma radiation measurement.

6.7 ISC: inclusion survey contractor.

6.8 Kcpm: thousand (kilo) counts per minute.

6.9 MVP Project: Monticello Vicinity Properties Project.

6.10 NEAWA: net estimated area-weighted average.

6.11 PUOR: post-UMTRA owner request; vicinity property requested to be surveyed by the owner after the cut-off date for accepting requests of July 31, 1990.

6.12 PU5: supplemental UMTRA inclusion survey performed on disturbed portions including fields of large vicinity properties usually greater than 5 acres. The original exclusion recommendation was based on a partial survey of the outlying areas as directed by the DOE.

6.13 RAC: remedial action contractor.

6.14 RDC: radon daughter concentration, usually expressed in working levels (WL).

6.15 TAC: technical assistance contractor.

6.16 UMTRA Project: Uranium Mill Tailings Remedial Action Project.

6.17 VPDMS form: vicinity property data management system form used for data entry at the UMTRA project office.

6.18 WL: working level; any combination of radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5MeV of alpha particle energy.

7.0 PROCEDURE

See Appendix 1, Inclusion Survey Report Flow Chart, for the flow-of-work pattern followed in preparing inclusion survey reports.

7.1 TEAM LEADER PREREPORT ACTIVITIES

7.1.1 Convert scintillometer count rates (kcpm) to exposure rates (μR/h).

a. Calculate exposure rates for sites with no derived conversion factor.

1. This direct conversion requires a conversion factor (CF) obtained by dividing the scintillometer count rate by the corresponding exposure rate in μR/h measured by a PIC (pressurized ionization chamber).

$$CF = \frac{y(kcpm)}{x(\mu R/h)}$$

where:

x = PIC value (μR/h)
y = gamma scintillometer value, kcpm

2. Divide the resulting conversion factor into the remaining scintillometer rates.

3. Record the calculated exposure rates on the Radiological Screening Summary sheet (Appendix 2) and the field map.

b. Calculate exposure rates for sites with a predetermined conversion factor.

1. Refer to Appendix 3, Conversion Formulas, for the appropriate conversion equation, $y = mx + b$

where:
y = gamma exposure rate, μR/h
x = scintillometer count rates, kcpm
b = y intercept

2. Record the calculated exposure rates on the Radiological Screening Summary sheet (Appendix 2) and the field map.

7.1.2 Write the following data on the field map:

a. all scintillometer rate ranges in kcpm,
b. all exposure rate ranges in μR/h,
c. HOG and HIG locations and values,
d. soil sample locations,
e. point source locations and exposure rates,
f. adjacent property address and location number if a spillover deposit is present (for UMTRA properties only),
g. posthole locations, and
h. any additional pertinent comments.

7.1.3 Enter soil sample analysis data on the Soil Sample Data Field Form (Appendix 4).

a. Obtain soil sample analysis results from the soils data base on the computer network or from the photocopy of the soil sample analysis sheet provided by extended measurements personnel.

7.1.4 Transmit copies of MVP field data to the TAC.

a. Complete soil and gamma worksheets as in 7.2.

b. Submit copies of the following to the clerical staff for transmittal to the RAC:

1. Soil Analysis Worksheet,
2. Gamma Analysis Worksheet,
3. Consent form,
4. Field map,
5. Survey Site Information sheet,
6. Radiological Screening Summary, and
7. Soil Sample Data Field Form.

7.1.5 Photographs

a. Label all site photographs with the location number.

b. Write the date surveyed on all UMTRA photographs.

c. Attach one site photograph securely to the property file.

d. For UMTRA photographs, archive one site photograph in an archive album retained by the team leader.

7.1.6 Initial and date the Property File Tracking Form in the appropriate spaces (Appendix 5).

7.1.7 Assign the property file to a team member for report writing.

7.2 CALCULATIONS

7.2.1 Calculate the net estimated area-weighted average (NEAWA) gamma exposure rate values for outdoor regions of contamination.

a. Use the Gamma Analysis Worksheet to record calculations. See Appendix 6 for a sample worksheet.

b. Field average elevated exposure rates for indoors and outdoors should be noted on the field data sheets by team leader. In the absence of this average, a mean average is calculated by the following equation:

$$G_{AV} = \frac{(G_l + G_h)}{2}$$

where:

G_{AV} = average scintillometer measurement, kcpm

G_l = low value of scintillometer measurement range, kcpm

G_h = high value of scintillometer measurement range, kcpm

c. Subtract the average background gamma exposure rate from the average gamma exposure rate of the contaminated region. The result is the net gamma exposure rate.

d. Multiply the net gamma exposure rate by the area in m^2 and divide by 100 m^2. The result is the NEAWA gamma exposure rate.

7.2.2 Calculate the NEAWA gamma exposure rate for indoor contaminated regions the same as for outdoor regions above.

a. Average over 9.3 m^2 or the area of the room, whichever is smaller, instead of 100 m^2.

b. Record calculations on the Gamma Analysis Worksheet.

7.2.3 Round the NEAWA gamma exposure rate to two significant digits for reporting purposes.

7.2.4 Compare the calculated NEAWA gamma exposure rate to the inclusion guideline of 25 μR/h above background averaged over 100 m^2 for outdoor regions and 20 μR/h averaged over 9.3 m^2 or the area of the room for indoor regions (see Reference 3.1.1, VPMIM).

a. If any NEAWA gamma exposure rate exceeds either criterion, a recommendation for inclusion may be written.

7.2.5 If there are no areas of contamination, calculate a background NEAWA gamma exposure rate of 0 for both indoor and outdoor areas on the Gamma Analysis Worksheet.

7.2.6 Calculate the NEAWA ^{226}Ra concentrations, recording calculations on the Soil Analysis Worksheet. See Appendix 7 for a sample worksheet.

a. Average the ^{226}Ra concentrations for all samples within each region at each depth (i.e., 0-15 cm, 15-30 cm).

b. Record the regional background ^{226}Ra concentration in pCi/g found in Appendix 8, from Reference 3.1.2, where average background ^{226}Ra concentrations were calculated on a state-by-state basis.

c. Record the area of the contaminated region.

d. Record the soil sample thickness as a range (e.g., 0-15 cm, 15-30 cm).

e. Use the following formula to calculate the NEAWA ^{226}Ra concentration:

$$C_{AW} = \frac{(C_{AV} - C_{BGD})(A_i)(D_i)}{(100\ m^2)(0.15\ m)}$$

where:

C_{AW} = net estimated area-weighted average ^{226}Ra concentration, pCi/g

C_{AV} = average ^{226}Ra concentration of samples, pCi/g

C_{BGD} = regional background ^{226}Ra concentration, pCi/g

A_i = area of contamination that samples represent, m^2

D_i = thickness of sample, m

7.2.7 Compare the calculated net estimated area-weighted average ^{226}Ra concentration to the inclusion criterion of ≥5 pCi/g (surface) or ≥15 pCi/g (subsurface) above background, averaged over 100 m^2 (see Reference 3.1.3).

a. If any NEAWA ^{226}Ra concentration exceeds either criterion, a recommendation for inclusion may be written.

7.2.8 For MVP, determine whether any point sources exceed the hot spot guideline (see Reference 3.1.4).

a. Record calculations on the Soil Analysis Worksheet.

b. Average areas less than 1 m^2 over 1 m^2.

c. Apply hot spot limits to areas 25 m^2 and smaller.

d. Find the appropriate calculated hot spot limits for areas from 1 to 25 m^2 in Appendix 9.

e. Subtract the background ^{226}Ra concentration from the gross average concentration to obtain the net ^{226}Ra concentration.

1. The background ^{226}Ra concentration for Monticello is 2.0 pCi/g. This value is consistent with the measurements made by the RAC (Remedial Action Contractor).

f. Compare the net ^{226}Ra concentration with the hot spot limit derived from the equation in Appendix 9 (S_{hg}) to determine if the hot spot exceeds the limits.

1. If any NEAWA ^{226}Ra concentration from an unknown or mill-related point source exceeds the hot spot guideline, a recommendation for inclusion may be written.

7.2.9 Round the resulting NEAWA ^{226}Ra concentrations to two significant digits for reporting purposes.

7.2.10 If no soil samples were taken, record "No samples taken" on the Soil Analysis Worksheet.

7.3 REPORT SKELETON

7.3.1 Choose the appropriate report skeleton:

a. UMTRA report (Appendix 10),
b. MVP report (Appendix 11),
c. PUOR report (Appendix 12),
d. PU5 report (Appendix 13),
e. UMTRA condensed report (Appendix 14),
f. MVP condensed report (Appendix 15),
g. PUOR condensed report (Appendix 16), or
h. PU5 condensed report (Appendix 17).

7.3.2 A condensed report may be written if the property meets all the following criteria:

a. The UMTRA property is not on the designated property list, or a daughter property of a spillover investigation. See Procedure TE-020.

b. The UMTRA property has no contamination other than point sources.

c. The MVP has no elevated gamma exposure rates except for natural radioactivity from dinosaur bone, petrified wood, brick, or other non-mill-related sources.

7.3.3 Write the site location number in the upper right-hand corner of each page of the report.

7.3.4 From the consent form or Survey Site Information sheet, enter the following on the cover page:

a. Address,
b. Team leader (for UMTRA reports), and
c. Report author, and report date (month and year).

7.3.5 Complete the introduction with the following information:

a. Date of radiological survey after "survdate";
b. Correct number of figures and tables;
c. For UMTRA reports, the type of conversion of gamma scintillometer measurements (kcpm) to exposure rates (μR/h) method used as appropriate; and
d. For UMTRA reports, the correct conversion factors from the Radiological Screening Summary sheet.

7.3.6 Significance of Findings:

The significance of findings describes idiosyncracies not found in the tables and briefly summarizes the survey findings. The exact wording is left to the discretion of the individual writer.

a. Provide a brief discussion of radiological results found on the site, both indoors and outdoors.

b. State the indoor and outdoor background gamma exposure rate ranges.

c. State the calculated net estimated area-weighted average gamma exposure rate and/or ^{226}Ra concentrations to support the recommendation for inclusion or exclusion.

d. It is not necessary to discuss every region of contamination if the specific exposure rate or extended measurements data are not pertinent to the recommendation.

e. For UMTRA reports, conclude by stating the site location number and recommendation for inclusion or exclusion by UMTRA.

7.3.7 Recommendation (UMTRA) or Findings (MVP):

a. For UMTRA reports, circle either "RECOMMENDED FOR: Inclusion" or "RECOMMENDED FOR: exclusion."

b. For MVP reports, check the appropriate box for "EXCEED" or "DO NOT EXCEED" the DOE guidelines.

c. Circle the applicable criteria to support the recommendation or findings. An exclusion recommendation or finding not exceeding the DOE guidelines requires that two standards be satisfied, one for indoors and one for outdoors. Only one standard need be satisfied for an inclusion recommendation or finding exceeding the DOE guideline.

7.3.8 Supplemental Standards

a. In certain situations, the radiological results may suggest an inclusion recommendation which would be inappropriate; examples of such circumstances follow:

1. Remediation may result in higher health risk to workers or the public.

2. Harm to environment outweighs potential health benefit to persons living near the site.

3. Cost of remediation outweighs the long-term benefits due to current and anticipated future use of site (e.g., tailings under roads, sidewalks, or railroad crossing).

4. No known remedial action.

5. Radionuclides other than ^{226}Ra and its decay products are present. See 40 CFR, Part 192.21, "Criteria for Applying Supplemental Standards," Reference 3.1.3.

b. If any of the above situations exists, make a recommendation for "Supplemental Standards"; the underlying reason does not have to be given.

c. State in the "Significance of Findings" and "Recommendation" sections of the report skeleton, in the letter of recommendation, and in the Vicinity Property Summary Evaluation form that supplemental standards are suggested.

7.3.9 Table 1. Location Information:

a. Enter owner and tenant information from the Survey Site Information sheet and the consent form. Include all applicable area codes and zip codes.

b. Enter the applicable two-letter property classification code from 7.6.2.

c. Enter the total area of the property in m^2, rounded to two significant digits.

1. Convert area units using the following equation:

$y = (X)(0.0929)$

where:

y = area of deposit, m^2
X = area of deposit, ft^2
0.0929 = conversion factor, m^2/ft^2

d. Briefly describe all structures present on the property.

7.3.10 Table 2. Radiological Screening Survey Results:

a. Complete a separate Table 2 for indoor and outdoor screening data from the Radiation Screening Summary sheet and the Gamma Analysis Worksheet.

b. Complete a separate Table 2 for each habitable structure surveyed, unless the structures have identical gamma exposure

rates. In this case the structures may be summarized on one table.

c. Enter a high outdoor gamma (HOG) and high indoor gamma (HIG) in every report.

d. Write "General" for Location of HOG if there are no elevated readings other than point sources. A point source cannot be a HOG or a HIG.

e. The wording may be adapted (within reason) to fit the specific site. For example, if exposure rates other than measured background are present on a site but are known not to be associated with mill tailings, the phrase "exposure rate range in elevated regions" may be substituted for "exposure rate range in contaminated regions."

f. Round off all gamma exposure rates and area measurements to two significant digits except for gamma exposure rates less than 10 μR/h, which should be rounded to one significant digit.

7.3.11 Table 3. Extended Survey Results:

a. Complete the Soil Sample Summary using the Soil Analysis Worksheet.

b. Complete the Radon Monitoring Summary from radon information provided by the extended measurements coordinator.

c. Round off all ^{226}Ra concentrations, area measurements, and annual average RDC to two significant digits.

d. Record individual alpha track radon measurements to three significant digits.

e. If any page of Table 3 is not used, draw an "X" through the page and include with the draft to inform the typist. Do not throw the page away.

7.3.12 Complete the caption for Figure 2, the property photograph, with the site location number and direction of the view shown. This information is taken from the Survey Site Information sheet.

7.3.13 Complete the property map as described in Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties.

7.4 LETTER OF RECOMMENDATION

7.4.1 Choose the appropriate letter of recommendation:

a. UMTRA letter of recommendation (Appendix 18),
b. MVP letter of recommendation (Appendix 19),
c. PUOR letter of recommendation (Appendix 20), or
d. PU5 letter of recommendation (Appendix 21).

7.4.2 Check appropriate responses in the text of the letter.

a. The evaluation basis shall reflect the measurements taken in the field.

b. The recommendation basis shall reflect the laws set out in the Federal Register (Reference 3.1.3).

7.4.3 Complete the site information at the bottom of the page.

7.4.4 Address the letter to the appropriate program manager.

a. For Grand Junction, CO, and Edgemont, SD, reports, address it to the current or acting DOE/GJPO (Grand Junction Projects Office) Project Manager.

b. For all other UMTRA site reports, address it to the current or acting DOE/UMTRA Project Manager.

c. For MVP reports, address to the Defense D & D Program Manager.

7.5 VICINITY PROPERTY SUMMARY EVALUATION

7.5.1 Choose the appropriate summary evaluation:

a. UMTRA Vicinity Property Summary Evaluation and Recommendation for all UMTRA reports or
b. MVP Vicinity Property Summary Evaluation and Findings for all MVP reports.

7.5.2 Complete all five sheets in black ink as neatly as possible. If an error is made, redo the page. Correction fluid may not be used.

7.5.3 Enter the location number at the top right-hand corner of each page.

7.5.4 Check the appropriate responses to each question on pages one and two under the column headed "Inclusion Survey Contractor (ISC)."

7.5.5 Check the correct box on page three for a recommendation for inclusion or exclusion (UMTRA reports) or whether radiation levels exceed or do not exceed the DOE guidelines (MVP reports).

7.5.6 Enter only the location number on pages four or five.

7.6 VPDMS FORM (Appendix 24)

This form is used only for UMTRA properties. Complete the following information:

7.6.1 Location ID: Site location number

7.6.2 Class: Location class code as shown below:

VL VACANT LAND: A parcel of land on which no habitable structure exists.

RS RESIDENTIAL SIMPLE: A single-family residence on a parcel of land where there is no contamination involved with the habitable structure. An attached garage is part of the habitable structure. A detached garage is not, unless it contains living quarters.

MR MAJOR RESIDENTIAL: A single-family residence on a parcel of land where contamination is associated with the habitable structure. See RS for definition of habitable structure.

SC SCHOOL: A habitable structure which serves primarily as an education facility. It may be a public or private institution.

HO HOSPITAL: A habitable structure which serves primarily as an in-patient medical care facility.

AP APARTMENT: A habitable structure containing more than one separate unit which serves as a primary dwelling.

MO MOTEL/HOTEL: A habitable structure which serves primarily as an establishment to provide lodging.

CS COMMERCIAL SIMPLE: A habitable structure which serves primarily as a place of business and is not any of the four types listed immediately above.

CC COMPLEX COMMERCIAL: A property specifically designated as such.

BU OTHER: A property which does not fit any of the above classifications.

NOTE: COMPLEX (usually) and MAJOR (always) indicate structural tailings involvement.

7.6.3 Consent Form Data

a. Enter the date the consent form was signed.

b. Enter the appropriate code from the Consent Form Status Codes table at the bottom of the VPDMS form.

7.6.4 Survey Data

a. Enter the date of the inclusion survey.

b. Enter the HIG in μR/h and the source code from the table at the bottom of the VPDMS form (I for ISC surveys).

c. Enter the HOG in μR/h and source code from the table at the bottom of the VPDMS form.

d. Enter the RDC in working levels (WL), Source and Type codes from the tables at the bottom of the VPDMS form.

e. Enter the tailing location code from the table at the bottom of the VPDMS form. This indicates the tailings location that the recommendation is based upon.

f. Enter the property and owner information from the consent form.

7.7 CONDENSED EXCLUSION REPORTS

7.7.1 Complete all report information as indicated.

7.7.2 All condensed exclusion reports must include the following:

a. Gamma Analysis Worksheet,
b. Soil Analysis Worksheet,
c. ACAD map,
d. photograph, and
e. Vicinity Property Summary Evaluation.

7.7.3 UMTRA reports must include a VPDMS form.

7.7.4 Do not complete recommendation letters for any condensed exclusion reports.

7.8 REPORT COMPLETION

7.8.1 Place the report, letter, worksheets, Vicinity Property Summary Evaluation, and VPDMS form in the location folder.

7.8.2 Initial and date the "draft preparation" space of the Property File Tracking Form (Appendix 5).

7.8.3 Submit the folder to the clerical staff for typing.

7.9 REPORT REVIEW

7.9.1 Initial Review

After the draft is typed, the team leader or assigned team member other than the report writer completes the initial review.

a. Place an ISC Report Review Checklist (Appendix 25) in the location file.

b. Examine the report and forms for correctness, consistency, and completeness.

c. Make all necessary corrections and check the appropriate boxes on the checklist.

d. Initial and date the Property File Tracking Form (Appendix 5) in the space "Team Leader Review".

e. Submit the file to typing for corrections.

7.9.2 Final Review

After the report is corrected, an assigned team member other than the report writer completes the final review.

a. Review the report and all forms as above.

b. Make all necessary corrections and check the appropriate boxes on the checklist.

c. Initial and date the Property File Tracking Form (Appendix 5) in the space "Alternate Team Review."

d. Submit the file to typing for corrections.

7.9.3 After the clerical staff corrects edits, the team leader or project manager verifies the final corrections and returns the folder to the clerical staff for transmittal.

7.10 FILE TRANSMITTAL

7.10.1 Have the appropriate project manager or designee sign the recommendation letter or condensed report and Vicinity Property Summary Evaluation form.

7.10.2 Place the following items in a manila folder stamped "Official Location Folder," and transmit to the appropriate project office:

a. Letter of recommendation,
b. VP Summary Evaluation form,
c. Two copies of the finished inclusion survey report, including one color photograph of the property.
d. Original signed access consent form,
e. Complete historical data file (if one exists),
f. Field map with raw and converted data,
g. Gamma Analysis Worksheet,
h. Soils Analysis Worksheet,
i. Copy of Soil Sample Data Field Form, and a
j. Copy of property drawing which has been shaded to show surveyed portions of the property.

7.10.3 Retain a copy of all transmitted materials in the original property file.

7.10.4 Pull the VPDMS form from the folder. Transmit all VPDMS forms completed during the month to the TAC on a monthly basis.

7.10.5 Submit the original file to the public relations department.

7.11 DATABASE ENTRY

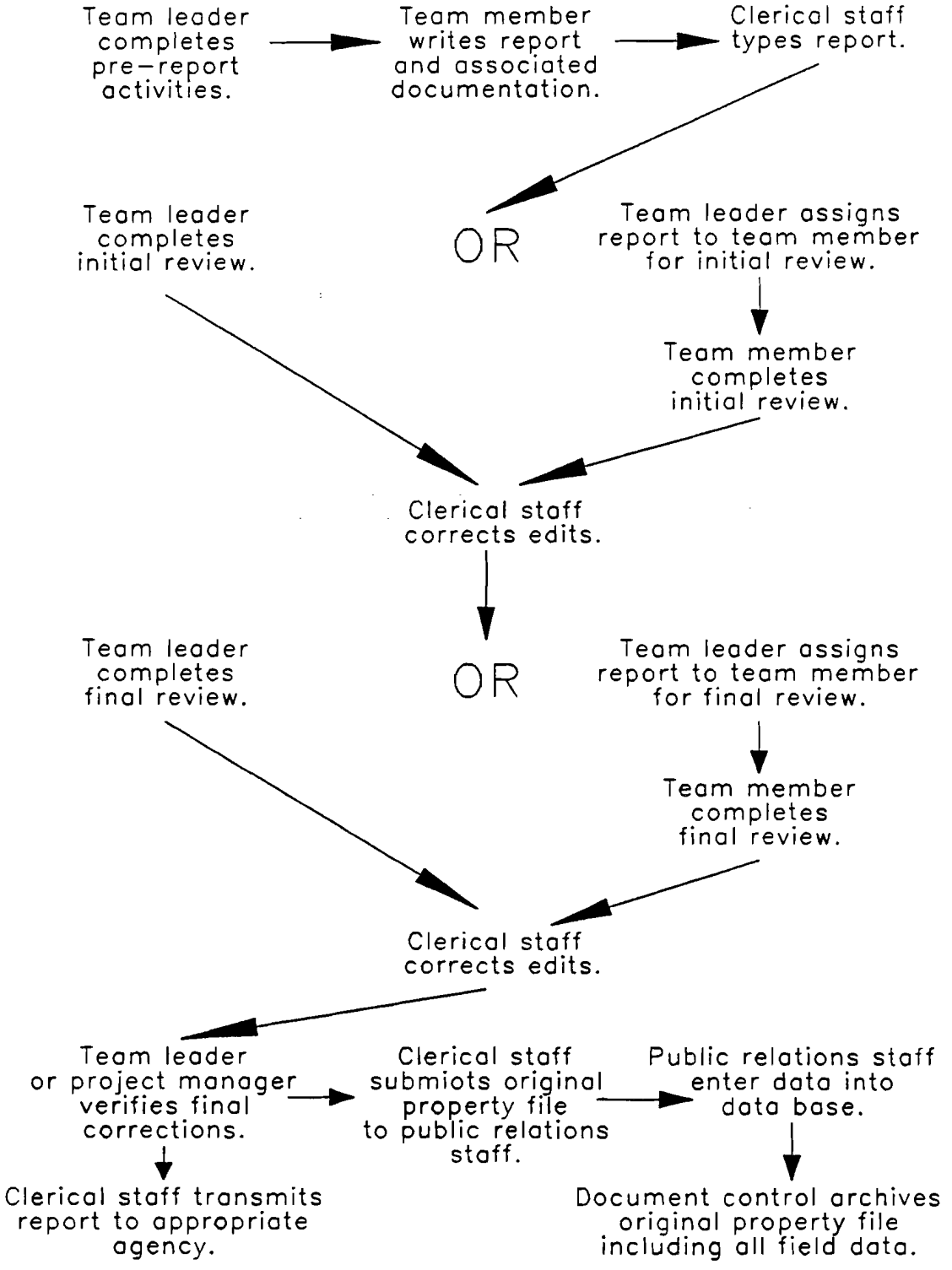
7.11.1 Enter the recommendation information into the database.

a. Use the following codes to describe the recommendation basis:

WOS Walk-on survey
01 indoor gamma
02 radon
03 outdoor gamma
04 soil samples
05 spillover

7.11.2 Submit the folder to Document Control for filing. See Procedure SU-070, Document Control.

Appendix 1. Inclusion Survey Report Flow Chart



Appendix 2. Radiological Screening Summary sheet

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h

_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000) GAMMA-RATE METER - 6"
LOCATION	PIC(uR/h)	CONVERSION(cpm/uR/h)
_____	_____	_____
_____	_____	_____
_____	_____	_____

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE: INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location_____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Appendix 3. Conversion Formulas

Grand Junction:	$y = 1.69x + 3.45$
Durango:	$y = 1.55x + 5.28$
Lowman:	$y = 1.98x + 5.92$
Green River:	$y = 1.60x + 7.34$
Gunnison:	$y = 1.47x + 10.33$
Naturita, Nucla, Slickrock and Vancorum:	$y = 1.80x + 5.64$
Rifle:	$y = 1.56x + 6.89$
Monticello:	$y = 1.46x + 7.20$

where:

y = gamma exposure rate, $\mu R/h$

x = gamma exposure rate, kcpm

Appendix 4. Soil Sample Data Field Form

OAK RIDGE NATIONAL LABORATORY SITE #_____

SOIL SAMPLE DATA FIELD FORM SURVEY DATE_____

	VISIBLE TAILING	SAMPLE NUMBER	DEPTH (M)	GAMMA kcpm	GAMMA μR/h	^{226}Ra pCi/g
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____
SAMPLE LOCATION:_____						
VISIBLE ORE__yes__no		____	Surface	____	____	____
BACKGROUND						
SAMPLE __yes__no	____	____	____	____	____	____
AREA REP:_____						
OTHER DESCRIPTION:	____	____	____	____	____	____
_____						
_____	____	____	____	____	____	____

Appendix 5. Property File Tracking Form

**********PROPERTY FILE TRACKING FORM**********

SITE NUMBER PARCEL NUMBER PROPERTY CLASS
ADDRESS

	Date Sent	Date Received	Status
Consent Form	/ /	/ /	
Follow-up			

	Date Tel.	Personal Visit	Status
Other Contact			

	Assigned	Completed	Drawing By
Graphics	/ /	/ /	

********** RADIATION SURVEY AND REPORT TRACKING **********

	DATE ASSIGNED	DATE PERFORMED
SURVEY DATE	PRC.CORD. INITIALS	TEAM LEADER INITIALS
	_____	_____

DATE & INITIALS

Soils Results _____ Data Conversion _____
Data Archiving _____ Photos _____

****

	Date compl/initials		Date compl/initials
Draft Preparation	_____ >TYPING	Requires Radon Sampling	_____
Team Leader Review	_____	Radon Sampling Complete	_____
Alternate Team Review	_____	Requires Drilling/Auger	_____
Process Coordinator	_____ > TYPING	Drilling/Auger Complete	_____
Transmittal Letter	_____		

****

SPILLOVER DATA

Loc.No.	Parcel No.	Address
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

DOE Action	INCL/EXCL	DATE	RETURNED DATE
	_____	_____	_____

Comments _____

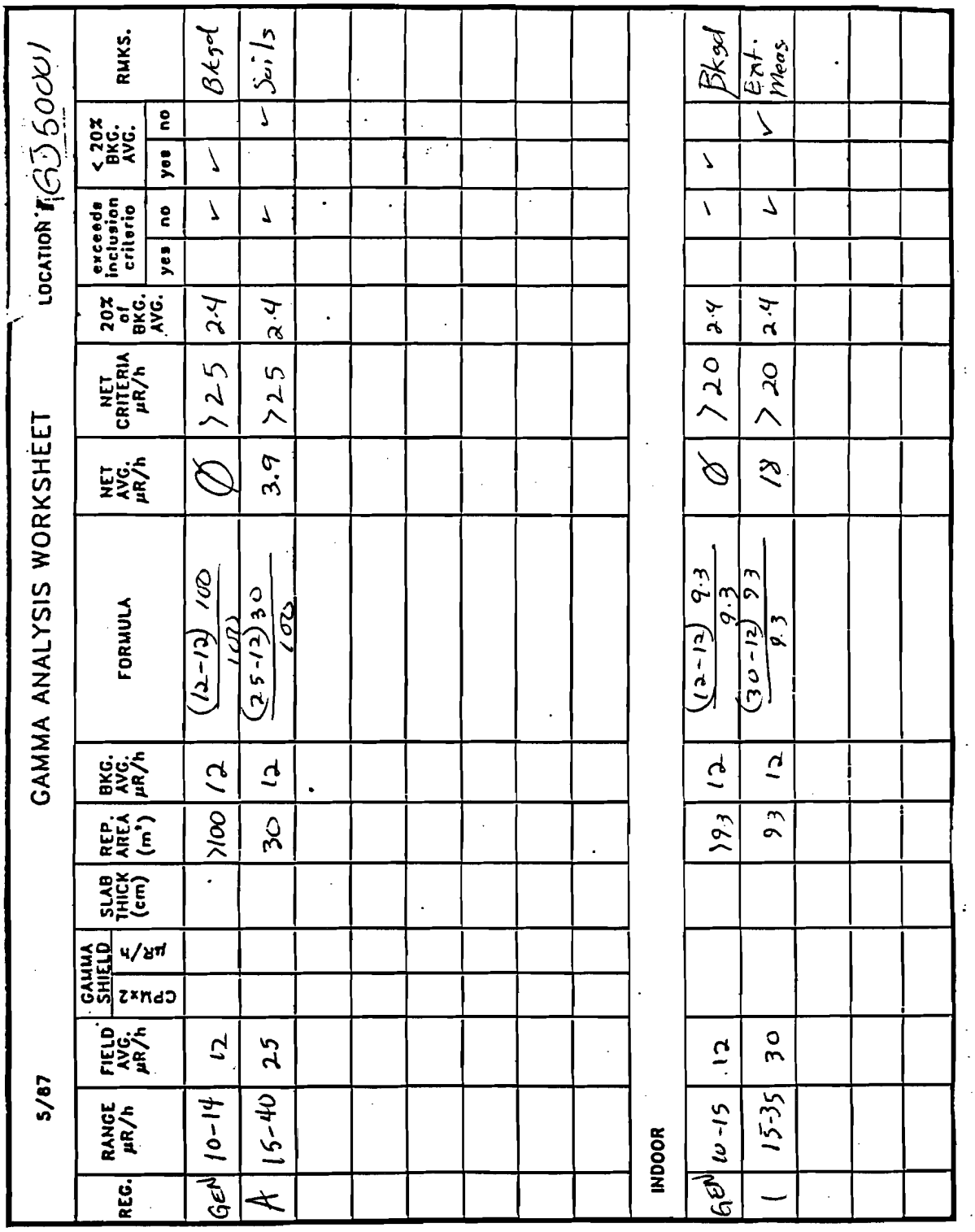
	Date complete & initials		Date complete & initials
Changes	_____	Transmittal letter	_____
Typing	_____	Resubmittal	_____

DOE Action	INCL/EXCL	DATE	RETURNED DATE
	_____	_____	_____

Comments _____

UCN17179 (9/90)

Appendix 6. Gamma Analysis Worksheet



GAMMA ANALYSIS WORKSHEET

5/87

LOCATION 1GD500U

REG.	RANGE µR/h	FIELD AVG. µR/h	GAMMA SHIELD CPM x 2	GAMMA SHIELD µR/h	SLAB THICK (cm)	REP. AREA (m²)	BKG. AVG. µR/h	FORMULA	NET AVG. µR/h	NET CRITERIA µR/h	20% of BKG. AVG.	exceeds inclusion criteria yes	exceeds inclusion criteria no	< 20% BKG. AVG. yes	< 20% BKG. AVG. no	RMKS.
GEN	10-14	12				>100	12	(12-12) 100 / 100	Ø	>25	2.4		✓	✓		Bkgd
A	15-40	25				30	12	(25-12) 30 / 100	3.9	>25	2.4		✓		✓	Soils
INDOOR																
GEN	10-15	12				193	12	(12-12) 9.3 / 9.3	Ø	>20	2.4		-	✓		Bkgd
1	15-35	30				93	12	(30-12) 93 / 9.3	18	>20	2.4		✓		✓	Ext. Meas

Appendix 7. Soil Analysis Worksheet

SOIL ANALYSIS WORKSHEET

LOCATION # GJ 50001

SAMPLE NBR(S)	REGION SMPLD	(LAB) RA-226 CONC. pCi/g		AVG. RA-226 CONC. pCi/g	(BKG) RA-226 CONC. pCi/g	REP. AREA SQUARE METERS	SOIL SAMPLE THICKNESS IN (m)	FORMULA	NET RA-226 CONC. pCi/g	NET CRITERIA pCi/g	RMKS.
		SMPL 1	SMPL 2								
S1A/S2A	A	10.3	19.8	15.1	1.4	30	.15	$\frac{(15.1-1.4)(15)(30)}{(.15)(100)}$	4.11	>5	Excl
S1B/S2B	A	17.6	15.2	16.4	1.4	30	.15	$\frac{(16.4-1.4)(15)(30)}{(.15)(100)}$	4.5	>15	Excl

Appendix 8. Background Concentrations of ^{226}Ra in Surface Soil

State	pCi/g
Alabama	0.82
Alaska	0.65
Arizona	0.95
California	0.77
Colorado	1.4
Delaware	1.2
Florida	0.84
Georgia	0.88
Idaho	1.1
Illinois	0.97
Indiana	1.1
Kansas	0.97
Kentucky	1.5
Louisiana	0.71
Maryland	0.72
Michigan	1.1
Mississippi	1.2
Missouri	1.1
Nevada	1.5
New Jersey	0.87
New Mexico	1.5
New York	0.85
North Carolina	0.78
Ohio	1.5
Oregon	0.82
Pennsylvania	1.2
Tennessee	1.1
Texas	0.89
Utah*	1.3
Virginia	0.85
West Virginia	1.3
Wyoming	1.0

*Note: the background ^{226}Ra concentration for Monticello, Utah, is 2.0 based on measurements by the RAC.

Appendix 9. Hot Spot Limits

To calculate the hot spot limit:

$$S_{hg} = S_g \times (100\ m^2/A)^{1/2}$$

where:

S_{hg} = the hot spot limit, pCi/g

S_g = the authorized limit (5 pCi/g for surface soil or 15 pCi/g for subsurface soil)

A = the area of the hot spot in m^2

Appendix 9. (continued)

SURFACE SOILS		SUB-SURFACE SOILS	
Area (m^2)	Limit (pCi/g)	Area (m^2)	Limit (pCi/g)
1.0	50.0	1.0	150.0
1.5	41.0	1.5	122.0
2.0	35.0	2.0	106.0
2.5	32.0	2.5	95.0
3.0	29.0	3.0	87.0
3.5	27.0	3.5	80.0
4.0	25.0	4.0	75.0
4.5	24.0	4.5	71.0
5.0	22.0	5.0	67.0
5.5	21.0	5.5	64.0
6.0	20.0	6.0	61.0
6.5	20.0	6.5	59.0
7.0	19.0	7.0	57.0
7.5	18.0	7.5	55.0
8.0	18.0	8.0	53.0
8.5	17.0	8.5	51.0
9.0	17.0	9.0	50.0
9.5	16.0	9.5	49.0
10.0	16.0	10.0	47.0
11.0	15.0	11.0	45.0
12.0	14.0	12.0	43.0
13.0	14.0	13.0	42.0
14.0	13.0	14.0	40.0
15.0	13.0	15.0	39.0
16.0	13.0	16.0	38.0
17.0	12.0	17.0	36.0
18.0	12.0	18.0	35.0
19.0	11.0	19.0	34.0
20.0	11.0	20.0	34.0
21.0	11.0	21.0	33.0
22.0	11.0	22.0	32.0
23.0	10.0	23.0	31.0
24.0	10.0	24.0	31.0
25.0	10.0	25.0	30.0

Appendix 10. UMTRA Report Skeleton

page 1

Location Number (GJ5000)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF INCLUSION SURVEY AT LOCATION GJ 50001
address 777 Home Court
Grand Junction, CO

Investigation Team

C. A. Little - Pollutant Assessment Group Leader
M. L. Espegren - PAG/UMTRA Project Coordinator
A.Z. Eames - Survey Team Leader

Author's Name Sam Berkoff

Date January 92

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 10. (continued)

Location Number: GJ50001

REPORT OF INCLUSION SURVEY AT LOCATION GJ50001
address 777 Home Ct
Gr. Jct. CO

INTRODUCTION

An inclusion radiological survey of location GJ50001 was conducted on (survdate) July 19 1990~~1988~~ by Oak Ridge National Laboratory. This property consists of a Single family residence. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG UMTRA Project Procedures Manual (April 1987). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1 (a and b). A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted. If presented, radon daughter concentrations result from radon measurements which were converted to working levels, assuming a 50% equilibrium factor.

(Insert for Direct Conversion)
The conversion formula used is y = x/CF, where "y" equals the exposure rate in μR/h, "x" equals the scintillometer measurements in kcpm, and "CF" equals the conversions factor determined in the field through a direct correlation between PIC and scintillometer measurements in kcpm/μR/h. For this property, CF equals ._____ for uncontaminated regions, ._____ for contaminated regions, and ._____ for indoor/other regions.

(or Insert for Conversion Equation):
The conversion formula used is y = mx + b, where "y" equals the exposure rate in μR/h, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 3.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

A complete gamma radiation screening of this property revealed a background gamma exposure rate ranges of 10-14 μR/h outdoors and 10-15 μR/h indoors.

Outdoors, one region of elevated gamma exposure rates was found (15-40 μR/h) (Region A, Figure 1a). Region A had a NEAWA gamma

Appendix 10. (continued)

Location Number: GJ50001

exposure rate of 3.9 μR/h. Radionuclide analysis of samples taken (Table 3) revealed NEAWA ^{226}Ra concentrations of 4.1 pCi/g for surface soils and 4.5 pCi/g for subsurface soils. These concentrations do not exceed the E.P.A. inclusion criteria of 5 pCi/g for surface soils and 15 pCi/g for subsurface soils. One point source, identified as ore, was found in the shed and had a gamma exposure rate of 600 μR/h. It was removed at the owners request.

Indoors, one region of elevated gamma exposure rates was found in the southeast bedroom with a gamma exposure rate range of 15-35 μR/h. The NEAWA gamma exposure rate was 18 μR/h which exceeds 20% of the background average. Three valid measurements for ^{222}Rn concentrations were taken. When converted to Radon daughter concentrations (RDC), they result in an annual average RDC of .031 WL which is greater than the EPA criterion of 0.02 WL (Table 3)

Based on these findings, it is recommended that location GJ50001 be included for further concideration by the UMTRA Project.

Appendix 10. (continued)

page 4

Location Number: GJ 50001

RECOMMENDATION

RECOMMENDED FOR:	Inclusion
RECOMMENDED FOR:	Exclusion
RECOMMENDATION BASIS:	Outdoor gamma is >25 μR/h above background averaged over 100 m^2
RECOMMENDATION BASIS:	Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Spillover from includable deposit on an adjoining property
RECOMMENDATION BASIS:	Indoor gamma is >20 μR/h above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is < the acceptable difference or 20% above background in all rooms
RECOMMENDATION BASIS:	Grab sample radon daughter concentration is >0.04 WL
RECOMMENDATION BASIS:	Grab sample radon daughter concentration is >0.01 WL
RECOMMENDATION BASIS:	Annual average radon daughter concentration is >0.02 WL
RECOMMENDATION BASIS:	Annual average radon daughter concentration is <0.02 WL

Appendix 10. (continued)

page 5

Location Number: GJ 50001

Table 1. Location Information

Property Information

LOCATION: 777 Home Court
Grand Junction, CO

OCCUPANT/TENANT: James T. Brothers

TELEPHONE: 247-8000 (H)
247-0001 (B)

PROPERTY CLASSIFICATION: Residential Major

TOTAL AREA OF PROPERTY: 1,100 m^2

STRUCTURES ON PROPERTY: 1- Single story brick house w/ c.s.
1- Garage - S-06
1- Shed - w/ dirt floor

Owner Information

OWNER: Alice B. Toklass

ADDRESS: 52960 117th St. West #672
San Francisco, CA 91277

TELEPHONE: 902-677-8210 (H)
902-821-7211 (B)

Appendix 10. (continued)

Location Number: GJ 50001

Table 2. Radiological Screening Survey Results

Outdoor Screening Data

BACKGROUND EXPOSURE RATE: 12 µR/h

BACKGROUND + 20%: 14 µR/h

BACKGROUND EXPOSURE RATE RANGE: 10-14 µR/h

EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:
A: 15-0 µR/h
B: ~~µR/h~~
C: ~~µR/h~~

HIGHEST OUTDOOR GAMMA (HOG) IN CONTAMINATED REGION: 40 µR/h

LOCATION OF HOG: Region A

POINT SOURCE *: 600 µR/h

ESTIMATED AREA OF OUTDOOR CONTAMINATION BY REGION:
A: 30 m²
B: ~~m²~~
C: ~~m²~~

NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION**:
A: 3.9 µR/h
B: ~~µR/h~~
C: ~~µR/h~~

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $G_{AW} = \frac{\sum_{i=1}^{n} G_i A_i}{100}$

where:
G_{AW} = the area-weighted exposure rate in [µR/h]
G_i = net average exposure rate in [µR/h]

($G_i = G_{Gross} - G_{Background}$)
A_i = area of region involved in [m²] and,
100 = threshold area in [m²]

Appendix 10. (continued)

page 7

Location Number: GJ 5000

Table 2. Radiological Screening Survey Results (Continued)

Indoor Screening Data

STRUCTURE DESCRIPTION OR NUMBER:	House
BACKGROUND EXPOSURE RATE:	12 µR/h
BACKGROUND + 20%:	14 µR/h
BACKGROUND EXPOSURE RATE RANGE:	10-15 µR/h
EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:	1: 15-35 µR/h 2: ~~µR/h~~ 3: ~~µR/h~~
HIGHEST INDOOR GAMMA (HIG) IN CONTAMINATED REGION:	35 µR/h
LOCATION OF HIG:	Region 1
POINT SOURCE*:	none µR/h
ESTIMATED AREA OF INDOOR CONTAMINATION BY REGION:	1: > 9.3 m² 2: ____ m² 3: ____ m²
NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION/ROOM**:	1: 18 µR/h 2: ____ µR/h 3: ____ µR/h

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $x = \frac{\sum_{i=1}^{n} G_i A_i}{9.3}$

where:

x = area-weighted gamma exposure rate [µR/h]

G_i = net gamma exposure rate in [µR/h]

A_i = area of deposit in [m²]

9.3 = threshold area in [m²]

Appendix 10. (continued)

page 8 Location Number: GJ 50001

Table 3. Extended Survey Results

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, CAW)
S1A	A	0-15	10	30	4.1
S2A			20		
S1B	A	15-30	18	30	4.5
S2B			15		

*Formula used $CAW = \frac{\sum_{i=1}^{n} CiAiDi}{(100)(.15)}$

where- C_{AW} = area-weighted ^{226}Ra concentration in [pCi/g]
C_i = net ^{226}Ra concentration in [pCi/g] and

($Ci = C_{analysis} - C_{background}$)
A_i = area of region that sample represents in [m^2]
D_i = thickness of sample in [m]
100 = threshold area in [m^2], and
.15 = threshold thickness in [m]

Appendix 10. (continued)

page 9

Location Number: GJ 50001

Table 3. Extended Survey Results (continued)

Indoor Extended Data

Radon Monitoring Summary

Region	Room	Date	RDC (WL)	Annual Average RDC (WL)**
1	S.E. Bedroom	Aug 17, 1990	0.0361	0.031
		Dec 1, 1990	0.0303	
			0.0272	

** Formula used: $WL = \frac{(WLR)\ (Rn)}{100}$

where: WL = Working Level
WLR = .5 (WL ratio as per VPMIM assuming 50% equilibrium)
Rn = Average ^{222}Rn concentration in pCi/l as reported by vendor.

**Annual average (WL) determined by: Oak Ridge National Laboratory - Terradex Track Etch^{R} Type SF Air Monitors

Appendix 10. (continued)

page 10

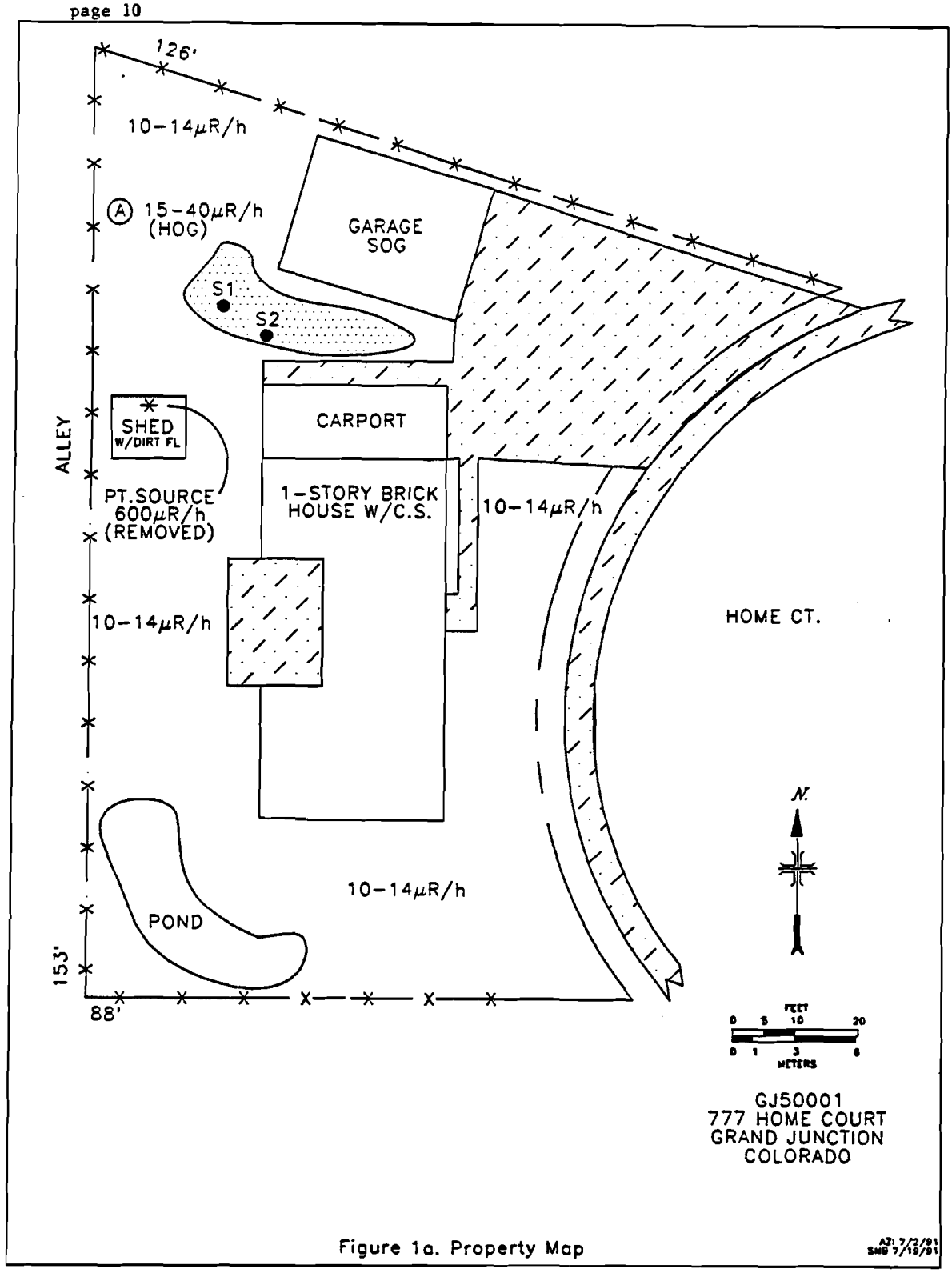
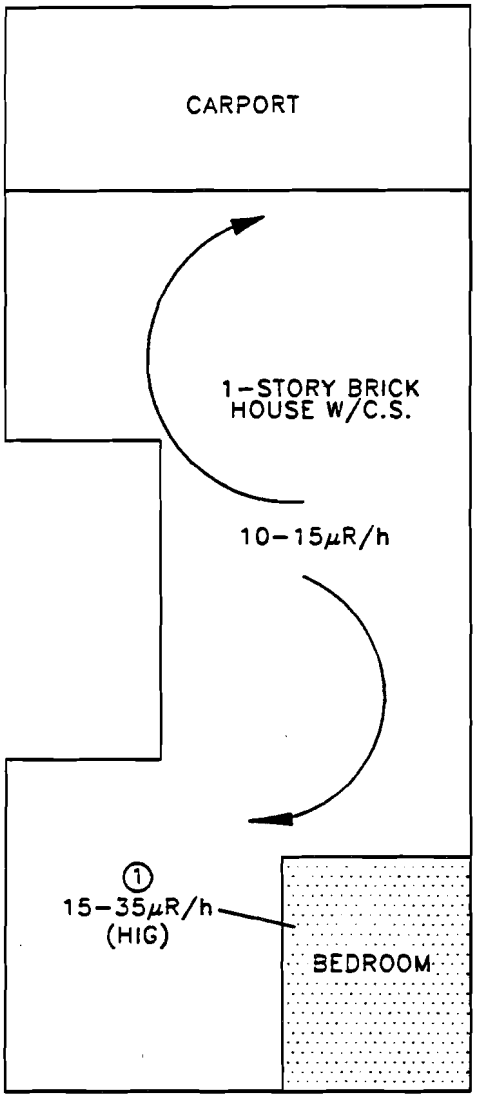


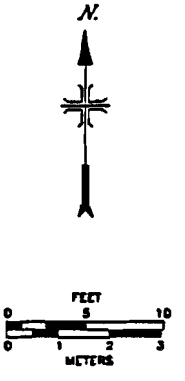
Figure 1a. Property Map

AZ1 7/2/91
SMB 7/18/91

Appendix 10. (continued)

page 11





GJ50001
777 HOME COURT
GRAND JUNCTION
COLORADO

Figure 1b. Property Map

AZ1 7/2/91
SMB 7/10/91

Appendix 10. (continued)

page 12

Figure 1. Location GJ5000! 777 Home Ct., Grand Junction, Colorado

Figure 2. Location GJ5000!, looking W at the front of the property.

Appendix 11. MVP Report Skeleton

Location Number MSXXXXX

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF RADIOLOGICAL SURVEY AT LOCATION MSXXXXX
19 South 1st West Street
MONTICELLO, UT 84535

Investigation Team

B. A. Berven - Environmental Measurements and Applications Section
C. A. Little - Pollutant Assessment Group Leader
M. J. Wilson - MVP-IVC Project Manager

S. K. Mather

July 1991

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 11. (continued)

Location Number: MSXXXXX

REPORT OF RADIOLOGICAL SURVEY AT LOCATION MSXXXXX
19 South 1st West Street
MONTICELLO, UT 84535

INTRODUCTION

The Surplus Facilities Management Program (SFMP) was established by the Department of Energy (DOE) in 1978. SFMP is responsible for managing the maintenance and surveillance of numerous DOE-owned radioactively contaminated facilities that have been declared surplus, and conducting a program leading to the ultimate disposition of those facilities. The SFMP's fundamental responsibility is to protect the public health and the environment from potentially harmful radioactive contamination contained within or derived from DOE-owned facilities. The Monticello mill site was declared surplus in 1981 and is currently awaiting remedial action to bring its condition up to present decontamination and reclamation standards. Prior to performing remedial action on the mill site, the properties surrounding the site and designated privately owned properties in Monticello are being assessed. Oak Ridge National Laboratory (ORNL) was directed by the DOE in July 1988 to assess the radiological condition of privately owned properties in Monticello which have been identified as possibly containing mill-related materials. If radiation levels on these properties exceed EPA and DOE standards, the property is eligible for clean-up under the Surplus Facilities Management Program. These assessments are referred to as screening and scoping surveys. A detailed investigation is referred to as a "screening" survey and an abbreviated form as a "scoping" survey.

A radiological screening survey of location MSXXXXX was conducted on (survdate) 06/01/91 ~~1989~~ by Oak Ridge National Laboratory. This property consists of a single family residence
This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG UMTRA Project Procedures Manual (April 1987), the Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program (April 1987) and the U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) (Revision 2, March 1987). The radiological survey of this property included: (1) a gamma scan of the entire ground surface outdoors and indoors; (2) samples of outdoor soil; and (3) evaluation of historical data when present. The gamma scan was conducted using a Victoreen Portable Ratemeter, Model 490 which is a gamma scintillometer.

General location information is provided in Table 1, radiological survey results are given in Tables 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

Appendix 11. (continued)

page 3

Location Number: MSXXXXX

SIGNIFICANCE OF FINDINGS

A complete gamma radiation scan was conducted on this property yielding background gamma exposure rate ranges of 12-15 uR/h outdoors and 12-14 uR/h indoors.

One area of elevated gamma exposure rates was detected and labeled Region A (Figure 1). Radionuclide analysis of soil sample S1 taken from Region A yielded a ^{226}Ra concentration of 47 pCi/g. This value exceeds the DOE Hot Spot guidelines for surface soils of areas 5 m^2 (Table 3).

A point source with a gamma exposure rate of 110 uR/h was located in a rock garden in the front yard. it was a piece of petrified wood and the property owner requested that it be left in place.

Appendix 11. (continued)

page 4

Location Number: MSXXXXX

FINDINGS

SITE CONTAINS RADIATION LEVELS WHICH [X] EXCEED [ ] DO NOT EXCEED THE DOE GUIDELINES BELOW:

Outdoor gamma is >25 μR/h above background averaged over 100 m^2

Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2

^{226}Ra is > the Hot Spot Guideline

^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

Spillover from includable deposit on an adjoining property

Indoor gamma is >20 μR/h above background averaged in any room

Indoor gamma is < the acceptable difference or 20% above background in all rooms

Appendix 11. (continued)

page 5

Location Number: MSXXXXX

Table 1. Location Information

Property Information

LOCATION:	19 South 1st West Street Monticello, UT 84535
OCCUPANT/TENANT:	Holden Caulfield
TELEPHONE:	801-555-1234
PROPERTY CLASSIFICATION:	Residential, Simple
TOTAL AREA OF PROPERTY:	3200 m²
STRUCTURES ON PROPERTY:	1 single story brick house with basement 2 sheds, 1-slab-on-grade, 1 dirt floor

Owner Information

OWNER:	Holden Caulfield
ADDRESS:	PO Box 999 Monticello, UT 84535
TELEPHONE:	same as above

Appendix 11. (continued)

Location Number: MSXXXXX

Table 2. Radiological Screening Survey Results

Outdoor Screening Data

BACKGROUND EXPOSURE RATE: 14 µR/h

BACKGROUND + 20%: 17 µR/h

BACKGROUND EXPOSURE RATE RANGE: 12-15 µR/h

EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:
A: 16-26 µR/h
B: ~~µR/h~~
C: ~~µR/h~~

HIGHEST OUTDOOR GAMMA (HOG) IN CONTAMINATED REGION: 26 µR/h

LOCATION OF HOG: Region A

POINT SOURCE *: 110 µR/h

ESTIMATED AREA OF OUTDOOR CONTAMINATION BY REGION:
A: 5 m²
B: ~~m²~~
C: ~~m²~~

NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION**:
A: <1.0 µR/h
B: ~~µR/h~~
C: ~~µR/h~~

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $G_{AW} = \frac{\sum_{i=1}^{n} G_i A_i}{100}$

where: G_{AW} = the area-weighted exposure rate in [µR/h]
G_i = net average exposure rate in [µR/h]

$(G_i = G_{Gross} - G_{Background})$
A_i = area of region involved in [m²] and,
100 = threshold area in [m²]

Appendix 11. (continued)

page 7

Location Number: MSXXXXX

Table 2. Radiological Screening Survey Results (Continued)

Indoor Screening Data

STRUCTURE DESCRIPTION OR NUMBER: All structures

BACKGROUND EXPOSURE RATE: 13 µR/h

BACKGROUND + 20%: 16 µR/h

BACKGROUND EXPOSURE RATE RANGE: 12-14 µR/h

EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:
1: µR/h
2: µR/h
3: µR/h

HIGHEST INDOOR GAMMA (HIG) ~~IN CONTAMINATED REGION:~~ 14 µR/h

LOCATION OF HIG: ~~Region~~ General

POINT SOURCE*: None µR/h

ESTIMATED AREA OF INDOOR CONTAMINATION BY REGION:
1: m²
2: m²
3: m²

NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION/ROOM**: 3 µR/h
1: µR/h
2: µR/h
3: µR/h

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $x = \frac{\sum_{i=1}^{n} G_i A_i}{9.3}$

where:

x = area-weighted gamma exposure rate [µR/h]

G_i = net gamma exposure rate in [µR/h]

A_i = area of deposit in [m²]

9.3 = threshold area in [m²]

Appendix 11. (continued)

Location Number: M.5XXXXX

Table 3. Extended Survey Results

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, CAW)	Hot Spot Guideline** (pCi/g)
51	A	0-15	47	5	2.3	>22

$$*\text{Formula used CAW} = \frac{\sum_{i=1}^{n} CiAiDi}{(100)\ (.15)}$$

where-
C_{AW} = area-weighted ^{226}Ra concentration in [pCi/g]
C_i = net ^{226}Ra concentration in [pCi/g] and

($Ci = C_{analysis} - C_{background}$)
A_i = area of region that sample represents in [m^2]
D_i = thickness of sample in [m]
100 = threshold area in [m^2], and
.15 = threshold thickness in [m]

$**Shg = Sg * (100\ m^2/A)^{1/2}$
where, Shg = the Hot Spot Limit (pCi/gram)
Sg = the Authorized Limit for a specific site (pCi/g)
A = the area of the Hot Spot in square meters

$(100/A)^{1/2}$ is the Hot Spot multiplication factor

Appendix 11. (continued)

page 9

Location Number: MSXXX

Table 3. Extended Survey Results (continued)

Indoor Extended Data

Radon Monitoring Summary

Region	Room	Date	RDC (WL)	Annual Average RDC (WL)**

** Formula used: $WL = \frac{(WLR)\ (Rn)}{100}$

where: WL = Working Level
WLR = .5 (WL ratio as per VPMIM assuming 50% equilibrium)
Rn = Average ^{222}Rn concentration in pCi/l as reported by vendor.

**Annual average (WL) determined by: Oak Ridge National Laboratory - Terradex Track Etch® Type SF Air Monitors

Appendix 11. (continued)

page 10

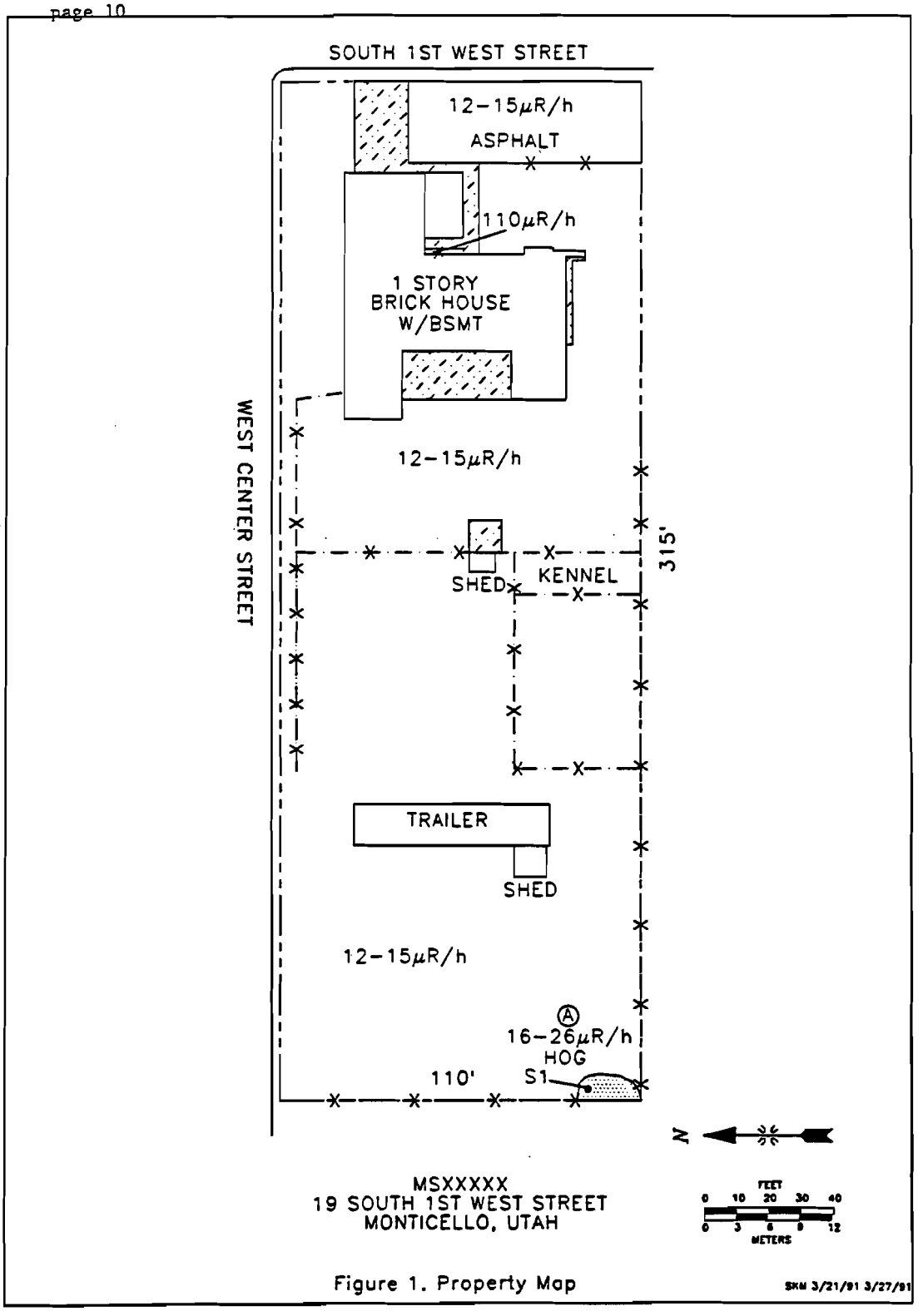


Figure 1. Property Map

SKM 3/21/91 3/27/91

Appendix 11. (continued)

page 11

Figure 2. Location MSXXXXX, looking west at the front of the property.

Appendix 12. PUOR Report Skeleton

The PUOR Skeleton includes pages 1 and 2 following, and pages 3-12 of the UMTRA report skeleton.

page 1
PUOR SKELETON

Location Number (_____)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF INCLUSION SURVEY AT LOCATION _____
address_____
_____

Investigation Team

C. A. Little - Pollutant Assessments Group Leader
J. A. Rice - PAG/UMTRA Project Coordinator
- Survey Team Leader

Author's Name_____

Date_____

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 12. (continued)

Location Number:_____

REPORT OF INCLUSION SURVEY AT LOCATION _____
address_____
_____

INTRODUCTION

The Department of Energy announced a cut-off date of July 31, 1990 for accepting requests for radiological surveys from property owners. The request to survey location_____ was accepted after the cut-off date.

An inclusion radiological survey of this location was conducted on (survdate) _____, 1991 by Oak Ridge National Laboratory. This property consists of_____. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988), and the ORNL PAG Procedures Manual (February 1991). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

The conversion formula used is $y = mx + b$, where "y" equals the exposure rate in $\mu R/h$, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 1.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 13. PU5 Report Skeleton

The PU5 skeleton includes pages 1, 2, 4, and 5 following, and pages 3, 6-12 of the UMTRA report skeleton.

page 1
PU5 SKELETON (8/91) Location Number (_____)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF SUPPLEMENTAL INCLUSION SURVEY AT LOCATION _____
address_____
_____

Investigation Team

C. A. Little - Pollutant Assessments Group Leader
J. A. Rice - PAG/UMTRA Project Coordinator
- Survey Team Leader

Author's Name_____

Date_____

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 13. (continued)

Location Number: _____

REPORT OF SUPPLEMENTAL INCLUSION SURVEY AT LOCATION _____
address_____
_____

INTRODUCTION

A supplemental inclusion radiological survey of location _____ was conducted on (survdate)_____, 1991 by Oak Ridge National Laboratory. This property consists of_____. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988), VPMIM Directive #E8 (December 1990), and the ORNL PAG Procedures Manual (February 1991). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

The conversion formula used is $y = mx + b$, where "y" equals the exposure rate in $\mu R/h$, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 1.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 13. (continued)

page 4

Location Number: _____

RECOMMENDATION

RECOMMENDED FOR:	Inclusion
RECOMMENDED FOR:	Exclusion
RECOMMENDATION BASIS:	Outdoor gamma is >25 mR/h above background averaged over 100 m^2
RECOMMENDATION BASIS:	Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Spillover from includable deposit on an adjoining property
RECOMMENDATION BASIS:	Indoor gamma is >20 mR/h above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is < the acceptable difference or 20% above background in all rooms

Appendix 13. (continued)

page 5

Location Number: _____

Table 1. Location Information

Property Information

LOCATION: _____

OCCUPANT/TENANT: _____

TELEPHONE: _____ (H)
_____ (B)

PROPERTY CLASSIFICATION: _____

TOTAL AREA OF PROPERTY: _____ m^2

Owner Information

OWNER: _____

ADDRESS: _____
_____

TELEPHONE: _____ (H)
_____ (B)

Appendix 14. UMTRA Condensed Report Skeleton

page 1

Location Number:_____
Location Address:_____
_____
Date of Issue:___(month/year)_____
Survey Date:_____

ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG/UMTRA Project Procedures Manual (April 1987). This property is recommended for exclusion from further consideration by the SFMP project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

-Outdoor Screening Data-
Exposure Rate Range(s) _____ µR/h
Background Exposure Rate + 20%: _____ µR/h
High Outdoor Gamma (HOG): _____ µR/h
Point Source(*): _____ µR/h

-Indoor Screening Data-
Exposure Rate Range(s): _____ µR/h
Background Exposure Rate + 20%: _____ µR/h
High Indoor Gamma (HIG): _____ µR/h
Point Source(*): _____ µR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

Appendix 14. (continued)

page 2

Figure 2. Location _____

Appendix 15. MVP Condensed Report Skeleton

The MVP condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

Location Number: xx???
Location Address:
Monticello, Utah 84535
Date of Issue: January 1991
Survey Date:

MVP-ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG Procedures Manual (April 1987). This property is recommended for exclusion from further consideration by the SFMP-MVP project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s):
Owner Address:
Monticello, Utah 84535

-Outdoor Screening Data-
Exposure Rate Range(s) μR/h
Background Exposure Rate + 20%: μR/h
High Outdoor Gamma (HOG): μR/h
Non Mill-related Point Source(*): μR/h

-Indoor Screening Data-
Exposure Rate Range(s): μR/h
Background Exposure Rate + 20%: μR/h
High Indoor Gamma (HIG): μR/h
Non Mill-related Point Source(*): μR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)

Comments:

Inclusion Survey Contractor

DOE Evaluator

Appendix 16. PUOR Condensed Report Skeleton

The PUOR condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

page 1 of 2

PUOR SHORT FORM
OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Location Number:_____
Location Address: _____
_____
Date of Issue:_____
Survey Date:_____

ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

The Department of Energy announced a cut-off date of July 31, 1990 for accepting requests for radiological surveys from property owners. The request to survey this location was accepted after the cut-off date.

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the ORNL PAG Procedures Manual (February 1991). This property is recommended for exclusion from further consideration by the UMTRA Project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

-Outdoor Screening Data-
Exposure Rate Range(s): _____ µR/h
Background Exposure Rate + 20%: _____ µR/h
High Outdoor Gamma (HOG): _____ µR/h
Point Source(*): _____ µR/h

-Indoor Screening Data-
Exposure Rate Range(s): _____ µR/h
Background Exposure Rate + 20%: _____ µR/h
High Indoor Gamma (HIG): _____ µR/h
Point Source(*): _____ µR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)

No soils taken

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

Appendix 17. PU5 Condensed Report Skeleton

The PU5 condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

page 1 of 2

PU5 SHORT FORM

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Location Number:_____
Location Address:_____
_____
Date of Issue:_____
Survey Date:_____

Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P.O. Box 2567
Grand Junction, CO 81502

Dear Mr. Tucker:

By letter from Mark L. Matthews to Douglas K. Halford, dated April 22, 1991, the UMTRA Project Office of the Department of Energy requested that Oak Ridge National Laboratory (ORNL) return to certain vicinity properties to perform outdoor surveys on lands associated with properties that were previously excluded.

Based on data taken during the supplemental survey of the location noted above, there is no change in the original recommendation that the property be excluded from further consideration by the UMTRA Project. Results of the survey follow:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

Area surveyed: see attached map

-Screening Data-

Exposure Rate Range(s)	μR/h
Background Exposure Rate + 20%:	μR/h
High Outdoor Gamma (HOG):	μR/h
Point Source(*):	μR/h

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

(8/91)

Appendix 18. UMTRA Letter of Recommendation

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Area Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix A, and/or [] other criteria stated below.

Other:

_____

_____

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
_____
Property Owner:_____
Owner Address:_____
_____
Tenant:_____

Appendix 19. MVP Letter of Recommendation

A. F. Kluk
Defense D & D Program Manager
Environmental Restoration and Waste Management
Northwestern Programs Branch
U.S. Department of Energy (MS-EM-423)
Washington, DC 20545

Dear Dr. Kluk:

Radiation levels at the property identified below appear [] to [] not to exceed the guidelines specified by the U.S. Department of Energy for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program Sites (SFMP) [Revision 2, March 1987].

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix A, and/or [] Hot Spot Guideline.

Other:_____

_____

This finding is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number: _____
Location Address: _____
Monticello, Utah 84535
Property Owner: _____
Owner Address: _____
Monticello, Utah 84535
Tenant Name: _____

Appendix 20. PUOR Letter of Recommendation

PUOR LETTER

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix A, and/or [] other criteria stated below.

Other:

_____

_____

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
Property Owner:_____
Owner Address:_____
Tenant:_____

Appendix 21. PU5 Letter of Recommendation

PU5 LETTER (6/93)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix A, and/or [x] other criteria stated below.

Other:
VPMIM Directive #E8, dated December 7, 1990, which addresses the method to be used in surveying large area vicinity properties.

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
Property Owner:_____
Owner Address:_____
Tenant:_____

Appendix 22. UMTRA Vicinity Property Summary Evaluation and Recommendation

Location Number _____

VICINITY PROPERTY SUMMARY EVALUATION AND RECOMMENDATION

1. SUMMARY EVALUATION

1.1 OUTDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U. S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >25 μR/h above background averaged over 100 m^2	[]	[]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background averaged over 100 m^2	[]	[]	[]	[]	[]	[]
^{226}Ra is >5 pCi/g above background in top 15 cm layer averaged over 100 m^2	[]	[]	[]	[]	[]	[]
^{226}Ra is >15 pCi/g above background in any subsurface 15 cm layer averaged over 100 m^2	[]	[]	[]	[]	[]	[]
Total activity of deposit(s) exceeds the total activity of criterion	[]	[]	[]	[]	[]	[]

Appendix 22. (continued)

Location Number _____

1.2 INDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U. S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >20 μR/h above background averaged in any room	[]	[]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background in all rooms	[]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is >0.04 WL	[]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is <0.01 WL	[]	[]	[]	[]	[]	[]
Annual average radon daughter concentration is >0.02 WL	[]	[]	[]	[]	[]	[]
Annual average radon daughter concentration is <0.02 WL	[]	[]	[]	[]	[]	[]

Other:_____

*Data were not taken because:

[ ] Data were not required to derive inclusion/exclusion recommendation.
[ ] This is a dovetail property.
[ ] Property owner did not authorize access for interior sampling.

Appendix 22. (continued)

Location Number _____

2. INCLUSION SURVEY CONTRACTOR RECOMMENDATION

Based on the ISC's evaluation, I recommend this property for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

_____ _____

C. A. Little, Ph.D. Date
Inclusion Survey Contractor

Appendix 22. (continued)

Location Number _____

3. DOE EVALUATION

Based on the DOE's evaluation, [] this property should be included, [] this property should be excluded, or [] additional data are required to support a determination.

_____ _____

DOE Evaluator Date

3.1 ADDITIONAL DATA REQUIRED:

Appendix 22. (continued)

Location Number _____

3.2 ISC'S RESPONSE TO DOE'S REQUEST TO ADDITIONAL DATA:

3.3 DOE APPROVAL OF RESPONSE:

Based on the DOE's review of this evaluation, including the further information provided by the ISC in Sect. 3.2 above, this property should be an [] inclusion [] exclusion.

_____ _____

DOE Evaluator Date

UCN17202
(Revised 6/88)

Appendix 23. MVP Vicinity Property Summary Evaluation and Findings

Location Number

VICINITY PROPERTY SUMMARY EVALUATION AND FINDINGS

1. SUMMARY EVALUATION

1.1 OUTDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U.S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >25 μR/h above background averaged over 100 m^2	[]	[ ]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background averaged over 100 m^2	[ ]	[]	[]	[]	[]	[]
^{226}Ra is >5 pCi/g above background in top 15 cm layer averaged over 100 m^2	[]	[ ]	[]	[]	[]	[]
^{226}Ra is >15 pCi/g above background in any subsurface 15 cm layer averaged over 100 m^2	[]	[]	[ ]	[]	[]	[]
^{226}Ra is > Hot Spot Guideline	[]	[ ]	[]	[]	[]	[]

Appendix 23. (continued)

Location Number

1.2 INDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U.S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >20 μR/h above background averaged in any room	[]	[ ]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background in all rooms	[ ]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is >0.04 WL	[]	[]	[ ]	[]	[]	[]
Grab sample radon daughter concentration is <0.01 WL	[]	[]	[ ]	[]	[]	[]
Annual average radon daughter concentration is >0.02 WL	[]	[]	[ ]	[]	[]	[]
Annual average radon daughter concentration is <0.02 WL	[]	[]	[ ]	[]	[]	[]

Other:_____

*Data were not taken because:

[ ] Data were not required to derive the findings.
[ ] Property owner did not authorize access for interior sampling.

Appendix 23. (continued)

Location Number

2. INCLUSION SURVEY CONTRACTOR FINDINGS

Based on the ISC's evaluation, this property contains radiation levels which [] exceed [] do not exceed the DOE guidelines for the Surplus Facilities Management Program.

_____ _____

C. A. Little, Ph.D. Date
Inclusion Survey Contractor

Appendix 23. (continued)

Location Number

3. DOE EVALUATION

Based on the DOE's evaluation, [] this property should be included, [] this property should be excluded, or [] additional data are required to support a determination.

DOE Evaluator _____ Date _____

3.1 ADDITIONAL DATA REQUIRED:

Appendix 23. (continued)

Location Number

3.2 ISC'S RESPONSE TO DOE'S REQUEST FOR ADDITIONAL DATA:

3.3 DOE APPROVAL OF RESPONSE:

Based on the DOE's review of this evaluation, including the further information provided by the ISC in Sect. 3.2 above, this property should be an [] inclusion [] exclusion.

DOE Evaluator

Date

Appendix 24. VPDMS Form

VPDMS INPUT SHEET - ORNL

LOCATION ID - CLASS

CONSENT FORM DATA:
Sign Date:. . . __/__/__
Status: . . . . __

SURVEY DATA: Survey Date . __/__/__
HIG-Src: . . . _____-__
HOG-Src: . . . _____-__
RDC-Src-Typ: . _-____-__-__

Tailings location code: . . ____

PROPERTY INFORMATION [ ] Check if owner address same as property address

Tenant/Desc: _____

Address : _____

City, St, Zip : _____ _____ _____

OWNER INFORMATION

Name : _____

Address : _____

City, St, Zip : _____ _____ _____

CONSENT FORM STATUS CODES:
A = Access approved
L = Limited access approved
D = Access denied

TAILINGS LOCATION CODES:
0 = None
1 = Structural
2 = Exterior
3 = Structural & exterior
4 = Windblown
5 = Spillover
6 = Unknown

RDC TYPE CODES:
A = Full-time (1yr.) integrated sample
B = Part-time (<1yr.) integrated sample
C = Multiple grab sample
D = Single grab sample

HIG/HOG/RDC SOURCE CODES:
P = Preliminary survey
I = Inclusion survey
R = REA survey
D = Access denied
X = Reading not reported or taken
N = Code not applicable

Appendix 25. ISC Report Review Checklist

ISC REPORT REVIEW CHECKLIST

LOCATION NUMBER | SURVEY TEAM LEADER | T.L. REVIEW/DATE

RECOMMENDATION/BASIS | SURVEY DATE | FINAL REVIEW/DATE

	Team Leader Review				Final Review				Comments
	ok	no	na	typo	ok	no	na	typo	
Are FIELD DATA SHEETS complete?									
Do gamma ranges, areas (regions), pt. sources agree? (FIELD SHEETS vs. FIELD MAP)									
Gamma and Soils CALCULATION SHEETS correct? In black ink and legible?									
TABLE 2:									
Agree with calculation sheets, two significant digits, pt. sources?									
Indoors - is there a TABLE 2 for each structure? (may be combined for identical gamma ranges)									
TABLE 3:									
Soil sample data agrees with field sheet, calculation sheet? Two significant digits?									
Rn data - correct detector type and location?									
highlighted values from ext. measurement sheet?									
two significant figures for annual average?									
RECOMMENDATION BASIS:									
Agrees with tables 2 and 3?									
Two reasons for exclusion (unless vacant),									
at least one for inclusion?									
Location number(s) correct on each page of report? (multiple numbers in ascending order, addresses match?)									
INTRODUCTION:									
Survey date, compare field sheets and tracking sheet?									
Property classification correct?									
Correct # of figures, tables?									
Conversion formula correct?									

UCN17178 (9/90)

Appendix 25. (continued)

	Team Leader Review				Final Review				Comments
	ok	no	na	typo	ok	no	na	typo	
S.O.F.									
Information correct? Recommendation supported?									
Point sources mentioned (see table 2 and field sheet/map)?									
Unusual circumstances described?									
Spillover data (location number and address)?									
Grammar, spelling, punctuation correct?									
OWNER/PROPERTY INFORMATION:									
Table 1: Location address/tenant data agrees with consent?									
Owner address/phone agrees with consent?									
Property classification and structure description agrees with field sheets and map?									
Area of property?									
MAP (Figure 1):									
North arrow correct?									
Gamma ranges agree with field map?									
MDG, MIG where required?									
Location Number/Address correct?									
Is there a completed " UNDOUNNIT" Map in the folder?									
Does it agree with field map and sheets as to areas surveyed?									
PHOTO (Figure 2):									
Check direction taken (field sheet and map)?									
RECOMMENDATION TO DOE LETTER:									
Property and owner information correct?									
Correct evaluation and basis for recommendation boxes?									
SUMMARY EVALUATION SHEETS:									
In black ink, no staples, no corrections?									
Agree with Calculation sheets, Table 2, recommendation?									
Location number(s) on each page?									
Inclusion/Exclusion checked on page three?									
VPDNS:									
Location number and property classification correct?									
Survey and consent acquisition dates correct?									
MIG, MDG, Rn values recorded?									
Property/owner addresses correct?									
Location of contamination code?									

UCN17178 (9/90)

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-031 Page: 1 of 9 Revision: 0 Date: 02/03/92

CORING DRILL OPERATION

1.0 PURPOSE

This procedure describes the operation of the portable coring drill used to core concrete and asphalt for slab sampling and subslab soil sampling.

2.0 APPLICABILITY

This procedure applies to concrete and asphalt coring to a maximum depth of 41 cm (16 in.) during radiological survey sampling.

3.0 OTHER DOCUMENTS

3.1 EXHIBITS

3.1.1 Exhibit 1: Electric Coring Drill

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 2-speed electric coring drill, KOR-IT Model 102, or equivalent
4.1.2 6-in.-diameter diamond coring bit
4.1.3 Expander set to fit the bit to the drill
4.1.4 Portable electric generator
4.1.5 Strap wrench
4.1.6 Extension cords
4.1.7 Tool box
4.1.8 Indoor/outdoor vacuum
4.1.9 Portable pressurized water can
4.1.10 Wedge
4.1.11 Bucket
4.1.12 Cement trowel
4.1.13 Tamping stick
4.1.14 Rubber mallet

Approved by:

Jack K. Halford 2/3/92
(Date)

Craig A. Little 2/4/92
C.A. Little (Date)

4.2 MATERIALS

4.2.1 Water
4.2.2 Gasoline
4.2.3 Cement or asphalt sufficient to reclaim sample holes
4.2.4 Orange surveyor's tape
4.2.5 Sand
4.2.6 Spray lubricant

5.0 RESPONSIBILITY

5.1 The drill operator is responsible for the following:

5.1.1 Setting up the drilling and sampling equipment;

5.1.2 Operating the equipment during coring;

5.1.3 Directing the assistant in sampling and equipment decontamination and lubrication;

5.1.4 Ensuring that all personnel are informed of all safety requirements pertaining to the operation of the equipment prior to drilling.

5.2 The drilling assistant is responsible for the following:

5.2.1 Assisting the drill operator in setting up the drill, generator, and sampling equipment and in running the coring equipment;

5.2.2 Collecting all samples and decontaminating and lubricating the equipment after coring is completed;

5.2.3 Assisting the drill operator in reclaiming the core hole.

6.0 SAFETY

6.1 All personnel involved in the coring operation must wear safety glasses or goggles, steel-toed boots, and hearing protection.

6.2 Consult the property owner and available maps, and visually check the area for buried gas, water, electrical or other utility lines.

6.3 Check the power box on top of the coring rig and all extension cords for frayed and exposed wires before starting the drill. Repair all defective wires before operating the coring rig.

6.4 Be familiar with coring procedures and follow all safety practices described in Section 7.0.

7.0 PROCEDURE

7.1 Attach bit to drill (Exhibit 1).

7.1.1 Diamond bits of 6 in. diameter are not threaded and require the use of an expander set to attach them to the main shaft of the drill.

a. The expander set consists of two bevelled plates and one split expanding ring.

7.1.2 Lubricate the bevelled plates and shaft to allow easy removal of bit after drilling.

7.1.3 Place the unthreaded expander plate on the shaft first with the bevelled portion down.

7.1.4 Install the expanding ring and then the threaded expander plate with the bevelled portion up.

a. The bevelled edges must face each other to expand the split ring outward against the inside of the bit barrel.

7.1.5 Slip the bit barrel over the expander set and tighten until a firm fit is obtained.

CAUTION: Make certain that the top of the bit is flush against the shoulder of the upper expander plate and then hand tighten as securely as possible. The bit must be flush against this shoulder to ensure the bit alignment. Do not drill until the bit runs true. A true-running bit ensures maximum bit life and lowest drilling cost.

7.1.6 Tighten the bit with a strap wrench.

7.2 Set up equipment.

7.2.1 Place the core drill with the attached bit over the sample location.

a. The core drill should be level and the bit perpendicular to the surface of the sample location.

b. Position the drill by adjusting the 3 leveling screws on the base of the drill. Wooden slats may be placed under the back end of the base if necessary.

c. When drilling on a surface at an angle such as a driveway, position the drill base on the downhill side of the incline.

7.2.2 Lay an extension cord from the drill to the generator or to an available electrical outlet.

7.2.3 Position an indoor/outdoor vacuum to remove excess water during and after the drilling process.

a. Lay a separate extension cord to connect the vacuum to the generator or electrical outlet.

7.2.4 Connect the line attached to the portable pressurized water can to the water swivel on the drill.

7.2.5 Start up the generator used to power the coring drill if no electrical outlet is available.

a. Open the fuel valve (on/off switch).

b. Close the choke if the engine is cold.

c. Set the speed control lever about midway between IDLE SPEED and OPERATING.

d. With one hand on the generator to steady it during cranking, grip the recoil starter handle and pull out smoothly and quickly. Repeat as necessary until the generator starts.

7.2.6 After the generator has warmed up for a couple of minutes, connect the extension cords from the drill and vacuum to the generator.

7.3 Drill the hole.

7.3.1 Turn on the water supply.

a. It is important to NEVER DRILL DRY.

b. The water must be flowing at all times when drilling to flush the cuttings and cool the bit.

c. Control the flow of water by the valve located on the water swivel. Adjust it so that enough water is flowing back out of the hole to flush the cuttings from the face of the bit.

d. Supply sufficient water to remove the cuttings and maintain a circle of clear water around the outside of the bit on the surface of the material being drilled.

e. Periodically pressurize the water can during the drilling to maintain the supply of water.

f. When in doubt, use too much water rather than too little.

7.3.2 Hold the drill firmly in place when drilling to permit application of proper feed pressure and to prevent possible shifting of the base, which would result in excessive wear on the bit and possible jamming in the hole being drilled.

a. Use body weight to stabilize the machine by standing on the base of the drill.

7.3.3 With the water flow adjusted, turn on the drill and lower the carriage carefully until the bit is in contact with the material to be drilled.

7.3.4 While drilling, maintain a firm steady pressure on the bit so that it is cutting at all times. This will prevent "polishing" of the diamonds which would impair their cutting ability.

7.3.5 If unsmooth drilling occurs, either:

a. increase the pressure on the bit until chattering ceases (especially when starting the hole) or

b. back out of the hole while the machine is still running and check to ensure that the bit is properly aligned on the main shaft and is running true.

7.3.6 If the core breaks while drilling, it will cause a bumping action and the bit should be backed up out of the hole immediately. After the bit is clear of the hole, shut off the power and remove the broken core.

CAUTION: To continue drilling with a broken core inside the barrel may seriously damage the bit.

7.3.7 If for any reason the bit jams in the hole, shut off the power at once.

WARNING: Do not step off the drill base if the bit jams or at any time when the power is on. This will cause the drill base to rotate out of control. Personnel could potentially be knocked down and seriously injured by the moving equipment.

7.3.8 Upon completing the hole, withdraw the bit while the machine is still running.

7.3.9 When the bit is clear of the hole, shut off the power.

7.3.10 Tighten the locking thumb screw to secure the diamond bit from dropping, and then turn off the water.

7.3.11 Use a strap wrench to remove the bit from the drill.

a. Place the strap wrench on the bit barrel near the expander in order not to damage the lower section of the barrel (Exhibit 2).

b. Do not use a pipe wrench since it will damage the bit barrel.

CAUTION: Take care not to drop the bit or hit it against anything hard. An accidental blow can damage either the diamond or the end of the bit.

7.4 Remove core from bit.

7.4.1 If the core does not drop out of the bit, remove the bit from the drill spindle and push the core out through the rear of the bit.

a. Do not pry cores out of the front of the bit.

7.4.2 A rubber mallet may be used to dislodge cores caught in the bit.

a. Tap lightly while flushing with water.

7.5 Remove core from the hole.

7.5.1 If the core remains in the hole, drive a wedge in one side to snap the core loose at its base.

7.5.2 Use screwdrivers placed on opposite sides of the core to pry the core up and out (Exhibit 3).

7.5.3 Use an extra bit, wedging the end without the diamonds around the core.

a. Twist the bit around a few times to secure the core within the bit.

b. Remove both the bit and the core from the hole.

7.6 Remove excess water from the hole with the vacuum.

7.7 Measure and record the depth of the core.

7.8 Reclaim the sample hole.

7.8.1 For concrete cores:

a. Replace any unused portion of the sample into the core hole.

b. Add sand to the hole to approximately 1 in. above the lower depth of concrete.

c. With a tamping stick, level out the sand.

d. To prepare concrete, mix enough water with pre-mix cement in a bucket to obtain a plastic consistency.

e. Use a cement trowel to fill the hole and smooth the surface, allowing the wet concrete to blend around the edge of the hole for adhesion.

f. Wet the concrete around the diameter of the hole to improve bonding.

g. Place orange surveyor's tape over the hole to prevent pedestrians from stepping in the wet concrete.

7.8.2 For asphalt cores:

a. Replace any unused portion of the sample into the core hole.

b. Replace asphalt cores with pre-mix cold patch asphalt.

c. Use a 2- to 3-lb hammer to compact the asphalt.

7.9 Decontaminate and lubricate equipment.

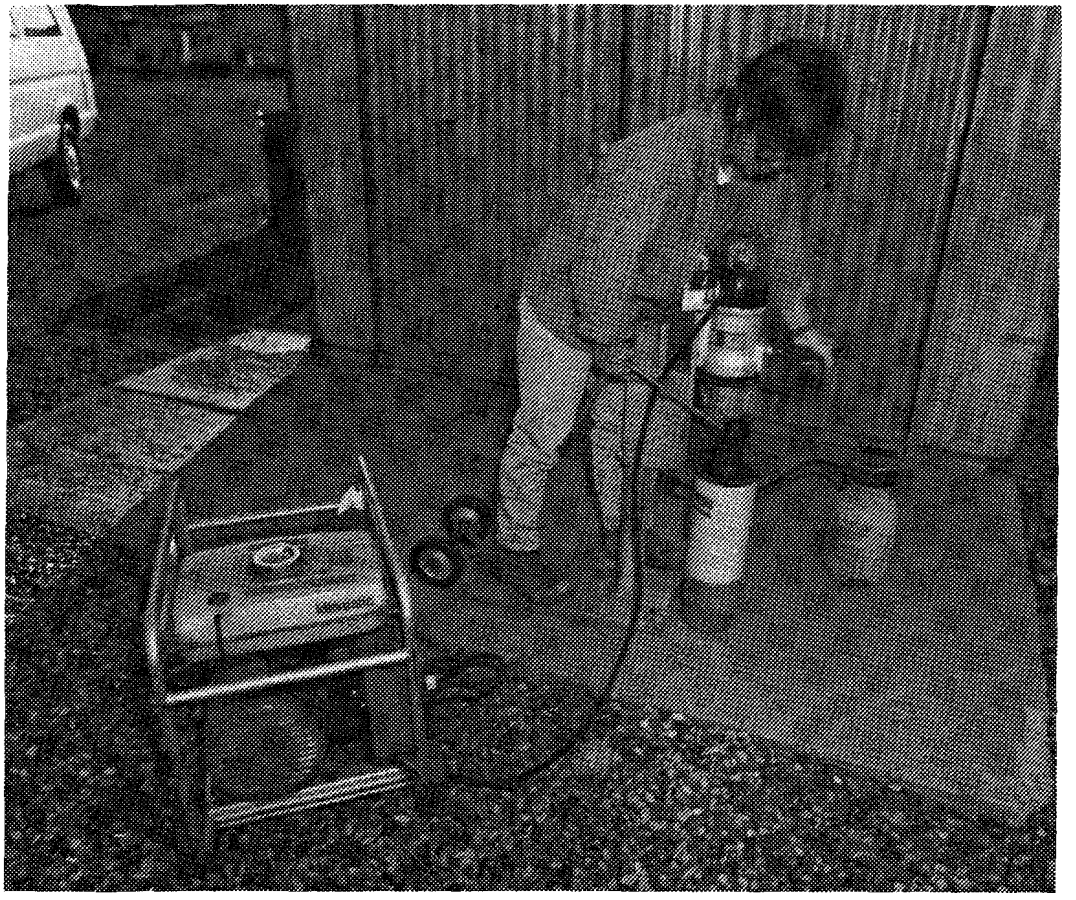
7.9.1 Thoroughly clean the drill bit and the square column.

7.9.2 Spray the bevelled plates and shaft with lubricant to prevent rust.

7.9.3 Oil and grease moving parts of the machine as required.

7.9.4 Empty the dirty water from the vacuum in an appropriate location either on-site or upon returning to the DOE compound.

Exhibit 1. Electric Coring Drill



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-032 Page: 1 of 12 Revision: 0 Date: 002/03/92

ALPHA-TRACK RADON DETECTOR PLACEMENT AND RETRIEVAL

1.0 PURPOSE

This procedure describes the activities for placement, retrieval, and associated documentation of alpha-track radon monitoring devices.

2.0 APPLICABILITY

This procedure applies to alpha-track radon monitoring detectors placed by PAG personnel.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 J. L. George and G. H. Langner Jr., *Validation of the Prompt Alpha-Track Method*, UNC/GJ-33 (TMC), United Nuclear Corporation, Grand Junction, Colorado, 1987.

3.2 APPENDICES

3.2.1 Appendix 1: Radon Verification Check Sheet - Track-Etch Method
3.2.2 Appendix 2: Data Conversion
3.2.3 Appendix 3: Radon Database Operations

3.3 EXHIBITS

3.3.1 Exhibit 1: Alpha-track Radon Monitoring Detectors on Spindle

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Alpha-track radon monitoring detectors (three for each monitored location)
4.1.2 Detector badge clips (one for each detector)
4.1.3 Spindles (one for each monitored location)

Approved by:

Jerald K. Hafford 2/3/92 (Date)

C.A. Little 2/4/92 (Date)

4.1.4 Gamma scintillation detector
4.1.5 Property folder

4.2 MATERIALS

4.2.1 Radon Verification Check Sheet - Track-Etch Method (one for each monitored location)

5.0 RESPONSIBILITY

5.1 It is the responsibility of the extended measurements coordinator to perform the following:

5.1.1 Determine the radon detector placement and retrieval dates.

5.1.2 Assign folders for radon detector placement and retrieval to the field technician.

5.1.3 Calculate the radon working levels from the manufacturer's results.

5.1.4 Direct exposure and documentation of the control detectors.

5.1.5 Ship the detectors back to the manufacturer for analysis.

5.1.6 Maintain the radon database.

5.2 It is the responsibility of the field technician to place and retrieve detectors and complete associated documentation. The technician may perform any of the extended measurements coordinator's responsibilities if assigned.

6.0 DEFINITIONS

6.1 **Alpha-track radon detector**: a passive monitor containing plastic detector material that registers damage tracks when exposed to alpha particles from the decay of radon and its daughter products.

6.2 **Radon**: the heaviest element of the noble gas group; produced as a gaseous emanation from the radioactive decay of radium.

6.3 **Radon daughter**: nuclide formed by the radioactive decay of radon.

6.4 **RDC**: radon daughter concentration, usually expressed in working levels (WL).

6.5 Spindle: an upright spike on a base usually used to stick papers for filing.

6.6 WL: working level; any combination of radon daughters in 1 L of air that will result in the ultimate emission of 1.3×10^5 MeV of alpha particle energy.

7.0 PROCEDURE

7.1 Prior to placement, store alpha-track radon monitoring detectors in a radon-free barrel until the scheduled installation date.

7.2 Place detectors in monitoring locations.

7.2.1 Use a minimum of three detectors together per monitored location.

a. Record the number of each detector.

b. Save the protective pouches in the property folder for returning the detectors to the manufacturer.

7.2.2 Label each detector with the date of installation.

7.2.3 Place a business card with the name and phone number of the extended measurements coordinator on a standing spindle.

7.2.4 Clip the detectors to the standing spindle. See Exhibit 1.

7.2.5 Using a gamma scintillation detector, place the spindle with the detectors in the structure according to the following priority:

a. room with the lowest elevation,

b. room with the highest gamma exposure rate, and

c. room with the least ventilation.

7.2.6 Document any deviation from the above priority on the Radon Verification Check Sheet (Appendix 1).

a. Structures with more than one region of indoor contamination may require monitoring of additional locations.

b. A separate Radon Verification Check Sheet should be completed for each location.

7.2.7 Place the detectors within the selected room, satisfying as completely as possible the following conditions:

a. at least 18 in. off floor, preferably at breathing height;

b. located to be least disturbed by the occupant and out of children's reach;

c. within the most natural air flow possible;

d. away from vents, doorways, windows, or other possible drafts;

e. away from concrete or masonry walls;

f. away from direct sunlight or heat sources;

g. not within a corner; and

h. not in a high humidity area such as a bathroom or laundry room.

7.2.8 Note the location of the detectors on the field map in the property folder.

7.2.9 Complete and initial the Radon Verification Check Sheet for placement and location requirements.

7.2.10 Enter the owner information, detector numbers, gamma information including the region monitored, placement date, and pertinent comments into the radon database.

a. See Appendix 3 for Radon Database Operations procedures.

7.3 Retrieve exposed detectors from the property after approximately 1 year exposure time.

7.3.1 Within Mesa County, detectors may be placed for periods of 2 to 6 months.

a. For details on the prompt track-etch method, see Reference 3.1.1.

7.3.2 At the time of retrieval, determine if measurements are valid by checking the filters for damage and whether or not the meters have been moved.

7.3.3 Complete the retrieval requirements on the Radon Verification Check Sheet.

7.3.4 To stop the monitoring period, place seals provided by the manufacturer over all the holes on the top of the detector.

7.3.5 Record the ending date on the detector labels.

7.3.6 Return the detectors to their respective pouches, fold the open end several times, and tape closed to prevent further exposure.

7.3.7 Store retrieved detectors in a radon-free barrel until returning them to the manufacturer for analysis.

7.3.8 Enter the retrieval date and any pertinent comments into the radon database.

7.4 Return the detectors and sheet to the manufacturer for analysis in batches of approximately 20.

7.4.1 Log the detector numbers on the sheet provided by the manufacturer, with corresponding dates of installation and removal.

7.5 Separate at least 4 to 6 detectors from each shipment of 20 to 40 detectors to be used as controls.

7.5.1 Locally Exposed Detectors

Keeping them in their foil pouches, send the detectors to Chem-Nuclear Geotech for exposure to known values in the radon chamber.

7.5.2 Standard Blanks

Keeping them in their foil pouches, place the detectors in the radon-free barrel for approximately 1 year.

7.5.3 Replicate Measurements

Place extra detectors on the spindle with the three standard detectors and place as in Sect. 7.2 to collect replicate measurements.

7.5.4 Documentation

a. Note detector numbers, exposure dates, type of exposure (locally exposed, standard blank, or replicate measurement), and exposure information in the appropriate shipment file located in the extended measurements coordinator's office.

b. Record dummy dates approximately 1 year apart for control detectors on the manufacturer's data sheet to be included with the shipment back to the manufacturer.

7.5.5 Evaluate results from control detectors.

a. Perform a linear regression between the known radon exposure level in pCi/L-days and the manufacturer's results to provide a means of comparison to manufacturer results.

b. If the results reported by the manufacturer are dubious, verify control results with Chem-Nuclear Geotech, have the detectors reanalyzed, or repeat the measurements, as necessary.

7.6 Enter the results received from the manufacturer into the radon database.

7.6.1 The database will convert the results to WL units using the formula described in Appendix 2.

7.6.2 Database procedures are located in Appendix 3.

Appendix 1. Radon Verification Check Sheet - Track-Etch Method

Alpha Track Detector Placement and Retrieval

Sheet ____ of ____

Location # _____
Address _____
_____

Choose one: _____ Inclusion Survey _____ Verification Survey

Detector ID # _____ _____ _____

Type of detector: Tech/Ops Landauer Radtrak™ Alpha-Track (Radon Gas) Monitors

PLACEMENT

Start date _____ Projected retrieval date _____
ORNL technician _____ RAC technician _____
Building _____ Room _____
Exact location in room _____
Region _____, Gamma range _____ μR/h, average _____ μR/h, area _____ m^2

	YES	NO
1. Placement Location		
a. Habitable room on the lowest level?	____	____
b. Indoor area of removal (verification only)?	____	____
c. Room with the highest gamma exposure rate?	____	____
d. Room with the least ventilation?	____	____
2. Placement Requirements		
a. Sealed bags intact before opening?	____	____
b. Number on bag same as number on detector?	____	____
c. Is the detector filter undamaged?	____	____
d. Detector placed away from direct sunlight, heat sources, doors, windows, or vents?	____	____
e. Placed at least 18 inches off the floor?	____	____
f. Out of reach of children?	____	____
g. Not in humid room (laundry or bathroom)?	____	____
3. Noted location on map?	____	____
4. Consent current for 1 year (inclusion survey only)?	____	____
5. Meets all requirements listed above? If "no", explain below.	____	____

RETRIEVAL

End date _____
ORNL technician _____
RAC technician _____

1. Are the filters undamaged?	____	____
2. Have the detectors been moved?	____	____
3. Was the detector properly sealed after retrieval?	____	____
4. Meets all requirements listed above? If "no", explain below.	____	____

COMMENTS

_____

_____

_____

Appendix 2. Conversion of Analysis Results to Working Levels

The analysis results sent from the detector manufacturer are converted to RDC WL values using a 50% equilibrium factor according to the following calculation:

$$WL = \frac{(WLR) * (Rn)}{100}$$

where:

WL = working level average value
WLR = WL ratio, 0.5
Rn = $\frac{^{222}Rn \text{ concentration in pCi/L-days reported by manufacturer}}{\text{number of days exposure}}$

Appendix 3. Radon Database Operations

1. **Data input when detectors are placed.**
   a. Turn on computer and monitor.
   b. Enter the following:
      1. system password
      2. network
      3. M:
      4. KMAN -G
   c. The KMAN screen will appear.
      1. Follow the login procedure.
      2. The KMAN prompt will appear.
      3. Type, USE RADON.
      4. Type, E.LMOD=FALSE.
      5. Type CREATE.
   d. A blank record file will appear.
      1. In the chronologic order as appearing in the table, enter the following data:
         LOCNO:
         ADDR:
         OWNER:
         PLACED: (date placed)
         PICKUP: (this is the projected pickup date)
         GRANGE: (gamma scan range)
         GAVG: (gamma average)
         SQMETER: (area of contaminated region)
         LCUP1: (detector monitor number)
         LCUP2: (detector monitor number)
         LCUP3: (detector monitor number)
         FILMLO: (detector location)
         GSTC: (if applicable, gamma spectrometer total counts)
         GSK: (if applicable, potassium counts)
         GSRA: (if applicable, radium counts)
         GSTH: (if applicable, thorium counts)
         GSRA/TH: (if applicable, radium/thorium ratio)
         CONC1: (if applicable, concrete ^{226}Ra concentration)
         CONC2: (if applicable, concrete ^{226}Ra concentration, 2nd sample)
         SOIL1: (if applicable, soil sample ^{226}Ra concentration)
         SOIL2: (if applicable, soil sample ^{226}Ra concentration, 2nd sample)
         REM1: (pertinent comments)
         REM2: (pertinent comments)
         REM3: (pertinent comments)
      2. Press the escape key to exit the data record.
      3. At the KMAN prompt, type BYE.

Appendix 3. (continued)

e. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

2. **Data input when detectors are retrieved.**
   a. Turn on computer and monitor.
   b. Enter the following:.
      1. system password
      2. network
      3. M:
      4. KMAN -G
   c. The KMAN screen will appear.
      1. Follow the login procedure.
      2. The KMAN prompt will appear.
      3. Type USE RADON.
      4. Type BROWSE FOR LOCNO="GJ----".
   d. The requested data file will come on screen.
      1. Check detector numbers on field sheet and on screen for accuracy.
      2. In the chronologic order as appears in the table, enter the following data:
         DATE: (actual pickup date)
         SHIP: (radon shipment to Tech/OPS, enter shipment number)
         REM1: (pertinent comments).
      3. Press the escape key to exit the data record.
      4. At the KMAN prompt, type BYE.
   e. Log out of the network.
      1. Park the hard drive.
      2. Turn computer and monitor off.

3. **Data input when results are received from Tech/OPS.**
   a. Turn on computer and monitor.
   b. Enter the following:
      1. system password
      2. network
      3. M:
      4. endspool
      5. KMAN -G
   c. The KMAN screen will appear.
      1. Follow the login procedure.
      2. The KMAN prompt will appear.
      3 Type USE RADON.
      4. Type BROWSE FOR LOCNO="GJ----".

Appendix 3. (continued)

d. The requested data file will come on screen.
   1. In the chronologic order as appears in the table, enter the following data:
      LRN1: (enter the RN concentration-pCi/l provided on the Tech/OPS report)
      LRN2: (enter the RN concentration-pCi/l provided on the Tech/OPS report)
      LRN3: (enter the RN concentration-pCi/l provided on the Tech/OPS report).
   2. Press the escape key to exit the data record.

e. To print the radon results for a property, input the following at the KMAN prompt:
   1. USE RADON
   2. E.OPRN=TRUE
   3. E.STAT=FALSE
   4. E.PAUS=FALSE
   5. EJECT
   6. #PREFIX="C:"
   7. REPORT RADON2 FOR LOCNO="GJ-----"

f. Press the escape key to exit the data record.

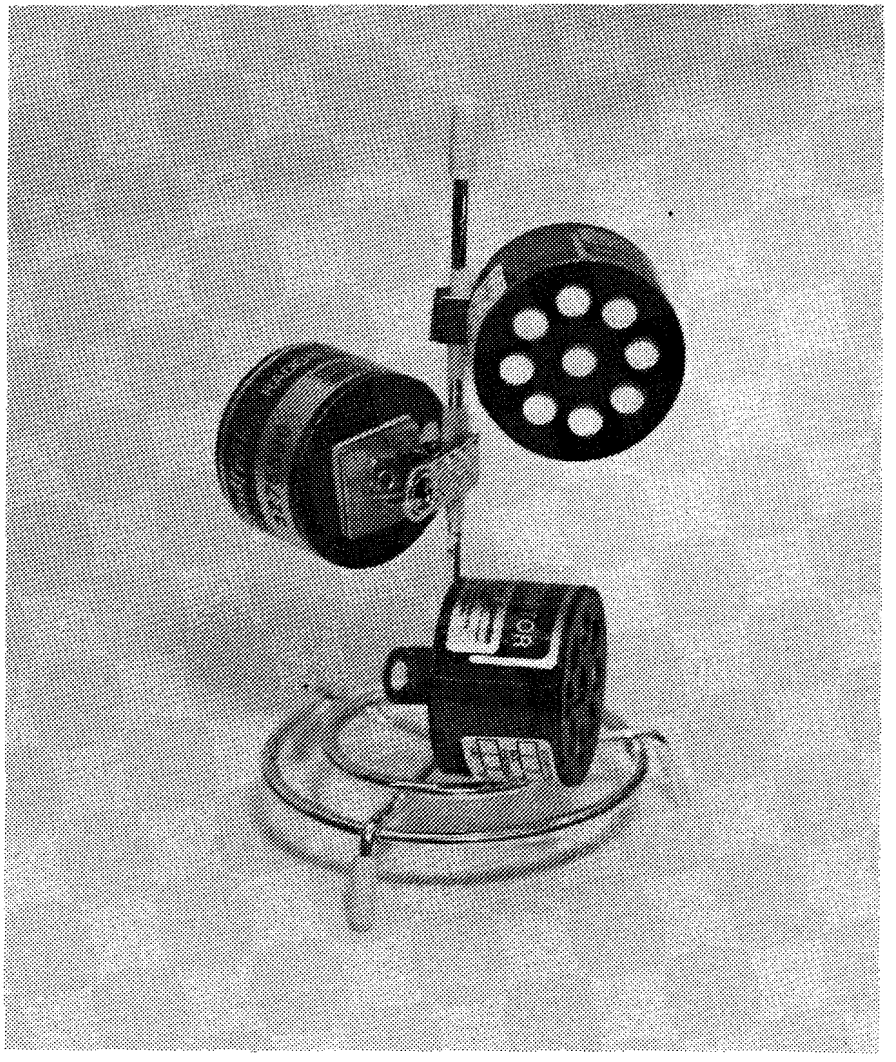
g. At the KMAN prompt, type BYE.

h. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

4. **Data input to obtain a printout of all properties in the radon database by pickup date.**
   a. Follow procedure to enter KMAN as described in section 3a and 3b of this appendix.
   b. Follow procedure to set up printer as described in section 3e.1-6 of this appendix.
   c. Type SELECT LOCNO,ADDR,PICKUP FOR TOJUL(Pickup)>=TOJUL("1/1/9-1") ORDER BY TOJUL(Pickup).
   d. Press the escape key to exit the data record.
   e. At the KMAN prompt, type BYE.
   f. Log out of the network.
      1. Park the hard drive.
      2. Turn computer and monitor off.

5. **To backup radon database onto a floppy after input of new data.**
   a. Enter network.
   b. Insert radon backup floppy.
   c. Type Copy M:\RADON.ITB A:

Exhibit 1. Alpha-track Radon Monitoring Detectors on Spindle



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-034 Page: 1 of 7 Revision: 0 Date: 07/01/91

CHAIN OF SAMPLE CUSTODY

1.0 PURPOSE

This procedure establishes chain of sample custody procedures for samples collected and/or analyzed by ORNL/PAG personnel.

2.0 APPLICABILITY

This procedure applies to all samples taken by PAG personnel and/or analyzed at ORNL/PAG facilities by ORNL/PAG personnel or other authorized personnel.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Chain of Sample Custody
3.1.2 Appendix 2: Chain of Sample Custody/Soil Sample Analysis Form
3.1.3 Appendix 3: Chain of Custody Seal

4.0 EQUIPMENT AND MATERIALS

4.1 MATERIALS

4.1.1 Chain of Sample Custody or Chain of Sample Custody/Soil Sample Analysis Form, whichever is applicable
4.1.2 Chain of Custody Seals

5.0 RESPONSIBILITY

5.1 TEAM LEADER/SITE PROJECT MANAGER

The team leader or site project manager assures all personnel follow chain of custody procedures, thereby maintaining sample accountability.

Approved by:

Joyce K. Halford 6/26/91 (Date)

Craig Little 6/26/91
C.A. Little (Date)

5.2 SAMPLER

The sampler maintains surveillance of the sample until custody is transferred to another individual or the sample is locked in a secure area or placed in sealed container. The sampler completes documentation on the applicable chain of custody form and packages the samples in sealed containers when appropriate.

5.3 LABORATORY PERSONNEL

Laboratory personnel receive samples from field personnel and maintain sample validity throughout the analysis process. Laboratory personnel are responsible for the care and custody of samples from the time they are received until they are relinquished to the originator, transferred to another individual, or transferred for ultimate disposal.

6.0 DEFINITIONS

6.1 **Chain of custody**: procedures which create an accurate written record that can be used to trace the handling and possession of a sample from the time of its collection through analysis and, if necessary, its introduction as evidence.

6.2 **Chain of custody seals**: strips of partially perforated adhesive-backed paper used to indicate tampering of a container.

6.3 **Secure area**: a locked cupboard, room, or building accessible only to authorized personnel. Hotel rooms and vehicles are not considered secure areas, even when locked.

7.0 PROCEDURE

7.1 An acceptable chain of custody is maintained when a sample is:

7.1.1 under direct surveillance by the assigned individual,

7.1.2 maintained in a tamper-free container, or

7.1.3 placed within a secure area.

7.2 FIELD CUSTODY

7.2.1 Complete the appropriate Chain of Sample Custody Form (Appendix 1 or 2) at the time of sample collection.

a. A photostat of the Chain of Sample Custody Form may be used if the sample will be analyzed in-house.

b. All samples should be handled by a minimum number of persons.

c. Information entered on the chain of sample custody form must match exactly information on the sample labels.

7.2.2 When the samples are not under direct surveillance or in a secure area, keep them in containers sealed with chain of custody seals (Appendix 3).

a. Sign and date the seal just before applying it to the container.

7.2 TRANSFER OF CUSTODY

7.2.1 Sign and date the chain of sample custody form when relinquishing custody of samples to the ORNL/PAG laboratory.

7.2.2 If no laboratory personnel are available to take custody of the samples, leave the samples with the signed chain of sample custody form inside the ORNL/PAG laboratory in a sealed container or in a secure area.

a. Notify laboratory personnel at the earliest opportunity that the samples are awaiting analysis.

7.2.3 When shipping samples, retain a copy of the completed Chain of Sample Custody Form and place the original Chain of Sample Custody Form inside the shipping container.

7.3 LABORATORY CUSTODY PROCEDURES

7.3.1 When receiving samples in the laboratory, verify that:

a. the samples have not been tampered with,

b. all samples are present, and

c. information on the Chain of Sample Custody Form and the sample labels match.

7.3.2 Sign and date the Chain of Sample Custody Form and take possession of the samples.

7.3.3 Return a copy of the Chain of Sample Custody Form to the team leader or project manager if duplicate copies of the Chain of Sample Custody Form are required by the project.

7.3.4 Store all samples in a secure area until after analysis.

Appendix 1. Chain of Sample Custody

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address:
P.O. Box 2567
Grand Junction, CO 81502

Street Address:
2597 B-3/4 Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody

Page _____ of _____

Date _____

Project No. _____ Project Name _____

Sample No.	Sample Type	Container	Filtered	Preservative	Analysis	Collection date/time	Remarks

Relinquished By	Date	Department	Received By	Date	Dept.

Company Name _____

Received By _____

Date _____

Distribution: Original accompanies samples, copies to relinquishers.

UCN-17189 (Rev. 3/91)

Appendix 2. Chain of Sample Custody/
Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¼ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

_____

_____

1. Project No. _____ 2. Project Name _____

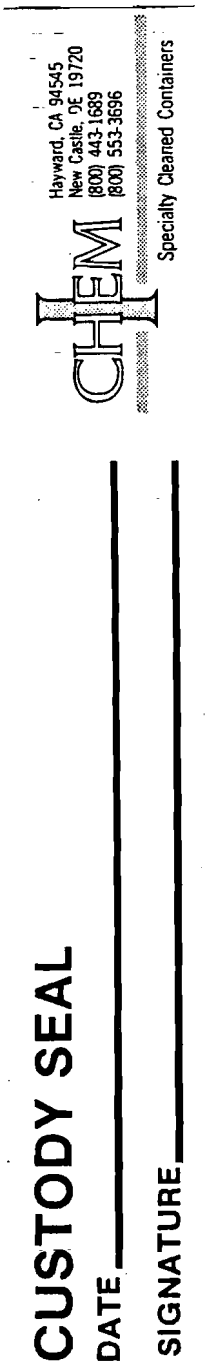
LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 3. Chain of Custody Seal



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-035 Page: 1 of 12 Revision: 0 Date: 12/02/91

SOIL SAMPLE PREPARATION FOR RADIONUCLIDE ANALYSIS

1.0 PURPOSE

This procedure describes the preparation of soil samples for radionuclide analysis.

2.0 APPLICABILITY

This procedure applies to all soil samples analyzed at the PAG soils laboratory for radionuclide concentration.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-034, Chain of Sample Custody.

3.2 APPENDICES

3.2.1 Appendix 1: Chain of Sample Custody/Soil Sample Analysis Form

3.3 EXHIBITS

3.3.1 Exhibit 1: Jaw Crusher
3.3.2 Exhibit 2: Cross Flow Solids-Solids Blender
3.3.3 Exhibit 3: Automatic Can Sealer

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Electronic scale
4.1.2 Ovens
4.1.3 Canner
4.1.4 Compressor
4.1.5 Crusher

Approved by:

Douglas K. Holford 12/3/91
(Date)

C.A. Little 12/3/91
(Date)

4.1.6 Blender
4.1.7 Safety glasses
4.1.8 Laboratory coats
4.1.9 Vacuum cleaner
4.1.10 Standard weights
4.1.11 Sample-excess container
4.1.12 Sample-excess barrel

4.2 MATERIALS

4.2.1 1/2 size medium deep aluminum pans (12 by 10 in.)
4.2.2 Sample labels
4.2.3 Rubber sealed aluminum lids
4.2.4 Rad-Con™ or similar surface decontaminant spray
4.2.5 Plastic bags
4.2.6 Cellophane tape
4.2.7 Utility wipes
4.2.8 Scale calibration logbook
4.2.9 Sample analysis form binder
4.2.10 Soils preparation logbook for each project
4.2.11 16-oz aluminum cans
4.2.12 Radionuclide dust mask
4.2.13 Rubber gloves
4.2.14 Ear plugs

5.0 RESPONSIBILITY

5.1 The extended measurements coordinator is responsible for supervising all laboratory personnel and ensuring that all procedures are followed.

5.2 The soils laboratory technician is responsible for preparing all soil samples, decontaminating the soils preparation laboratory, and recording all sample preparation data.

6.0 DEFINITIONS

6.1 Barrel: 55-gal drum used for soil sample storage after analysis.

6.2 ISC: inclusion survey contractor.

6.3 IVC: independent verification contractor.

6.4 RAC: remedial action contractor.

6.5 Sample excess: soil sample left over after canning; dust and sweepings from the soils preparation laboratory.

7.0 SAFETY

7.1 Do not eat, drink, or smoke in the soils preparation laboratory.

7.2 Unauthorized personnel are not allowed in the soils preparation laboratory when sample preparation is in progress.

7.3 Wear safety glasses, a lab coat, a radionuclide dust mask, and rubber gloves during soil sample preparation.

7.4 Turn on the appropriate fan when operating the crusher or blender or when working under the hood.

7.5 Check for visible contamination and clean up as necessary after handling soil samples.

7.6 Laboratory personnel are required to wear a thermoluminiscent dosimeter (TLD) when working in the soils preparation laboratory.

8.0 PROCEDURE

8.1 Follow chain of sample custody procedures as defined in Procedure TE-034.

8.2 Prepare ISC samples for drying.

8.2.1 Prepare all ISC samples for one project at a time.

a. Each project has its own soil sample analysis form binder.

8.2.2 Line up the ISC samples in the aluminum sample cans or pans on the counter top.

8.2.3 Obtain the Chain of Sample Custody/Soil Sample Analysis Forms (Appendix 1) for the samples from the front section of the soil sample analysis form binder. This form will hereafter be known as the soil sample analysis form.

8.2.4 Align the cans and pans in the order listed on the soil sample analysis forms, starting with the form showing the earliest sample date.

8.2.5 Refer to the previous ISC soil sample analysis form for the last pan number assigned and record the next consecutive pan number on the current soil sample analysis form.

8.2.6 Write the corresponding pan numbers on the sample cans and pans.

8.2.7 Remove the can lids and place them in the box below the ovens.

8.2.8 Record the sample location identification, pan number, and date in the soils preparation logbook.

8.2.9 Fill out a sample can label for each sample.

8.2.10 Return the soil sample analysis forms to the ISC section of the back of the sample analysis form binder.

8.3 Prepare IVC field composite samples for drying.

8.3.1 Line up the verification field samples in the 8- by 8-in. ziplock bags on the counter.

8.3.2 Obtain the soil sample analysis forms from the appropriate soil sample analysis form binder.

8.3.3 Organize the samples in the order listed on the field sample analysis forms, starting with the earliest form.

8.3.4 Refer to the previous soil sample analysis form, and write the next consecutive pan numbers on the current soil sample analysis forms.

8.3.5 Number large aluminum sample pans accordingly.

8.3.6 Transfer the samples to the numbered pans.

8.3.7 Record the sample location identification, pan number, and date in the verification preparation logbook.

8.3.8 Fill out a sample can label for each sample.

8.4 Prepare RAC split samples for canning.

8.4.1 Line up the samples in the order listed on the soil sample analysis form.

8.4.2 Refer to the previous verification soil sample analysis form, and write the next consecutive pan number on the current soil sample analysis form.

8.4.3 Fill in the verification preparation logbook.

8.4.4 Fill out a sample can label for each sample.

8.4.5 Record the RAC's soil ticket number in the comments section of the preparation logbook and on the sample label.

8.4.6 Return the soil sample analysis forms to the back of the verification section of the soil field data logbook.

8.4.7 Write the sample number range (e.g., V162-V187) on the box the samples arrived in.

8.4.8 For RAC split samples, remove the can lid and proceed to 8.8.

8.5 Place the pans in the oven.

8.5.1 Load samples in the oven from the top rack down to prevent cross-contamination.

8.5.2 Turn on the oven to approximately 120° F (setting "6") and dry samples for 12 h.

8.5.3 Inspect the area for contamination and clean up and dispose of any visible contamination in the radioactive waste trash container.

a. Place any excess sample material in plastic bags.

b. Mark the bags with the appropriate site code (e.g., GJ for Grand Junction, RF for Rifle).

c. Place the bags in the assigned sample excess barrel outside the soils analysis laboratory.

8.5.4 If samples still contain moisture after 12 h, leave them to dry for another 12 h.

8.5.5 Turn off the ovens to allow the samples to cool.

8.5.6 Remove the pans from the oven and place them on the counter opposite the ovens.

a. Remove pans from the bottom rack upward to prevent cross-contamination.

8.6 Crush samples.

8.6.1 Check the grease and oil levels in the jaw crusher (Exhibit 1) and automatic canner (Exhibit 3).

8.6.2 Grease and oil the crusher and canner if necessary.

8.6.3 Crush each sample in the jaw crusher.

a. The jaws of the crusher are set to produce material fine enough to pass through a 1/4-in. sieve.

8.6.4 Replace each sample in its numbered pan or can.

8.6.5 Place the samples in sequence under the hood.

8.6.6 Clean the jaw crusher and the tray that catches the crushed sample with compressed air between each sample.

8.7 The IVC field composite samples in the large aluminum pans must be further blended to obtain a homogeneous sample.

8.7.1 Place the sample in the cross flow blender (Exhibit 2) for approximately 5 min for thorough mixing.

8.7.2 Replace each sample in its numbered pan.

8.8 Can samples.

8.8.1 Turn on the electronic scale and allow it to warm up for 30 min.

8.8.2 When the scale is warmed up, check its calibration by using the 200 g and 500 g standard weights.

a. Weigh the standards.

b. Record the weights, scale, date, and initials in the scale calibration logbook.

8.8.3 Check each can for damage. If the lip is damaged, discard and replace.

8.8.4 Tare a sample can on the scale.

a. Place a can on the scale.

b. Depress the tare key; the scale should zero.

8.8.5 For samples in pans, pour a sample into the can and fill the can up to, but not over, the top ridge on the side of the can while working in the hood.

a. Tap the can on the counter to settle the sample.

b. Continue filling until the contents have reached the top ridge on the side of the can.

c. Dump any excess from the cans into the sample-excess container under the crusher.

d. If there is not enough sample to fill the can up to the marked line, measure the height of the sample and record that value in the soil preparation logbook.

e. Wipe off the lips of the cans with tissues to remove dirt from the seals.

8.8.6 For samples in cans, dump any excess from the can into the sample-excess container under the crusher so that the sample reaches to, but not over, the top ridge on the side of the can.

8.8.7 Wipe off the lips of the cans with tissues to remove dirt from the seals.

8.8.8 Place the can on the scale.

8.8.9 Record the weight on the soil sample analysis form, in the preparation logbook, and on the label corresponding to the sample.

8.8.10 Place an aluminum lid on the can.

8.8.11 Turn the base plate handle to the left as far as possible.

8.8.12 Set the can on the base plate of the automatic can sealer, and turn the base plate handle to the right as far as possible.

8.8.13 Push the power foot switch located on the floor underneath the automatic canner.

8.8.14 Push the starting lever on the right side of the canner frame; the machine will make one complete cycle and stop.

8.8.15 When the machine has stopped, push the base plate handle to the left and remove the can.

a. If the can sticks to the sealing chuck, it can be removed by pushing the can towards the sealer.

8.8.16 Spray the can with Rad-Con, and wipe it off with a paper towel.

8.8.17 Attach the completed label to the can.

a. Cover the label on the side of the can with transparent tape.

8.8.18 Repeat until all samples have been canned and labeled.

8.9 Clean the working area.

8.9.1 Place all sample excess in large plastic bags.

8.9.2 Place the sample cans in an empty cabinet in the soils analysis laboratory.

8.9.3 Write the number of samples, date canned, and the date due for analysis (18 days from the date canned) on the sheet on the side of the cabinets near the entrance to the soils analysis lab.

8.9.4 Wipe off the canner with a dry paint brush if necessary.

8.9.5 Vacuum the area under the hood, crusher, blender, and all counter tops with Rad-Con and wipe with paper towels at the end of each day.

a. Throw the used paper towels in the radioactive waste trash container.

8.9.6 Store the radioactive waste trash and plastic bags containing sample excess in the sample-excess barrel.

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

_____

_____

1. Project No. _____ 2. Project Name _____

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pCi/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 1. Chain of Sample Custody/Soil Sample Analysis Form

Exhibit 1. Jaw Crusher

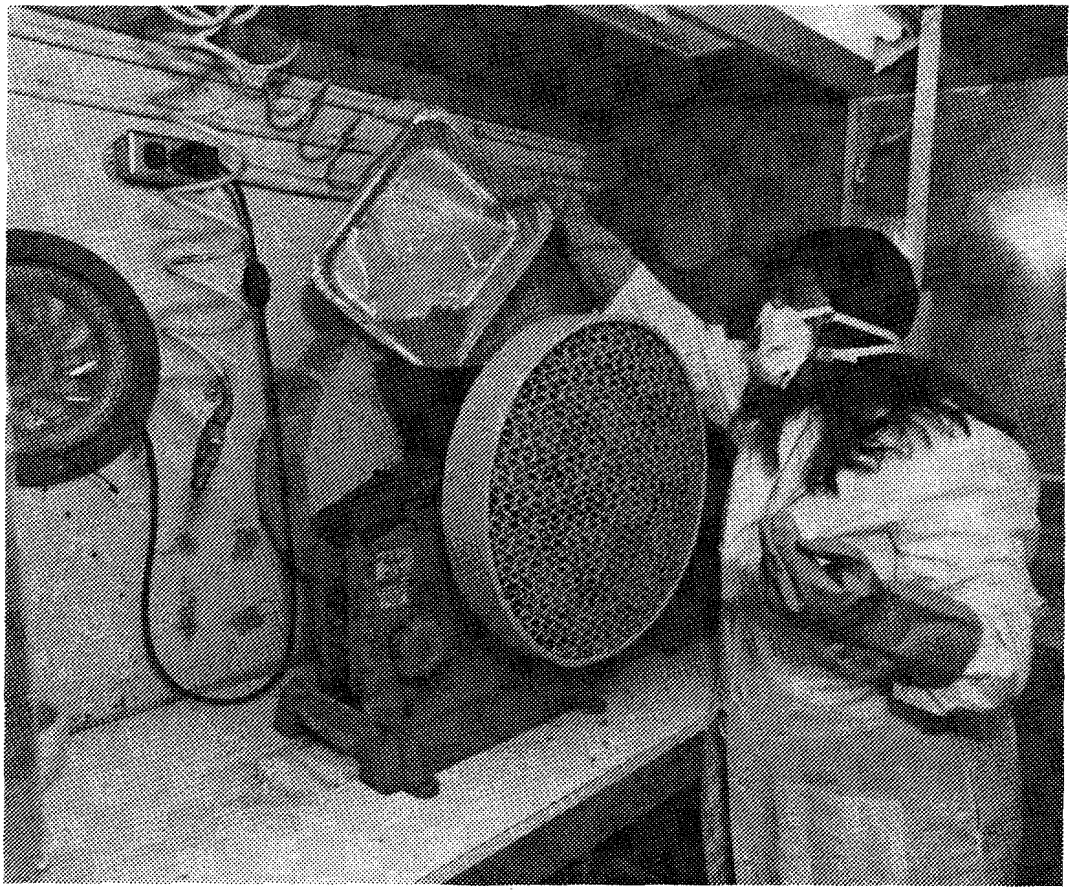


Exhibit 2. Cross Flow Solids-Solids Blender

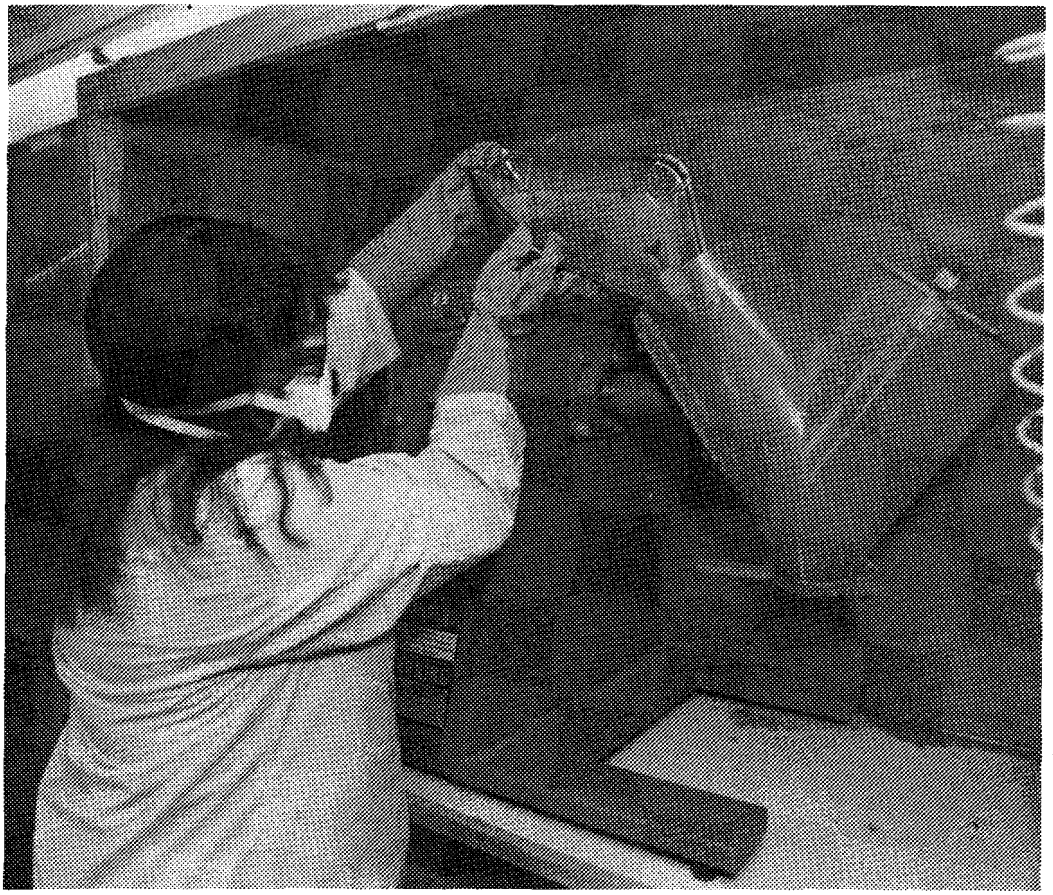
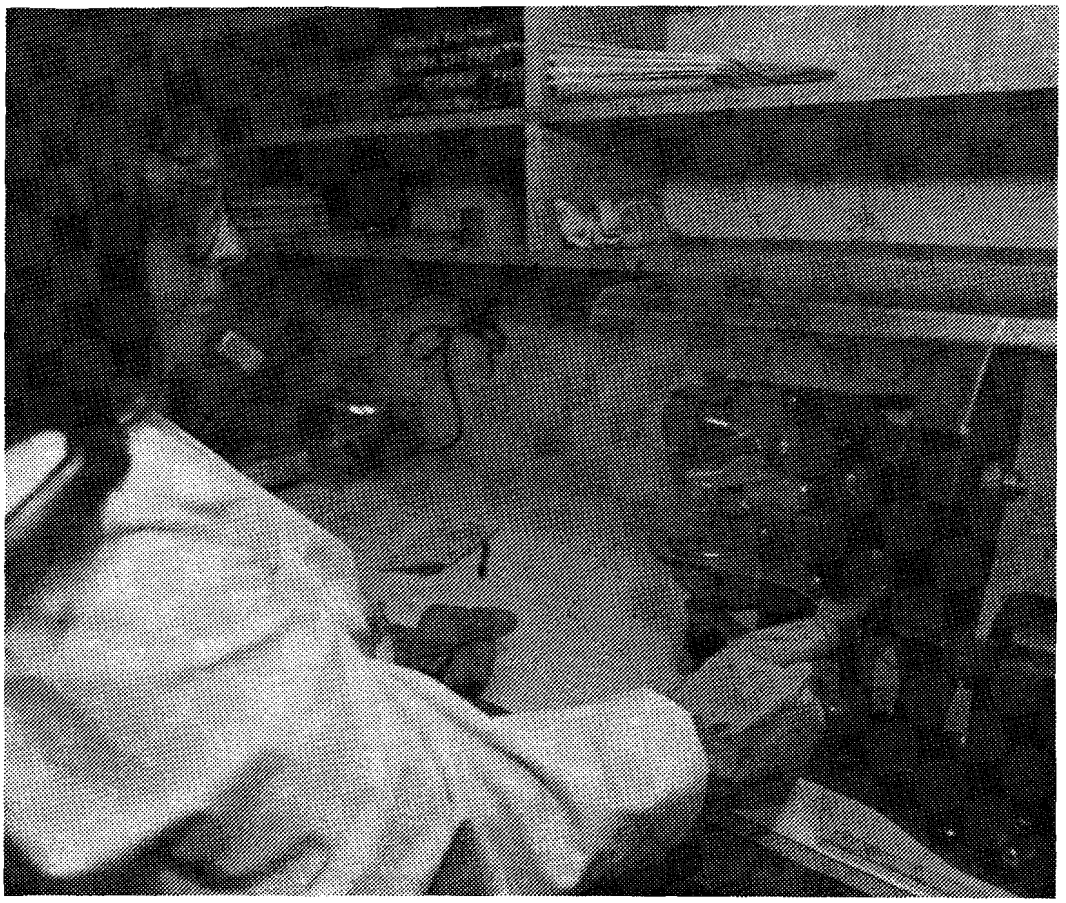


Exhibit 3. Automatic Can Sealer



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-036 Page: 1 of 11 Revision: 0 Date: 12/02/91

ANALYSIS OF RADIONUCLIDES IN SOILS

1.0 PURPOSE

This procedure describes the analysis of radionuclides in soils using the ND-66 gamma spectroscopy system.

2.0 APPLICABILITY

This procedure applies to all soil samples analyzed for radionuclides by the ND-66 system at the PAG soils laboratory.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure SU-022, Calibration of Soil Laboratory Gamma Spectrometry System.
3.1.2 Procedure TE-034, Chain of Sample Custody.

3.2 APPENDICES

3.2.1 Appendix 1: Chain of Sample Custody/Soil Sample Analysis Form
3.2.2 Appendix 2: Soil Data Base Menu Procedures

3.3 EXHIBITS

3.3.1 Exhibit 1: Lead Pig
3.3.2 Exhibit 2: ND-66 gamma spectroscopy system

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 ND-66 NaI(Tl) well detector system
4.1.2 IBM computer
4.1.3 Computer printer

Approved by:

x [signature] 12/6/91
(Date)

[signature] 12/6/91
C.A. Little (Date)

4.2 MATERIALS

4.2.1 Rad-Con™ or similar surface decontaminant spray
4.2.2 Utility wipes
4.2.3 Soil analysis logbook
4.2.4 Soil analysis form binder
4.2.5 Spectral data storage disk

5.0 RESPONSIBILITY

5.1 The extended measurements coordinator is responsible for supervising all laboratory personnel and ensuring that all procedures are followed.

5.2 The soils laboratory technician is responsible for the following analyzing the soil samples and recording the analysis data.

6.0 DEFINITIONS

6.1 **ADC**: analog to digital converter; electronic equipment which sorts the pulses received from the amplifier.

6.2 **Barrel**: 55-gal drum used for soil sample storage after analysis.

6.3 **Detector**: sodium iodide (NaI) crystal used to detect photon emissions from unstable radioactive samples.

6.4 **KMAN**: Knowledge Man data base management software.

6.5 **KRTCOM**: command program for acquisition of analytical data.

6.6 **ND number**: unique, alpha-numeric number assigned by the KRTCOM program to each acquired spectrum.

7.0 SAFETY

7.1 Do not eat, drink, or smoke in the soils analysis laboratory.

7.2 Wear a thermoluminescent dosimeter (TLD) at all times when working in the soils analysis laboratory.

8.0 PROCEDURE

8.1 Follow chain of sample custody procedures as described in Procedure TE-034.

8.2 Wait at least 18 days after canning to analyze samples.

8.3 Calibrate the soils analysis system according to Procedure SU-022.

8.4 Obtain the appropriate Chain of Sample Custody/Soil Sample Analysis Forms (Appendix 1) from the soil analysis form binder.

8.5 Analyze samples.

8.5.1 Enter the analysis mode by selecting option 3 on the KRTCOM program main menu. The printer will print a sample header.

8.5.2 Place a sample in the lead pig for analysis (see Exhibit 1).

8.5.3 Begin data acquisition by pressing the acquire and initialize keys on the ND-66 keyboard (Exhibit 2).

8.5.4 When data acquisition is finished, input the number of the detector for transfer of data to the computer. The spectral data will be printed on the screen and the data automatically stored on disk.

8.5.5 Input all sample information requested.

a. Verify that the information has been entered correctly. Type "Y" to continue execution of the program. Any other response will return the user to the first requested data input.

b. Hit any key except zero (0) to return to the analysis mode.

8.5.6 Repeat the above steps until all samples have been analyzed.

8.5.7 After analyzing all samples, input a zero (0) to return to the main menu.

8.6 Add sample results to the KMAN data base by executing the following steps. See Appendix 2 for more detailed information about the soil data base menu.

8.6.1 Select option 4 of the main menu and log into the network.

8.6.2 Select option 15 to copy the sample set TEMPDB.DAT to the network.

8.6.3 Select option 12 to enter the KMAN data base.

8.6.4 Select option 4 of the KMAN data base menu to add records to the soil data base.

a. Assign a barrel number to each sample for storage until disposal.

b. Input the barrel number and edit any records at this time.

8.6.5 Select option 6 to obtain a printout.

8.6.6 Select option 5 to update the soil data base to the network data base for all users to view.

a. The data base does not have to be updated every time soil samples are analyzed but should be updated at least once a week.

8.6.7 Select option 0 to exit KMAN. This automatically exits the network.

8.7 Select option 8 of the main menu to park the hard disk.

8.8 Turn off the monitor and printer.

8.9 Complete the Chain of Sample Custody/Soil Sample Analysis Forms with the date analyzed, barrel number, spectral data storage disk, and sample pCi/g concentration.

8.10 Put photocopies of these forms into the appropriate team leader's or project manager's mailbox.

8.11 Place the hard-copy printout and the original Chain of Sample Custody/Soil Sample Analysis Forms in the back of the appropriate soil sample analysis form binder.

8.12 Place the analyzed samples in the designated barrel for storage and archival.

Appendix 1. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

_____

_____

1. Project No. _____ 2. Project Name _____

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pCi/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 2. Soil Data Base Menu Procedures

Soil analysis data acquisition is accomplished by the KRTCOM program which stores the data in an ASCII text file named TEMPDB.DAT. The data is then transferred to the KMAN data base where it may be accessed.

To add records to the soil data base and to access the KMAN data base:

1. Select option 4 on the main menu.
2. Log into the network.
3. Select option 15 to copy TEMPDB.DAT to the network.
4. Select option 12, Data Base Menu.
5. Log into KMAN; the soil data base main menu will appear.

KMAN Data Base Options:

1.0 Reindex Soil Table

a. This option reindexes IDS.IND and SDB01.IND used for soil program operation.
b. Do not use this option unless so instructed by computer support personnel.

2.0 View Records by Date Analyzed

a. This option allows the user to browse/edit the soil data base by retrieving records on the date analyzed.

b. Enter the date for which soils analysis results are desired.

c. If no records satisfy the given input date, the message "NO RECORDS SATISFY THIS REQUEST" is displayed at the bottom of the screen. Press any key to return to the main menu.

d. If the input date matches records in the data base, the first record for the given date is displayed on the screen. Notice the cursor at the upper right corner of the screen.

1. To edit, press the return key. The cursor will move to the first field allowable for editing. The user may edit the sample I.D., weight, and barrel number fields.

Appendix 2. (Continued)

2. If no change is desired, press the return key and that field will remain unchanged. The cursor will move to the next field allowable for editing.

e. At the bottom of the display, notice three choices:

1. Select the next record
2. Select the previous record
3. Return to menu.

f. Input the first letter of the desired option to execute that option.

1. The next record option will display the next record for the given day analyzed. If the next record's date does not match the date requested, the program returns to the main menu.

2. The previous record option will display the previous record for the given day analyzed. If the previous record's date does not match the date requested, the program returns to the main menu.

3.0 View Records by Sample Number

a. This option allows the user to browse/edit the soil data base by retrieving records by sample number or ND number. The records are organized in alpha-numeric order.

b. Enter the sample number for which analysis results are desired.

c. If no records match the given request, the user is notified and is asked whether to continue with the closest match.

1. A "Y" response to this request will display the record which most closely matches the given sample I.D. number.

2. Any other response will return the user to the data base main menu.

d. The routine will continue viewing records in alpha-numeric order regardless of the analysis date when requesting "next" or "previous" records.

e. At the bottom of the display, notice three choices:

Appendix 2. (Continued)

1. Select the next record
2. Select the previous record
3. Return to menu.

f. Input the first letter of the desired option to execute that option.

1. The next record option will display the next record for the given day analyzed. If the next record's sample number does not match the date requested, the program returns to the main menu.

2. The previous record option will display the previous record for the given day analyzed. If the previous record's sample number does not match the date requested, the program returns to the main menu.

4.0 Add Records to Data Base

a. This option transfers records for samples just analyzed to the soil data base, inputs the barrel number, and shows how many records were added.

b. After logging into the network, select option 4, "Add Records to Data Base."

c. Input the correct barrel number.

5.0 Update Network Soil Data Bases

a. This option transfers the updated data in the network to the users' data base for all users to view.

6.0 Hard-Copy Printout

a. This gives a printout either by daily, weekly, or monthly analysis.

7.0 Delete Individual Records

a. This feature allows the user to delete a specific record.

b. Identify the record by the sample number or ND number. The program will bring key fields onto the screen for viewing.

Appendix 2. (Continued)

c. At this point the user can back out, view the next record to delete or go ahead and delete.

d. When a record is deleted, a printout is produced showing the deleted record with its fields.

8.0 Barrel Routine

a. This option accesses the barrel routine menu.

9.0 Exit to K-MAN

10.0 Exit to DOS

a. This exits out of KMAN and returns the user to DOS programs.

Exhibit 1. Lead Pig

Exhibit 2. ND-66 Computer Analysis System

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-040 Page: 1 of 79 Revision: 1 Date: 02/03/92

VERIFICATION SURVEY ACTIVITIES

1.0 PURPOSE

The purpose of this section is to define the sequence of events for a property from the UMTRA program to receive independent verification. The transfer of data records pertaining to the selected vicinity properties is also defined.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 UNC Geotech, *Field Assessments Procedures Manual*, 1989.

2.1.2 40 Code of Federal Regulations Sect. 192.

2.2 APPENDICES

2.2.1 Appendix 1: Type I verification tracking form

2.2.2 Appendix 2: Type II verification tracking form

2.2.3 Appendix 3: Type III verification tracking form

2.2.4 Appendix 4: Soil data field sheet

2.2.5 Appendix 5: Chain of Sample Custody/Soil Sample Analysis Form

2.2.6 Appendix 6: Type I verification flow of work

2.2.7 Appendix 7: Completion report check-off sheets

2.2.8 Appendix 8: Type I vicinity property certification summary and decision form and report skeleton

2.2.9 Appendix 9: Type I letter of recommendation

Approved by:

2/3/92 (Date)

C.A. Little 2/4/92 (Date)

2.2.10 Appendix 10: Type II verification flow of work

2.2.11 Appendix 11: Delta gamma field data sheet

2.2.12 Appendix 12: Gamma screening summary

2.2.13 Appendix 13: Alpha Track Detector Placement and Retrieval form

2.2.14 Appendix 14: WLM method form

2.2.15 Appendix 15: Verification survey field notes

2.2.16 Appendix 16: Soil analysis worksheet

2.2.17 Appendix 17: Radon calculations worksheet

2.2.18 Appendix 18: Verification report skeleton

2.2.19 Appendix 19: Type II and Type III letter of recommendation

2.2.20 Appendix 20: Vicinity property certification summary and decision

3.0 TYPES OF VERIFICATION

Independent verification activities may be performed at different phases of the remedial action process. The type of verification depends on the phase of remedial action, and are as follows:

3.1 TYPE I PROPERTY

A Type I property is a property chosen for independent verification by the DOE after reception of a certification recommendation from the RAC. The Independent Verification Contractor (IVC) will review the RAC's completion report, perform confirmatory analysis of soil samples, and review the available data to make a recommendation to DOE.

3.2 TYPE II PROPERTY

A Type II property is a property chosen for independent verification at random by the IVC from the RAC's construction schedule. These properties will receive field verification surveys as well as all work associated with the Type I properties.

3.3 TYPE III PROPERTY

A Type III property is a property chosen by the DOE after receipt of a certification recommendation from the RAC. The DOE is uncertain about some aspect of the property and has requested that the IVC take field measurements needed to make a recommendation.

4.0 ROLES OF AGENCIES

4.1 REMEDIAL ACTION CONTRACTOR

The RAC is responsible for the physical clean-up of the properties.

At the direction of the DOE, the RAC will provide the radiological and engineering assessment (REA) property folio and soil samples to the IVC. The RAC will notify the IVC when RAC verification surveys are schedule and when radon daughter concentration (RDC) monitors are to be placed and retrieved. The RAC is required to give the IVC a minimum notice of one hour for a Grand Junction property verification and forty-eight hours for remote site verification.

4.2 DEPARTMENT OF ENERGY

The DOE has the ultimate responsibility for certification of remediated properties.

The DOE selects the Type I and Type III properties for which independent verification is desired and sends a letter of notification to the IVC along with the completion reports.

The IVC recommends certification to the DOE on properties which have radiation levels below the applicable standards (40 CFR 192).

4.3 INDEPENDENT VERIFICATION CONTRACTOR

The IVC's verification independently assures that 10% of the Grand Junction vicinity properties for which the DOE is responsible are remediated to comply with EPA standards for remedial action.

The IVC assures that a property has radiation levels below the applicable EPA guidelines by determining the adequacy of the RAC's remediation and by taking independent measurements.

If the property is a Type I (remedial action is complete), the IVC will request splits (portions) of the soil samples taken by the RAC. A visit to the property will not be required.

If the property is one where remedial action has been initiated (Type II) or where DOE has concerns about the property (Type III), a site visit(s) is required.

The IVC will select the Type II properties to be verified as the RAC notifies the IVC by phone of their schedule. The IVC will notify the DOE and the RAC of the properties selected. The IVC will request a copy of the REA and inclusion survey report for the selected vicinity properties from the RAC. The IVC will review the inclusion report and the REA to become familiar with the property.

The IVC verifies and reports on Type I, II and III properties approximately 10 to 12 weeks from the time the completion report is received for review.

5.0 DATA MANAGEMENT

A data base recording property information is available to all verification personnel. A data base record is created for each new property assigned to verification. At this time a manilla folder labelled with the appropriate property location number, address, and verification type is prepared to contain the documents, and a tracking sheet is placed in the front. An archive file is also prepared for Type II and Type III properties to contain copies of all field data collected.

6.0 VERIFICATION TRACKING

6.1 LOGBOOK

The verification logbook is kept by the IVC team leader. The verification file cabinet contains all the active verification folders and the data archival. In the front of each file drawer exists a folder with a checkout list.

6.2 FORMS AND EQUIPMENT

The verification forms and the verification field equipment are kept in a central location easily accessible by all field personnel.

6.3 DATABASE

The verification data base is patterned after the main ISC data base. It is programmed in KMAN. Technicians and administrative staff may browse the data base and edit some fields.

Refer to Appendices 1, 2, and 3 and consider these items on the verification tracking form:

6.3.1 The site number is the vicinity property location number.

6.3.2 The property class is determined by the RAC and is RS (residential simple), MR (major residential), CS (commercial structure), etc.

6.3.3 The site address

6.3.4 The most recent owner information from the RAC property folio.

6.3.5 The date assigned to ORNL, used also as an index to the logbook.

6.3.6 Type of verification (Type I, II or III).

6.3.7 Site survey information: applicable only to Type II and Type III.

6.3.8 Radon information: applicable only to Type II.

6.3.9 Report Information: the same reviewers who edit the completion report on a Type II draft usually also do the reviews of the verification draft or the final review. Therefore, one reviewer may sign and initial several items.

a. ISC REPT REVIEW: Type II only

b. REA REPT REVIEW: Type II only

c. Completion Report:
Review 1: and Review 2: Type I, II, and III

d. Verification Report:
Draft, Review 1: and Review 2: Type I, II, and III.

e. Final review: Types I, II, and III. A proofreading review.

f. Data base verified: To be conducted after the recommendation for certification has been mailed. A verification that all fields in the data base for a recommended property have been completed.

g. DOE certified: obtained from a monthly list provided by the DOE. This is also tracked in the data base.

7.0 CONFIRMATORY SOIL ANALYSIS

Confirmatory analysis is performed on soil samples tabulated in the completion report. The IVC follows these steps in acquiring split samples for verification properties.

7.1 TYPE I

Obtain the RAC's ticket number from the property completion report.

7.2 TYPE II

Request splits prior to reception of the completion report.

Obtain the RAC's ticket numbers at the time of the field survey and record them on the IVC's soils data field sheet (Appendix 4).

7.3 TYPES I AND II

7.3.1 Fill out a Chain of Sample Custody/Soil Sample Analysis Form (Appendix 5) showing the property address, location number, split sample identification number, i.e., X1, X2, etc., and RAC ticket number on both forms.

7.3.2 Hand the Chain of Sample Custody/Soil Sample Analysis Form to RAC sample plant personnel.

7.3.3 Date of request for splits is noted in IVC logbook and on individual tracking sheets.

7.3.4 A copy of the chain-of-custody form is filed for reference.

7.3.5 Sign off on the chain-of-custody form when the samples are picked up.

7.3.6 Deliver the samples to IVC prep lab for analysis.

7.3.7 Original split sample requests are filed in soils trailer and soil results are filed in the soil trailers and in the coordinator's office.

7.3.8 The samples are analyzed and results are given to the verification team to input into the soils data sheet. Please refer to Sect. 9.5, Soil Samples, for procedure details.

8.0 TYPE I VERIFICATION ACTIVITIES

8.1 PROCEDURE

The purpose of this procedure is to provide guidance for the Type I verification review of the RAC's completion report. A flow chart of the general work process is shown in Appendix 7.

8.2 DOE NOTIFICATION

The DOE notifies the IVC of properties to be verified under Type I verification. The completion reports for the selected properties accompany the letter of request from the DOE.

8.3 REPORT REVIEW PROCESS

8.3.1 Initial Completion Report Review

After the results of confirmatory soil analysis and a copy of the original RAC radon report results are received (refer to Sect. 7.0), the completion report and property portfolio are submitted to technical personnel for initial review and draft of IVC verification report. The technical personnel obtain and use the following documents in reviewing and drafting:

a. Soil data field sheet (Appendix 4): Complete the soil data sheet with ORNL's analysis of the soil sample splits.

b. Completion report check-off sheets (Appendix 8): Respond to each question by checking the appropriate column. Notes explaining unusual circumstances or other comments may be written next to the appropriate questions.

c. Summary and decision sheets (Appendix 9).

d. Letter of recommendation to DOE project manager (Appendix 10). After completion of the review, sign and date the last page of the check-off sheets and initial the tracking form.

At this time the IVC draft report is sent to typing accompanies by the RAC portfolio.

8.3.2 Second Review of Completion Report

The property portfolio will be forwarded to another technician for an independent second review of the completion report and a first review of draft IVC report. The reviewer should compare comments on the check-off sheets and reconcile any differences. When completed, the reviewer should sign and date the last page of the review form and initial the tracking form in the correct space.

The draft summary and decision sheets are checked for correctness and completeness. Assumptions, inferences, and interpretations are checked for conformity. The cover letter and summary and decision sheets are checked for conformity and agreement of recommendations.

8.3.3 Type I Verification Reporting

All properties which receive the IVC Type I completion report review will have the results of that review reported in the following manner.

The verification reporting for Type I properties is limited to a short summary and decision form.

a. Summary and Decision (Appendix 9)

The Summary and Decision sheets provide a description of the IVC's findings and the IVC's recommendation for the DOE. The sheets shall be completed in permanent, black ink and as neatly as possible or typed if possible. If an error is made, the form must be redone (no "white-out").

Calculations for the Type I review are limited to checking the math used by the RAC in the completion report (e.g.: RDC annual average and average radium concentration in soil). Calculations are not necessarily required in the Type I review. However, the IVC reviewer may include any calculations in the report package considered relevant to the recommendation.

b. Type I Letter of Recommendation (Appendix 10)

The final typed copy of this letter is the official notification to DOE indicating the IVC recommendation. The appropriate phrases must be included and site information at the bottom of the page must be completed by the report writer. The evaluation basis shall be the completion report review. The recommendation basis shall reflect the laws set out in the Federal Register (40 CFR 192).

9.0 TYPE II VERIFICATION ACTIVITIES

The purpose of a Type II site survey is to provide independent verification by field survey, the collection of independent data, and revision of the completion report to show that the radiation levels on a property are below applicable standards. The general flow of work for a Type II verification is shown on Appendix 11.

9.1 EQUIPMENT

These procedures are brief descriptions of the operation of gamma and delta gamma scintillation detectors.

9.1.1 Gamma scintillation detector

See TE-020, Gamma Scintillation Detector.

9.1.2 Delta counter

The delta counter is used to measure equivalent radium-in-soil in pCi/g. Two measurements are made, one unfiltered (without lead shield) and one with a filter (lead shield) between the detector and the area of interest. The difference between the two measurements is the gamma radiation emanating directly from the area of interest beneath the detector. In other words, adjacent sources of emanation have been subtracted from the total gamma measurements. In this sense, the delta counter is used to measure a source within a field of emanation or "shine".

The field team leader is responsible for selection of appropriate measurement locations, and assuring that the data is properly recorded. The field team is also responsible for ensuring that the instrument is working properly, and is calibrated.

a. Equipment and supplies

Bendix-Designed Delta Counter. This system includes the following:

1. Delta counter, EL-0018, EL-0018a,
2. Field check jig, BFEC-EL0012 or equivalent,
3. Radium source, BFEC 10027-2 or equivalent for the Bendix EL-0018 with front mounted detector or BFEC RA-32b2 or equivalent for the Bendix EL-0018a,

4. Tungsten filter,

5. Delta gamma field data sheet (Appendix 12).

b. Delta counter field check

The field check for these instruments will be performed prior to the field survey by the verification team.

1. Turn power switch ON.

2. If batteries are low, an arrow and colons will appear in the display; batteries should be replaced if these indicators appear.

3. Select the proper counting interval of 5 minutes.

4. Remove the metal shield from the base of the instrument.

5. The plastic source jig has a GJ# to match the GJ# on the delta counter. Place the counter on the correct source jig.

6. The UP and DOWN counts are both initiated by pressing the START button. Press the start to begin the UP (total) count.

7. Verify that the count is increasing. The RESTART switch can be used to initiate counting at any point.

8. After 5 minutes, the delta counter emits an audible signal. Record the total count in the verification field calibration logbook.

9. Insert the metal shield into the base of the counter.

10. Push the start button and verify the count is decreasing. Count DOWN for 5 minutes.

11. Record the difference, or delta count, in the verification logbook.

12. If the delta count is not within the range stipulated, the measurement must be repeated. If the second delta count is also outside the range, the instrument cannot be used. Report the instrument's failure to the instrument technician. A replacement delta counter can be obtained from the instrument technician.

c. **Field measurements with delta counter**

1. Position the instrument on the surface to be measured. A plastic bag may be placed between the detector and the soil to protect it from contamination or dampness as needed.

2. If possible the instrument should not be moved during the sequence of unfiltered and filtered measurements. The measurement is taken as follows:

3. Turn the instrument on, and set the counting interval at 2 minutes.

4. With the shield removed, depress the START button to initiate the total count. Make sure the count is increasing; if not, RESET the instrument and START again.

5. At the end of the counting interval, record the total count on the Delta gamma field data sheet.

6. Place the shield into the slot beneath the detector without moving the detector, if possible.

7. Depress the START button and verify that the count is decreasing. If not, RESET and START over with step 3.

8. At the end of the counting interval, record the difference, or delta count on the data form (Appendix 12).

d. **Data reduction of delta counts**

Reduction of the delta counts per second to equivalent-radium (^{226}Ra) concentration is accomplished by a program in Quick Basic based upon the RAC's procedure. The program is called DELTA.

9.1.3 OTHER EQUIPMENT

Other equipment includes the following:

a. JMC auger
b. JMC "mud sampler" auger
c. Ziplock bags
d. Sharpie pens
e. Pager
f. Radio

g. Measuring tapes
h. Clipboard and pens
i. Water sprayer, brush
j. Trowel or shovel

9.2 DATA RECORDING

The purpose of this procedure is to define data records related to Type II verification site survey and soil sample collection. Not all forms may be necessary for each property.

Field data sheets are used to record all non-graphic data collected at the verification survey site. Field personnel are responsible for keeping data properly recorded on sheets. All appropriate blanks should be completed before the team leaves the site. The site number and the survey date are recorded in the space provided.

9.2.1 Field map

The field map is used to illustrate the locations of excavated tailings regions and point sources, indicate gamma radiation measurements at appropriate locations, sample locations, and provide any other pertinent information. Outdoor and/or indoor field maps may be required, depending on the location and extent of contamination on the property.

9.2.2 Gamma screening summary

See Appendix 13, Example of Gamma Screening Summary.

a. Location number and address:

   This section is completed by field personnel prior to or during the site visit. The information is taken from the ISC or REA report.

b. Sheet #:

   The sheet number is filled out appropriately with each new page. After all site visits are completed, the total number of pages is filled out on the second blank of the following: "SHEET__OF___".

c. Gamma conversion equation:

   The appropriate conversion is checked.

d. "Post RDC's required" determines whether the property will be monitored for RDC, and the reason if it is not required.

e. Background gamma exposure rate:

The background exposure rate and how it was determined are recorded.

f. Excavation Identifier:

This is a code uniquely identifying the excavation; it corresponds to the code used on the field maps. The code and the excavation are chosen by the field personnel.

g. Gamma range from REA:

Document the gamma range at the time of the assessment survey from the Remedial Engineering Assessment (REA).

h. Region Type:

Document whether the excavation was indoor or outdoor.

i. Depth of Excavation:

Document the depth of the excavation, specifically if it was <15 cm.

j. Table:

Fill out form as indicated. If further action is recommended, explain in detail under the comment section.

9.2.3 Soil data form sheet

See Appendix 4, Example of Soil Data Field Sheet.

a. Location number and address:

This section is filled out by field personnel prior to or during the site visit. The information is taken from the ISC or REA report.

b. Property status (Remedial Action):

Check as appropriate.

c. Date and initial:

State the date that the V samples were taken and the date requested for RAC sample splits (X samples). Initial for all samples.

d. Sample location:

The code designating which region the sample was taken from should be entered.

e. Area represented:

This refers to total measured surface area that the collected sample represents.

f. Sample depth:

Record depth at which sample is taken (0-15 cm or >15 cm is adequate).

g. IVC sample number:

The sample number assigned by the IVC as taken from the labelled sample container.

h. ^{226}Ra content:

The "^{226}Ra, pCi/g" blanks are completed once the respective sample has been analyzed.

9.2.4 Radon verification check sheets

Forms associated with radon data collection include: Verification of Alpha Track Detector Placement and Results and the WLM Method Form. The address and location are filled out as required on the appropriate form.

a. Verification of Alpha Track Detector Placement and Retrieval form: see Appendix 13.

1. Fill out appropriate location number and address.

2. List the three detector identification numbers, which are placed in the structure.

3. The dates of placement and retrieval are filled in on the respective placement dates.

4. The actual number of days in place is calculated at the time of retrieval.

5. Document the name of the RAC's technician placing or retrieving the detectors, and the IVC verification inspector's name.

6. Document the type of alpha track detector used and the structure and room in which the detector is placed.

7. Answer or verify the questions with a "yes or no" response.

8. Initial and include comments at the bottom of the page.

b. Calculation of RDC:

1. When the RAC receives the results of alpha track analysis, they will supply the IVC with the manufacturer's data.

2. The RDC is calculated, and compared to the RAC's calculation presented in their completion report.

3. The verification inspector performing this calculation documents their name in the appropriate place.

c. WLM Method Form

See Appendix 15, WLM method form.

1. Instrument number and calibration "up-to-date" blanks must be completed.

2. Information for "before measurement field check" should be entered in the "operational check data" near the top of the form. This information will be transferred from the RAC's calibration data sheet.

3. Measurements section

- Setup Parameters should be entered from the RAC measurements form.

- All blanks and questions should be completed.

- If the measurement is a short term grab sample, record the 12-hour WL, Maximum WL, and wind speed information.

- If the measurement is a one week sample record "N/A" in the blanks for 12-hour WL, Maximum WL, and wind speed information.

4. Information for after measurement field check should be entered in the "operational check data" at the bottom of the form. The information can be transferred from the RAC's calibration data sheet.

9.2.5 Verification survey notes

See Appendix 16, Verification survey field notes.

The survey notes are used to record notes or information which is pertinent to the property or would assist the report writer. The names of the RAC and State of Colorado personnel involved in the survey are also documented here.

A narrative of the site visit is documented on this form. Several forms may be used for a large remedial action.

9.2.6 Chain of Sample Custody/Soil Sample Analysis Form

See Appendix 5. This form should be completed at the time of sample collection. See Procedure TE-034.

9.2.7 Tracking form

The tracking form (Appendix 2) is used for recording the progress of work associated with the specific property. Blanks should be initialed and dated.

9.2.8 Delta gamma field data sheet

The delta gamma field data sheet (Appendix 12) is used for recording measurements taken with the delta counter. Fill out appropriate blanks as indicated.

9.3 EXTENT OF TYPE II VERIFICATION SURVEY

9.3.1 Purpose

The purpose of this procedure is to provide guidelines for the extent of data to be collected during a Type II verification site survey, while allowing the greatest possible cost efficiency.

The guidelines are based upon the procedures set forth by the RAC in the Field Assessments Procedures Manual (UNC Geotech, 1990), and the procedures of the ISC (TE-020). The paralleling of procedures allows the IVC to better verify that levels of radiation are below EPA standards by using methods comparable to those of the RAC.

9.3.2 Applicability

This procedure applies to the performance of independent verification surveys by PAG personnel in support of IVC activities for the UMTRA Project. The procedure applies to those properties where remedial action is in progress (type II).

9.3.3 Selection of Properties

The IVC will randomly choose new properties to perform Type II verification surveys from daily calls by the RAC informing the IVC of pending verifications.

9.3.4 ISC/REA Review

a. Field documents

Prior to the site survey, the IVC will obtain a copy of the remedial engineering assessment (REA), the ISC report, a blank gridded field map, and any other appropriate maps from the RAC's record management department. The verification team will review the inclusion survey report (ISC report) and the REA and compare their maps for inconsistencies.

b. Data management

The data management for Type II properties goes through the process described in Sect. 5.0. A data base record is created for each property, and the most current property and owner information are documented there.

c. Partial surveys

The IVC will arrive at the location unannounced and proceed to verify the property is cleaned up to within EPA standards.

The construction methods required to remediate properties often cause the verification site surveys to be done in stages (e.g. the back yard will be remediated and backfilled before construction begins in the front yard).

The partial site surveys will occur on different days and may be required at more than one property at a time; therefore, the field personnel conducting one part of a specific property's verification survey may be different than the personnel conducting subsequent surveys at that site. The field person conducting each partial survey shall document that portion, recording the information on the appropriate data sheets, initialing and dating the tracking sheet, bringing soil samples and analysis forms to the soils lab, and conducting the required post-verification survey activities.

In the cases of partial surveys, the IVC will arrive unannounced for the first survey, but will be notified by the RAC for subsequent surveys. The property will be a designated IVC property after the first survey.

9.3.5 Gamma scintillometer scan

a. A complete gamma scan of the excavation and the ground within approximately 10 ft. of the excavation will be performed on each site survey. If interior work has been done, the interior excavation will be scanned using the same methods.

b. The background exposure rate for the property will be determined using one of three sources: (a) the inclusion survey, (b) the REA, or (c) a new post-excavation measurement.

c. The range of scintillometer readings found during the scan of the excavated areas will be included on the field drawing. When gamma exposure rates above the background range are detected, further explanation or investigation is required. Measurements using a delta scintillometer or soil samples should be used to verify that the contamination has been remediated to comply with EPA standards.

9.3.6 Deposit definition

If contamination above the standards is discovered, it will be pointed out to the RAC's verification personnel, if on site. If the contamination is to remain in place it will be characterized using techniques similar to inclusion procedures to determine whether it exceeds EPA standards

(see Sect. 9.5). If obvious problems with respect to possible certification are encountered, DOE will be notified immediately with notification by letter within 24 hours.

9.3.7 Soil sample collection

a. At least one independent soil sample will be collected on each property where there is outdoor excavation. The number of independent samples will vary according to the size and extent of the remedial action as follows:

Excavation Area Size (m^2)	Number of Independent Samples
<100	1
100-500	2
>500	4

b. The area from which the samples are collected may be determined in one or more of the following manners:

1. Random selection of the RAC's sampling areas, and duplicating the RAC's sample by taking an aliquot at the center of each grid block.

2. Selection of a 100 m^2 area which contains the HOG.

3. Random selection of the RAC's sampling area, with the aliquots taken from the grid intersections versus the RAC's sampling in the center of each grid block.

4. Biased selection from questionable locations.

c. Soil samples taken by the IVC on the vicinity property will generally parallel the RAC's sampling procedure (UNC Geotech, 1989). Generally, a composite sample will be taken from each 100 sq. meter area (+/- 20%), with one aliquot from each 100 sq. ft. grid block within this area.

d. Individual samples, if needed, will be taken using the best technique for the location; this may be a composite of aliquots or standard inclusion survey techniques (see TE-020). Sample aliquots will be taken with a JMC Auger, a sample tube or other available tool and placed in an appropriate container. Samples will be labelled as in TE-020, using a "V" for the ORNL verification sample code (e.g. GJ13309-V1) and a "B" for biased samples (e.g. GJ13309-B1).

Chain of Sample Custody/Soil Sample Analysis Forms are to be completed on a daily basis by field personnel and turned over to the soil coordinator with the samples at the end of each verification survey day or the earliest convenient time.

9.3.8 Chain of Sample Custody Procedures

a. Use chain-of-custody protocol for all soil samples.

   1. Whenever the samples are out of sight and in an unsecured area, keep them in a cooler or other container sealed with chain-of-custody seals.

   2. Complete a Chain of Sample Custody/Soil Sample Analysis Form and sign it when transferring samples to the soils lab.

   3. If no one is at the soils lab to receive the samples, lock the samples in the soils prep lab in a sealed container or locked cupboard accompanied by the Chain of Sample Custody/Soil Sample Analysis Form.

9.3.9 Verification inside structures

a. Excavations inside structures will be scanned with a scintillometer as described in TE-020. A range for the entire indoor excavation will be recorded on the field map.

b. The indoor gamma exposure rates may not exceed 20 μR/h. In some cases, a contaminated footer may remain in place and will affect the indoor gamma exposure rate range. When measuring the gamma radiation, care should be taken to eliminate any emanation from areas engineered to remain in place. This may be done with a delta counter or by use of the lead shield (Sect. 9).

c. If the remedial action has achieved a gamma exposure rate range which is as low as reasonably achievable (ALARA), but exceeds 20 μR/h, the verification will depend solely on the result of the RDC measurement. This measurement should not normally exceed .02 WL annual average and in no case exceed .03 WL. The RAC may take measures to vent the structure, ultimately lowering the RDC. This should be noted on a separate indoor map or on the outdoor field map if space is available.

d. If the property requires post-remedial radon daughter concentration measurements, the IVC will verify that the RAC is placing approved RDC measuring devices in the structure. This will include verifying that the instrument is placed at the proper location and that approved procedures are followed.

9.3.10 Tailings left in place

a. Refer to the RAC's procedure manual, Sect. 3.7.3 (UNC Geotech, 1989).

b. In some instances, the RAC may have justification for leaving exterior and interior tailings in place. These unique occurrences may be due to one of the following:

1. The engineering design cannot provide reasonable assurance that significant structure damage will not occur. This often refers to foundations where tailings were used as part of the concrete matrix.

2. The safety of workmen cannot be assured. This often refers to high voltage lines, high pressure water lines, or other utilities.

3. Mature trees or shrubbery will be permanently damaged.

c. The IVC will obtain an independent measurement of contamination to be left in place. Gamma exposure rate and radium-in-soil measurements will be taken to determine if EPA standards have been met. These values will be averaged over 100 m^2 for outdoor areas and, if necessary, 9.3 m^2 for indoor areas.

d. In most cases, the outdoor and indoor areas designated to be left in place have net estimated area-weighted radium concentrations and gamma exposure rates which fall below EPA standards. If they do not, the RAC must apply for supplemental standards (UNC Geotech, 1990).

9.3.11 Decontamination

Equipment should be checked for contamination and decontaminated, if necessary (see TE-090, Sect. 9.0).

9.3.12 Checklists

A brief checklist of equipment and items needed before conducting a site survey is provided to each verification field technician, as follows:

a. **Verification survey checklist**

1. Calibrated gamma scintillometers,
2. Calibrated delta counter (essential if there is indoor remediation),
3. A JMC auger,
4. Large ziplock bags to collect composite samples,
5. Sharpie pens to label samples,
6. The field team pager,
7. The RAC radio,
8. A thirty foot tape,
9. Clipboard with red pens, scales, etc.,
10. Field forms (survey notes, soil data, gamma screening, delta gamma, soil analysis),
11. The survey folder (from "active file") if 2nd visit,
12. Blank, gridded copy of indoor and outdoor RAC maps (without folder if 1st visit survey),
13. Decontamination equipment,
14. A small trowel or shovel,
15. The smaller size JMC auger ("mud sampler") if the weather is wet,
16. Rain gear (if weather is wet), and
17. Drinking water.

Another checklist for field use by the verification team is shown below. It describes the general field procedure of surveys and serves as a reminder in the field of the requirements for verification.

b. IVC site radiological surveys

1. IVC randomly selects a site to survey. A survey where the remedial action is only partially completed is called a "partial" survey, and a "final" survey is one where the remedial action is complete. There may be several "partials" before the remedial action is "final". It is important to determine in the field survey notes whether the verification survey is partial or final.

2. Obtain the file folder, which remains in the "active" file drawer until the time of final survey.

3. Examine the REA - ISC Review Checklist for information on the remedial action.

4. Upon arriving at the site, personnel must equip themselves with a hard hat and steel toed boots as required by OSHA. The contractors are often working and heavy equipment is in use.

5. Communication with the RAC team leader is essential. They will inform us of any extenuating circumstances, and will point out the excavations to be verified.

6. Map the extent of the excavation as accurately as possible with tape measure. Large discrepancies are of concern, but the difference in the area of an excavation between the RAC's map and the IVC's map does not directly concern us or effect the decision, unless it contains contamination which appears to exceed the applicable standards.

7. Gamma scan the extent of the excavation. Scan 10 feet away from the perimeter of the excavation to assure that the contamination was completely removed. Notify the RAC team leader if any readings consistently above background plus 30% are found. Record the gamma exposure rate ranges on the field map.

8. Collect a composite sample, matching the RAC sample locations. A grid is established and every 10 sq. ft. is sampled using a JMC auger. Approximately 10 to 13 plugs make up one composite sample. Record RAC's soil sample ticket number, which may or may not correspond to ORNL's composite sample.

9. Be sure that all excavations have been verified before leaving the site.

10. Indoor Excavations:

    RAC does not collect soil samples from indoor excavations at this time. If the excavation to be verified is indoors, gamma scan the region thoroughly. The average gamma exposure rate must not exceed 20μR/h above background for any room-sized areas (9.3 square meters). If the upper level of the range exceeds background plus 30%, gamma readings must be taken at a minimum of 10 ft. intervals. (UNC Geotech, 1990)

11. Contamination may be left in place if it threatens the structural integrity of the building. Biased samples are collected from these areas, and an area-weighted average is calculated.

9.4 POST-VERIFICATION SURVEY ACTIVITIES

9.4.1 Purpose

The purpose of this procedure is to state responsibilities of verification field personnel prior to preparation of the verification report.

9.4.2 Procedure

After each verification site visit, field personnel complete the field data sheets as thoroughly as possible. The following activities are involved post-survey:

a. Convert all kcpm to μR/h on field maps and notes.

b. Sign tracking form in appropriate place.

c. Xerox field map and all field forms for archival, after each partial and final field survey, and place in the archive file.

d. Input field data to IVC data base.

e. Note in field logbook the assign date or if the verification was a "final".

f. Place folder in "active" file drawer, for RDC device placement.

9.4.3 Soil sample data

The verification field personnel are responsible for completing the "ORNL ^{226}Ra Analysis, pCi/g" blank on the soil sample field form once the sample has been analyzed by soils laboratory personnel.

The sample coordinator provides the verification personnel with a weekly print-out of samples analyzed and their respective ^{226}Ra concentrations.

The sample data should be entered on the soil field form when results are available. These results should also be compared to the EPA standards to ascertain that the property was remediated to the applicable levels.

9.5 SOIL SAMPLES

9.5.1 Purpose

The purpose of this procedure is to describe the procedures for acquiring sample splits from the RAC and the analysis of verification soil samples.

9.5.2 Applicability

This procedure applies to the analysis of soil samples with the sodium iodide (NaI) well crystal detector system in support of the IVC activities.

9.5.3 Responsibility

The sample technician is responsible for preparation of samples according to this procedure.

9.5.4 Procedure

These procedures are divided into four sections distinguished by the type of sample being processed and the procedures common to both types of samples.

a. Soil sample splits from the RAC

These samples are a portion of the soil sample which was taken by the RAC during their verification survey. These samples are identified by an "X" on the sample ID number (e.g. GJ12901-X1).

1. The RAC soil sample number shall be determined from the verification personnel or from the completion report. This sample

should then be requested from their soils laboratory using the Chain of Sample Custody/Soil Sample Analysis Form (Appendix 5). The RAC samples will have been dried, crushed, and blended by the RAC's lab. The RAC's samples will be assigned an appropriate ORNL soil sample number using an "X" as the sample code to identify the sample as a split. This code should be written on the container for the sample. The ORNL soil analysis sheet (Appendix 5) should be filled out for samples provided to the soils lab.

2. The samples will be taken to the ORNL soils preparation lab. Refer to TE-035, Soil Sample Preparation.

b. IVC verification soil samples

This section applies to those samples taken by the IVC during verification site surveys. These samples are identified by the code letter "V" in the sample ID number (e.g. GJ12901-V1).

1. See TE-035, Drying the sample.

   Use of a turkey pan is required if the sample is an aliquot due to the size of the sample; however, smaller foil pans may be used if the sample will be contained.

2. Crush the dried sample in the jaw crusher.

3. Place the entire sample in the soil blender, replace the seals, and mix the sample for approximately five minutes. Return the sample to the foil pan.

c. Sample canning

Refer to TE-035.

These procedures apply to type "X" and "V" samples.

d. Analysis

See TE-036.

e. Sample storage

1. Soil sample splits (code "X" samples) acquired from the RAC should be returned to the RAC soils lab. The Chain of Sample

Custody/Soil Sample Analysis Form must be taken to document return of the sample.

2. The IVC verification samples (code "V" samples) will be stored according to TE-036.

9.6 TYPE II VERIFICATION REPORT

9.6.1 Purpose

The purpose of this procedure is to provide guidance for writing Independent Verification Survey Reports of properties where remediation has been initiated (Type II).

9.6.2 Applicability

All properties at which the IVC conducted on-site surveys (Type II and Type III properties) will have a verification report written. All verification survey reports written for PAG will follow this procedure and its references.

9.6.3 Responsibility

All PAG personnel responsible for authoring verification survey reports will comply with this procedure.

9.6.4 Procedure

The verification report will be drafted following the completion report review.

a. Calculations

Pertinent calculations must be performed by the report writer prior to completion of the verification report skeleton. The calculations performed shall be recorded and attached to the field data sheets prior to submittal of the report for typing and review. The format of the radium-in-soil calculations record is provided in the soil analysis worksheet (See Appendix 17). RDC will be calculated using original data and the radon calculations worksheet (Appendix 18). Calculations such as conversions from feet squared to meters squared, indoor and outdoor area-weighted elevated gamma exposure rates, field averages, outdoor area-weighted ^{226}Ra values, soil background and background +30% are found in TE-030.

b. Report skeleton

Once the necessary calculations have been performed and recorded, the report skeleton (Appendix 19) is completed by the writer as follows:

1. The site location number must appear in the upper right-hand corner of each page of the report in the space provided.

2. Cover page:

   Pertinent information is taken from the property portfolio and the appropriate entries are made.

3. Introduction:

   This section of the report explains the purpose of the survey, when and by whom the survey was conducted, the classification of the property, and methods by which it was conducted. The type of conversion [data conversion of gamma scintillator measurements (kcpm) to exposure rates (μR/h)] method used is inserted as appropriate.

4. Significance of findings

   The main purpose of the significance of findings is to describe idiosyncrasies not found in the tables. The writer should provide a brief discussion of verification results found on the respective site, both indoors and outdoors. The last sentence shall contain the site location number and recommendation. The exact wording is left to the discretion of the individual author, although the following outline may be used for general format:

   I. Measurements performed in the IVC survey

      A. Gamma results

      B. Soil results

      C. Were the RAC's field methods adequate?

   II. Confirmatory analysis (split samples)

      A. Do the two sets of samples agree?

B. Use and refer to Table 3 for discrepancies

III. Review of RAC completion report

A. Is the documentation adequate?

B. Are there discrepancies?

C. Explanation of discrepancies

D. If no discrepancies exist, state that the report documentation was in compliance.

IV. RDC data (Both Type I and Type II)

A. Was it verified and in compliance with EPA standards?

B. Was the location of the RDC meters adequate and in compliance with procedures?

V. Discrepancies

A. Carefully document any discrepancies causing the report to be recommended for any action other than certification.

IV. EPA standards and guidelines

A. Use in conclusion

B. Have they been exceeded?

5. Recommendation

This section of the report simply states the recommendation and the basis of such. After "Recommended for:" only the applicable statement shall appear. The basis section shall state the applicable criteria that the site does or does not exceed.

6. Table 1. Location information

The applicable information is taken from the property portfolio and entries are made appropriately. All structures present on the site will be adequately described. The most current owner and property information are recorded here.

7. Tables 2, 3, 4, and 5, Radiological survey results

   The applicable radiological information is entered into each table, each column from its appropriate source.

8. Caption of figure

   "Fig. 1." is the site location map. The caption shall include the location number and address. If an indoor map is required, there shall be a "Fig. 1a" (outdoor) and a "Fig. 1b" (indoor), both bearing an appropriate caption.

9. Tracking form

   When the draft is complete the report writer initials and dates the appropriate space on the tracking form.

c. Type II letter of recommendation (Appendix 20)

The final typed copy of this letter is the official notification to DOE indicating the IVC recommendation. Appropriate phrases must be included and site information at the bottom of the page completed by the report writer. The evaluation basis shall reflect the measurements taken in the field. The recommendation basis shall reflect the laws set out in the Federal Register (40 CFR 192).

d. Vicinity property certification summary and decision form (Appendix 21)

These sheets are another means by which information regarding the verification survey and IVC recommendation is exchanged between the IVC and the DOE. The sheet shall be completed in permanent, black ink and as neatly as possible. If an error is made, the form must be redone (no correction fluid).

e. Site location map

Data shall be transferred to final drawings (outdoor and indoor, if required) from the field radiological maps. The verification survey map should show final exposure rate ranges over excavated areas, soil sample location if individual samples were taken, and any other pertinent data.

1. After a property is selected for verification, an IVC original drawing is created. The source of IVC original drawing is a RAC

drawing available in the property folio, stored on floppy disk. The RAC drawing is copied, renamed, and modified for IVC use.

2. Once the field surveys are complete, the rad data can be added to the original drawing. The field survey map is the primary source of rad data for the drawing. Additional field data may be found on the IVC gamma screening summary, soil data sheet or survey notes. All gamma rate ranges, and composite and biased sample locations are put on the final rad map. Rad information is entered on specific IVC drawing layers. In the case of a complicated indoor drawing, a separate indoor drawing is created. An indoor drawing is labeled Figure 1b in the verification report. Once the drawing is complete, the IVC technician signs and dates in the lower right corner. During the verification process, all recently edited drawings are backed up on tape at two-week intervals. After notification of certification is received from the DOE, the final drawings with the radiologic information are backed up on tape. The tape is designated for verification drawings only.

9.7 VERIFICATION REPORT REVIEW

9.7.1 Purpose

The purpose of this procedure is to provide guidance for the review of the verification survey reports.

9.7.2 Applicability

All PAG/RAD personnel reviewing verification survey reports shall follow this procedure and its references.

9.7.3 Responsibility

The verification personnel are responsible for the "initial" and "final" reviews (may also be called review 1 and review 2) of the verification reports.

9.7.4 Procedure

The IVC report review process usually includes three types of reviews: initial (first), second and final reviews.

a. Initial review

After the draft has been typed, the report and its property portfolio are forwarded to a verification technician, preferably a technician who conducted a radiological survey of the site but not the author. The following items are to be checked in the review:

1. Site location number on all appropriate pages,

2. Site address on all appropriate pages,

3. Report author on cover page,

4. Report date on cover page,

5. Verification survey dates on all appropriate pages,

6. Owner information on all appropriate pages,

7. Read entire report and check for misspellings, grammatical errors, and report completeness,

8. Two significant digits on all data,

9. Introduction: the conversion formula is checked to ensure correct usage and result.

10. Significance of Findings: the wording is checked for correctness and completeness. Assumptions, inferences, recommendations, and interpretations are checked for conformity.

11. Recommendation: the recommendation is verified and checked for consistency. If the report recommendation is changed during the review process, a consultation with the report writer occurs to ensure that correct interpretations are made by the report writer.

12. The site location map(s) is checked for accuracy and agreement with the report and the field maps. Soil sample numbers and locations, gamma exposure rates, and any other pertinent information should be checked.

13. All outdoor exposure rates and areas on all appropriate pages are checked for consistency.

14. All indoor exposure rates and areas on all appropriate pages are checked for consistency.

15. All extended measurements and corresponding regions on all appropriate pages are checked for consistency.

16. Figure captions and number of figures.

17. Verification of greater than (>) and less than (<) signs on all appropriate pages

18. The letter to DOE and the decision forms are checked for conformity and agreement of recommendations.

19. The completion report review portion of the report is checked as described in Sect. 8.3.1.

b. Second review

After the first draft has been typed, the report and its property folio are forwarded to another IVC technician for the second review. During the second review:

1. the completion report check-off sheets (Appendix 8) are used to review the completion report thoroughly again,

2. the IVC report draft is reviewed for corrections, consistency, and completeness, and

3. the reviewer dates and initials the property file tracking sheet.

c. Final review

After the final report has been typed, the report and it's property folio are assigned to another IVC technician for the final review. The final review is conducted by the project coordinator or a designated person. During the final review:

1. the completion report check-off sheet is checked through,

2. the IVC draft is reviewed for correctness, consistency, and completeness, and

3. the reviewer dates and initials the property file tracking sheet.

10.0 TYPE III VERIFICATION ACTIVITIES

10.1 EQUIPMENT

Refer to Section 9.1 entitled "Equipment". Type III surveys require the use of a posthole digger and 500 g aluminum pans, lids, and plastic ziplock bags for sampling.

10.2 DATA RECORDING

The purpose of this procedure is to define data records related to Type III verification site survey and soil sample collection.

10.2.1 Field map

The field map is used to locate gamma exposure rate information, soil sample locations, and any other information appropriate to the verification survey.

10.2.2 Field data sheets

Refer to TE-020, Field Data Sheets, Chain of Sample Custody/Soil Sample Analysis Form, and Extended Measurements Data Form.

Also included in Type III survey field sheets is the verification survey notes described in Sect. 9.2.

10.2.3 Tracking form

The tracking form (Appendix 3) is used for recording the progress of work associated with the specific property. Blanks should be initialed and dated.

10.3 EXTENT OF TYPE III VERIFICATION FIELD SURVEY

The purpose of this procedure is to provide guidelines for the extent of data to be collected during a Type III verification site survey while allowing the greatest possible cost efficiency.

The guidelines are based upon the procedures set forth by the RAC (UNC Geotech, 1989).

This procedure applies to the performance of independent verification surveys by PAG personnel in support of the IVC activities for the UMTRA Project. The procedures apply to those properties where remedial action and restoration of a site has taken place.

10.3.1 Selection of properties

The DOE assigns type III properties to the IVC for verification. The DOE does not specify why the property has been selected.

10.3.2 Procedure

a. Prior to the site survey and contact with the property owner, the IVC will obtain a copy of the remedial engineering assessment (REA), the inclusion survey report, a blank gridded map, and any other appropriate maps from the RAC's record management department.

b. A data base record and property folder is created for each property. The data management process is described in Section 5.0.

c. An appointment is made with the property owner or tenant for the survey. One property visit should be sufficient unless extended measurements require subsequent visits.

d. A complete gamma scan of the property is performed. Refer to TE-020.

e. Extended measurements may be necessary, i.e. soil samples or radon daughter concentration measurements. Refer to TE-020.

f. Information is recorded on appropriate data field sheets (TE-020). Tracking form will be initialed and dated (Appendix 3).

g. Samples will be taken to the sample prep lab.

h. Equipment will be decontaminated. Refer to TE-020.

10.3.3 Checklist

a. calibrated gamma scintillometers,

b. calibrated delta gamma meter (essential if there is indoor remediation),

c. a JMC auger,

d. large ziplock bags to collect composite samples,

e. Sharpie pens to label samples,

f. the field team pager (pager no. 1),

g. the UNC radio,

h. a thirty foot tape,

i. clipboard with red pens, scales, etc.,

j. field forms (survey notes, soil data, gamma screening, delta gamma, soil analysis) (should be included in folder),

k. the survey folder (in "active file", blue file cabinet, trailer C, room 6),

l. blank, gridded copy of indoor and outdoor UNC maps (should be included in property folder),

m. decontamination equipment,

n. a small trowel, or shovel of some sort,

o. the smaller size JMC auger ("mud sampler") if the weather is wet,

p. rain gear (if weather is wet),

q. drinking water, and

r. field clothes: steel toed boots, hard hat.

10.3.4 Post verification activities

Refer to Section 9.4.

10.3.5 Soil samples

Refer to Section 9.5.

10.3.6 Type III verification report

Refer to Section 9.6.

10.3.7 Verification report review

Refer to Section 9.7.

11.0 DOCUMENT STORAGE

11.1 PURPOSE

The purpose of this procedure is to describe the methods for storing the property data and making it available to the verification personnel.

11.2 APPLICABILITY

The verification of vicinity properties may require multiple visits to a specific property. Each visit to the property may have to be done by a different verification person. In addition, the verification field work may have to be done on short notice; therefore, the files for the properties must be easily accessible to the verification personnel. The document storage system will be in a location which is available to the verification personnel.

Properties undergoing independent verification may be processed through various combinations of the verification stages.

Properties which have not yet been remediated will normally proceed through at least four of the five stages; not all properties require radon monitoring. Properties which have been remediated will only require the final stages.

11.3 STAGES

11.3.1 Active files

These include properties presently undergoing remediation. Property files can be removed from the storage location by verification personnel, as needed. The file must be returned as soon as possible after the verification survey and post-verification survey duties are performed. After the final verification survey the file will remain in this location until RDC monitoring is initiated, if no RDC monitoring is required the file will be moved to the next appropriate stage.

11.3.2 Active files/RDC monitoring in progress

These include properties undergoing RDC monitoring. Removal can be made by verification personnel. Files should be returned to this area as soon as data is entered. After RDC monitoring is complete, the file will be removed and placed in the next appropriate stage.

11.3.3 Files awaiting sample analysis

These include files which have samples currently in the analysis process. These files should remain in the designated area until all analysis results are added.

11.3.4 Inactive files/awaiting completion report

These include property files where verification field work and data entry is complete. Verification recommendation is awaiting the completion report from the RAC. These files should remain in the designated area until the completion report is received.

11.3.5 Recommendation to DOE/awaiting decision

These include property files where verification is complete and recommendation has been made to DOE - awaiting DOE's final certification. These files should remain in the designated area until DOE's certification has been received.

11.3.6 Closed

Property files which DOE has certified. These files should remain in the designated area.

11.3.7 Field data archival

This area will be used as a backup against loss of field verification data. One file folder will be assigned per property and all archive copies of field data will be placed in that file.

11.3.8 Final archival

Final archival of IVC data will follow procedures set forth in SU-070 of this manual.

Appendix 1. Type I verification tracking form

SITE NUMBER:
PARCEL NO:

SITE ADDRESS:

PROPERTY CLASS:

OWNER INFO:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE I

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	SITE VISIT	SURVEY DATE	TECH. INITIALS

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

COMPLETION REPORT

REVIEW 1: _____
REVIEW 2: _____

FINAL REVIEW _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17219 (9/90)

Appendix 2. Type II verification tracking form

SITE NUMBER:
PARCEL NO:

SITE ADDRESS:

PROPERTY CLASS:

OWNER INFO:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE II

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	DATABASE INPUT	SITE VISIT	SURVEY DATE	TECH. INITIA

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____
REA/ISC REPT REVIEW: _____

COMPLETION REPORT
REVIEW 1: _____
REVIEW 2: _____

VERIFICATION REPORT
DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

FINAL REVIEW _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17220 (9/90)

Appendix 3. Type III verification tracking form

SITE NUMBER:
PARCEL NO:

PROPERTY CLASS:

OWNER INFO:

SITE ADDRESS:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE III

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	DATABASE INPUT	SITE VISIT	SURVEY DATE	TECH. INITIA

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

VERIFICATION REPORT

DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

FINAL REVIEW _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17221 (9/90)

Appendix 4. Soil data field sheet

VICINITY PROPERTY INDEPENDENT VERIFICATION
SOIL DATA SHEET

PROPERTY ADDRESS:_____ LOCATION NUMBER_____

Check one: _____ Type I Remedial Action Complete (Paper Review)
_____ Type II Property in Progress (IVC Site Survey)
_____ Type III (Special Property)

ESTIMATED AREA OF EXCAVATIONS_____ # OF OUTDOOR EXCAVATIONS_____
OF COMPS REQUIRED _____ # OF INDOOR EXCAVATIONS _____

IVC			RAC			SOILS		
Date	Ints.	IVC sample #	COMP #	Ticket #	Depth of Sample	^{226}Ra Content (pCi/g) *S/S	RAC	IVC

Comment: _____

*NOTE: S/S IS THE SPLIT SAMPLE RESULTS OF RAC SOILS. ANALYZED BY ORNL LAB.

UCN17176(8/90)

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

_____

_____

1. Project No. 6R0004-180 2. Project Name Monticello Vicinity Properties ISC & IVC

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

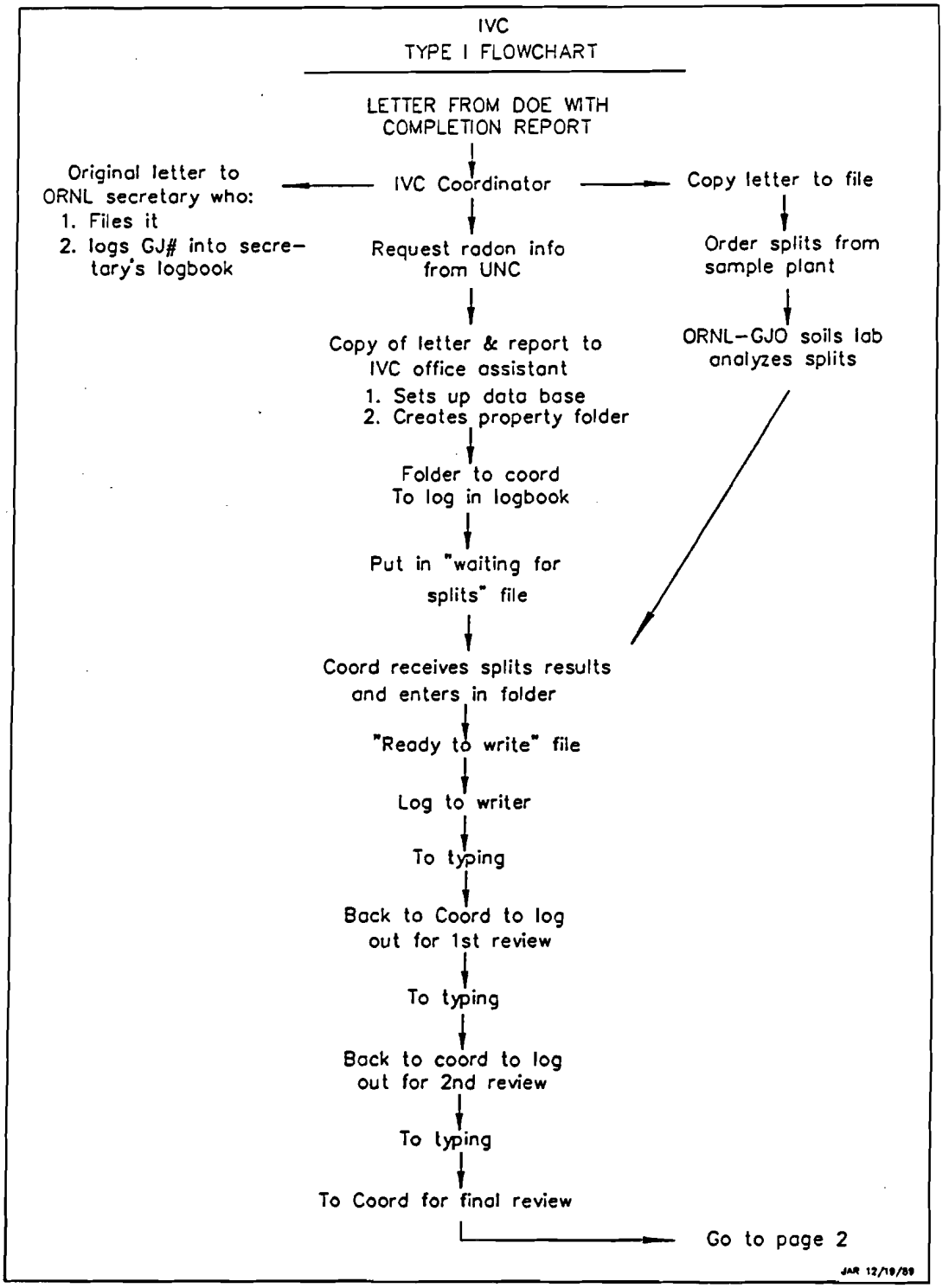
Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

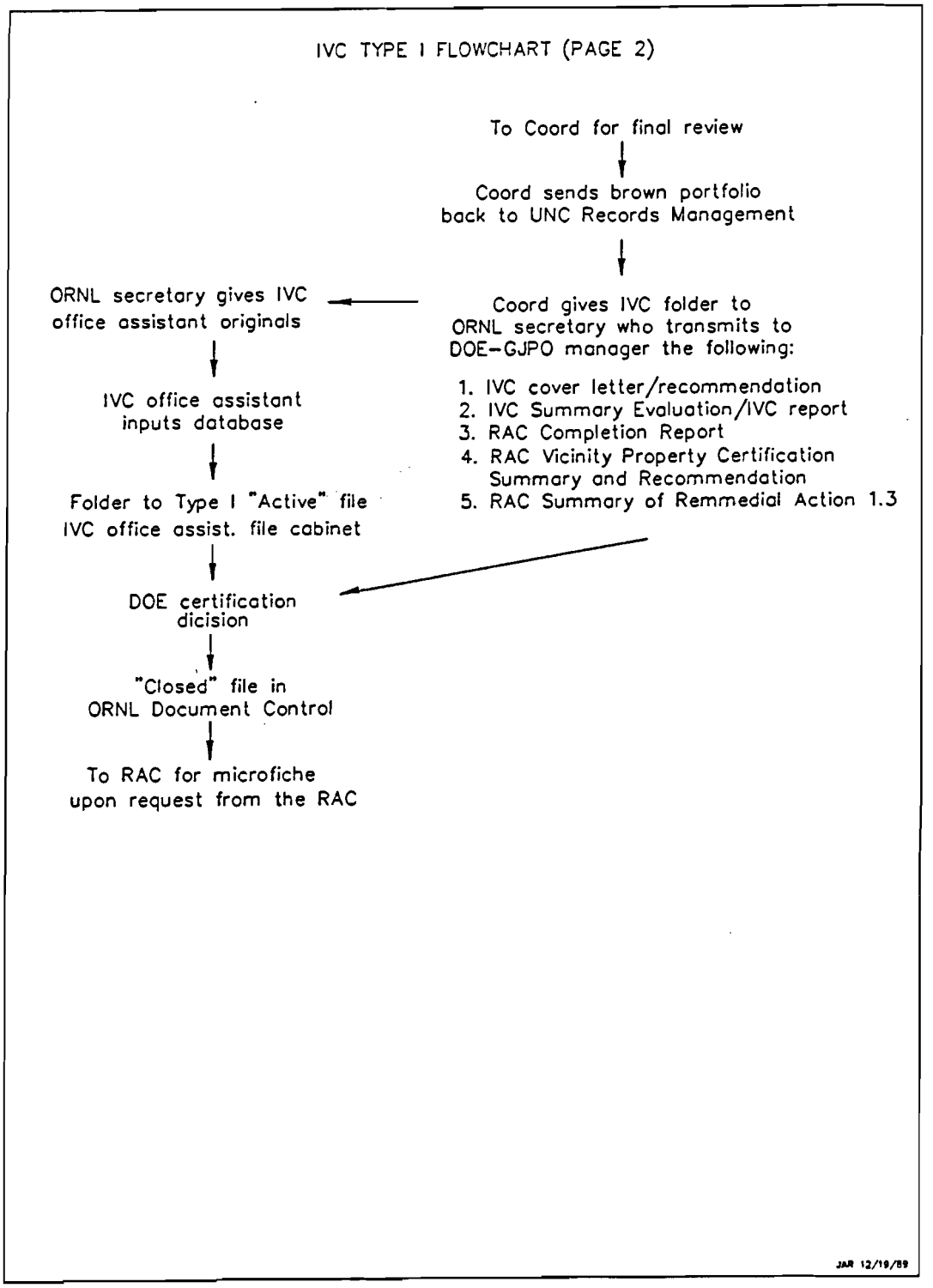
UCN 17345A (1/91)

Appendix 5. Chain of Sample Custody/Soil Sample Analysis Form

Appendix 6. Type I verification flow of work



Appendix 6. continued



Appendix 7. Completion report check-off sheets

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____ REVIEWER_____
PROPERTY ADDRESS_____ DATE_____
_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
I. COMPLETION REPORT GENERAL STRUCTURE & SUMMARY (Section I)				
1) Project manager signature?				
2) Is vicinity property location number present and correct on all pages and figures? except table of contents)				
3) Is the report documentation concise (e.g., no extraneous pages, figures, or tables)?				
4) Summary section reasonable and correct? (Section I)				
5) Do addresses, parcel #'s, dates, and statistics agree throughout the report?				
6) Is the owner's name correct?				
II. OPERATIONS SUMMARY (Section 2.0)				
1) Sec. 2.1, Abstract of Remedial Action Plan				
a) Reasonable and correct				
b) Description of where remedial action took place, backfill material, and restoration?				
2) Sec 2.2, Previously Unidentified Contamination				
Description and explanation?				

Appendix 7. Continued

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
3) Sec 2.3, Unanticipated Items				
Description and explanation?				
4) Sec 2.4, Application of Supplemental Standards (if applicable)				
a) Description of areas where supplemental standards were applied?				
b) Volume of remaining material stated?				
c) Location of remaining material stated?				
d) Radiological activity of remaining material stated?				
e) If numerical standards were not met, is this due to presence of natural radioactivity? (Sec 2.4)				
f) If all residual radioactivity at the property was not cleaned up, were supplemental standards (40 CFR 192 Subpart C) applied? (Sec. 2.4)				
g) Did appropriate state and federal agencies concur in this application of supplemental standards?				

Appendix 7. Continued

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
III. VERIFICATION SUMMARY (Sec 3.0)				
1) Sec 3.1.2 and Figure 2.1, Soil Excavation				
a) Was an outdoor gamma survey conducted in excavated areas? (Sec. 3.1.2, Fig. 2.1)				
b) Were soil samples or composites collected from contaminated regions after excavation? (Sec. 3.1.2, Fig. 2.1)				
2) Sec 3.1.2,Post-Excavation Survey				
a) Is contamination to remain on the property adequately described?				
b) Post-excavation exposure rate range?				
c) Exterior post-excavation soil sample results correct?				
d) Interior contamination to remain adequately described?				
e) Interior post-excavation exposure rate range?				
3) Sec. 3.1.3, Post-Remedial Action RDC measurements If RDC measurements were performed before remedial action and results were above standards, were they repeated after remedial action was completed? (Sec. 3.1.1 & Sec. 3.1.3)				

Appendix 7. Continued

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
4) Sec. 3.2, Recommendation for Certification				
Present and accurate?				
5) Certification Data Summary Table:				
a) Are survey results below the associated standards for:				
Interior gamma?				
RDCs?				
Exterior surface soils?				
Exterior subsurface soils?				
IV. 4.0 APPENDIX				
Table 3.1, Post-Excavation Sample Measurement Results:				
1) Area identifier and exposure ranges match with Figure 2.1?				
2) Sample results quoted?				
Table 3.2, Post-Remedial Action RDC measurement results?				
1) Are working level measurements correct (if original data sheets are available)?				
2) Instrument type(s) listed?				
3) Start and end dates and times correct?				
4) Do total hours agree with start/end times (RPISU or WLMI)				

Appendix 7. Continued

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Are measurement locations stated?				
V. FIG. 2.1, (MAP) (RADIOLOGICAL-AS-BUILT)				
Does Figure 2.1 clearly show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Areas of contamination removal clearly shown?				
4) Remaining contamination?				
5) Is legend clear and legible?				
6) Structure outlines?				
7) RDC sampler locations?				
VI. GENERAL INDOOR RADIOLOGICAL				
If interior excavation was performed, does Figure 2.1 or additional figure(s) show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Basement and second story information (if applicable)?				
4) Remaining contamination?				

Appendix 7. Continued

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Were assessment measurements taken in the lowest habitable level of every habitable building? (Sec. 3.1.2)				
6) After remedial action, was the average value for each room or 9.3 m^2 area less than 20 $\mu R/hr$ above background? (Sec. 3.1.2)				
7) If any measurment exceeded 20 $\mu R/hr$ above background, was it investigated to ensure no tailings involvement? (Sec. 3.1.2)				
VII. CERTIFICATION Is this property recommended for certification as meeting the EPA standards for residual radioactive material?				
_____ Signature of Reviewer & Date				
_____ Second Reviewer Signature & Date				

Appendix 8. Type I verification property certification summary and decision form and report skeleton

DOE ID Number:_____

VICINITY PROPERTY CERTIFICATION SUMMARY AND DECISION

1.0 SUMMARY EVALUATION

The data presented in the property portfolio indicate:

		IVC (ORNL)			U.S. Dept. of Energy		
		Yes	No	N/A	Yes	No	N/A
1.	The Ra-226 concentration in the top 15cm of soil averages < 5 pCi/g above background over 100 m2.	[]	[]	[]	[]	[]	[]
2.	The Ra-226 concentration in any 15 cm layer of soil below the top 15cm surface layer averages <15 pCi/g above background over 100 m2.	[]	[]	[]	[]	[]	[]
3.	The indoor gamma readings are <20 mR/hr above background in every habitable room.	[]	[]	[]	[]	[]	[]
4.	The radon daughter concentration in any habitable room is < 0.02 working levels, or at most 0.03 WL's.	[]	[]	[]	[]	[]	[]
5.	Supplemental standards were applied in accordance with EPA standards 192.21.*	[]	[]	[]	[]	[]	[]

COMMENTS:_____

_____

_____

_____

Appendix 8. Continued

DOE ID Number: _____

2.0 ORNL's RECOMMENDATION

Based on ORNL's evaluation of the [] Completion Report [] Completion Report and field survey data, I recommend this property for:

[] Certification

[] Certification pending resolution of the deficiencies described below

[] Additional measurements and/or additional information in the Completion Report as described below

[] Additional remedial action

_____ Date: _____

C. A. Little, Ph.D.
Independent Verification Contractor

2.1 ORNL's DESCRIPTION OF FINDINGS AND EVALUATION

This summary describes the findings of the IVC after review of the Completion Report, information in the property portfolio, and analysis of other available data.

Confirmatory analysis of sample splits from the RAC was performed. The splits were taken from the samples tabulated in the completion report. They are as follows:

UNC Ticket #	RAC Ra226 Content	IVC Ra226 Content
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g
_____	_____ pCi/g	_____ pCi/g

A review of the completion report and folio for location _____ found the property to be in compliance with EPA regulations for ^{226}Ra concentrations in surface/subsurface soil layers. Analysis of the ^{226}Ra concentrations of split samples from the Remedial Action Contractor (RAC) were found to be in close agreement with those of ORNL IVC.

_____

_____

_____

Appendix 8. Continued

The indoor gamma exposure rate range and annual radon daughter concentration are both in compliance with EPA standards.

Based on these findings, it is recommended that location _____ be certified by the DOE.

Appendix 8. Continued

DOE ID Number: _____

3.0 DOE/UMTRA EVALUATION

DOE Decision: [] Certify

[] Requires additional measurements prior to certification

[] Requires additional remedial action

Comments:_____

_____

_____

_____

_____

_____ Date:_____

U.S. Department of Energy
Certification Official

*Certification concurred on by NRC on_____
(date)

Appendix 9. Type I letter of recommendation

Mr. Michael K. Tucker, Manager
U.S. Department of Energy
Grand Junction Area Office
P.O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below do not exceed the U.S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This recommendation is based upon the Independent Verification Contractor's assessment of the ^{226}Ra concentration in the soil, indoor radon daughter concentration, and indoor gamma exposure rate at this property.

Therefore, this property is recommended for

(choose one)

certification by the U.S. Department of Energy.

certification upon resolution of the deficiencies described in the ORNL/IVC Certification Summary and Decision.

further study by the Uranium Mill Tailings Remedial Action Project.

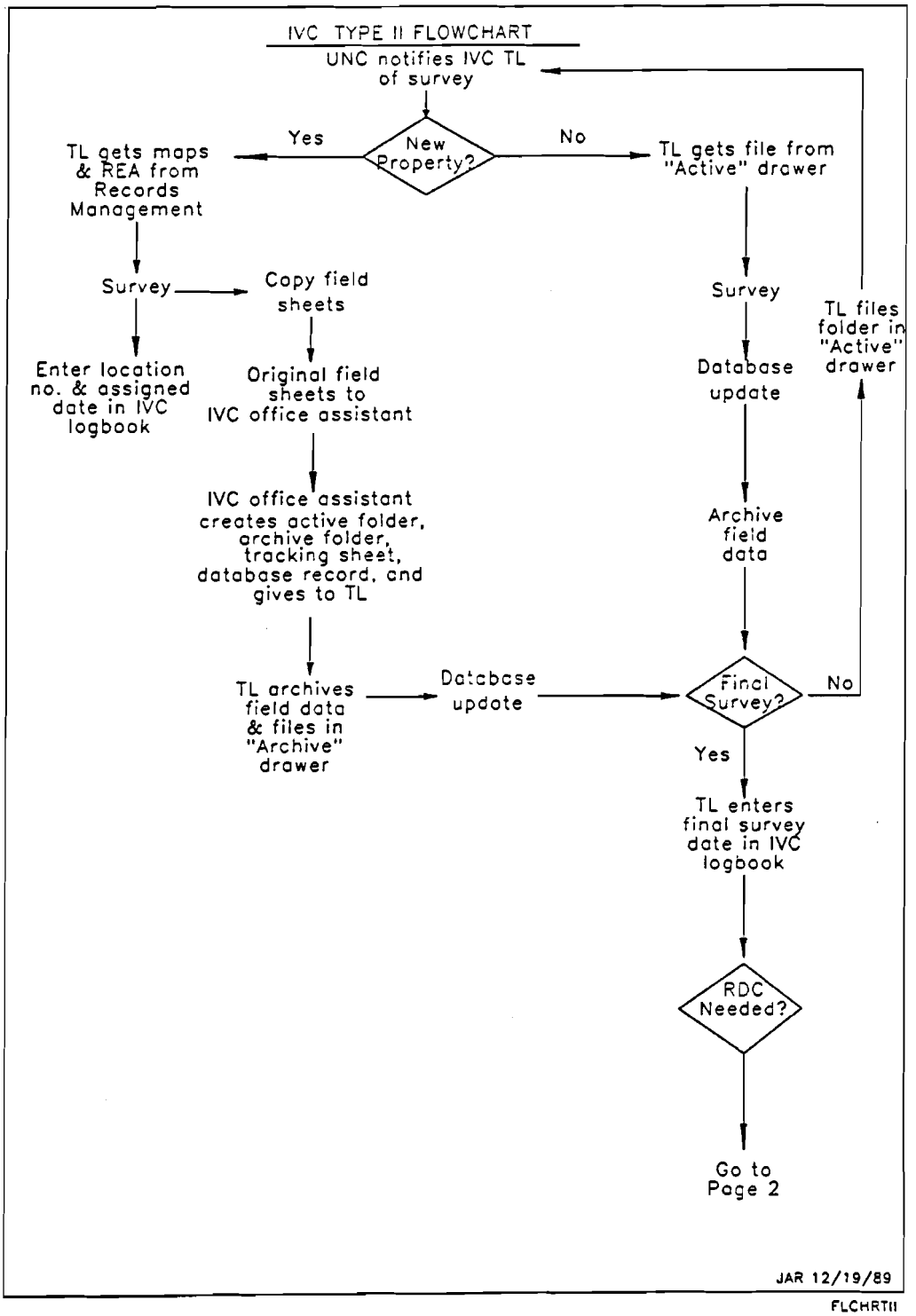
further remedial action by the Uranium Mill Tailings Remedial Action Project.

Sincerely,

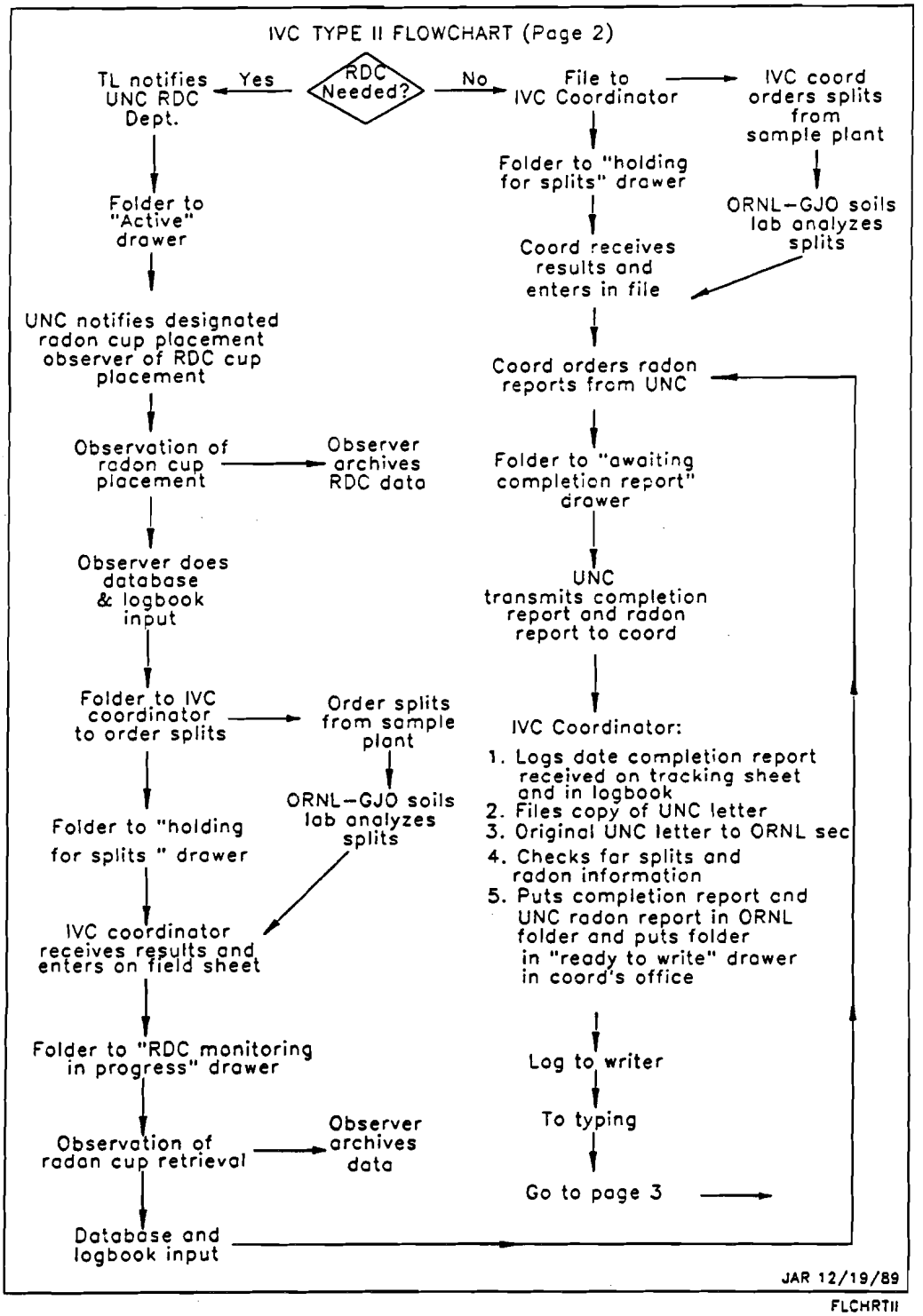
C.A. Little, Ph.D.
Independent Verification Contractor

Location Number: _____
Location Address: _____
_____
Property Owner: _____
Owner Address: _____

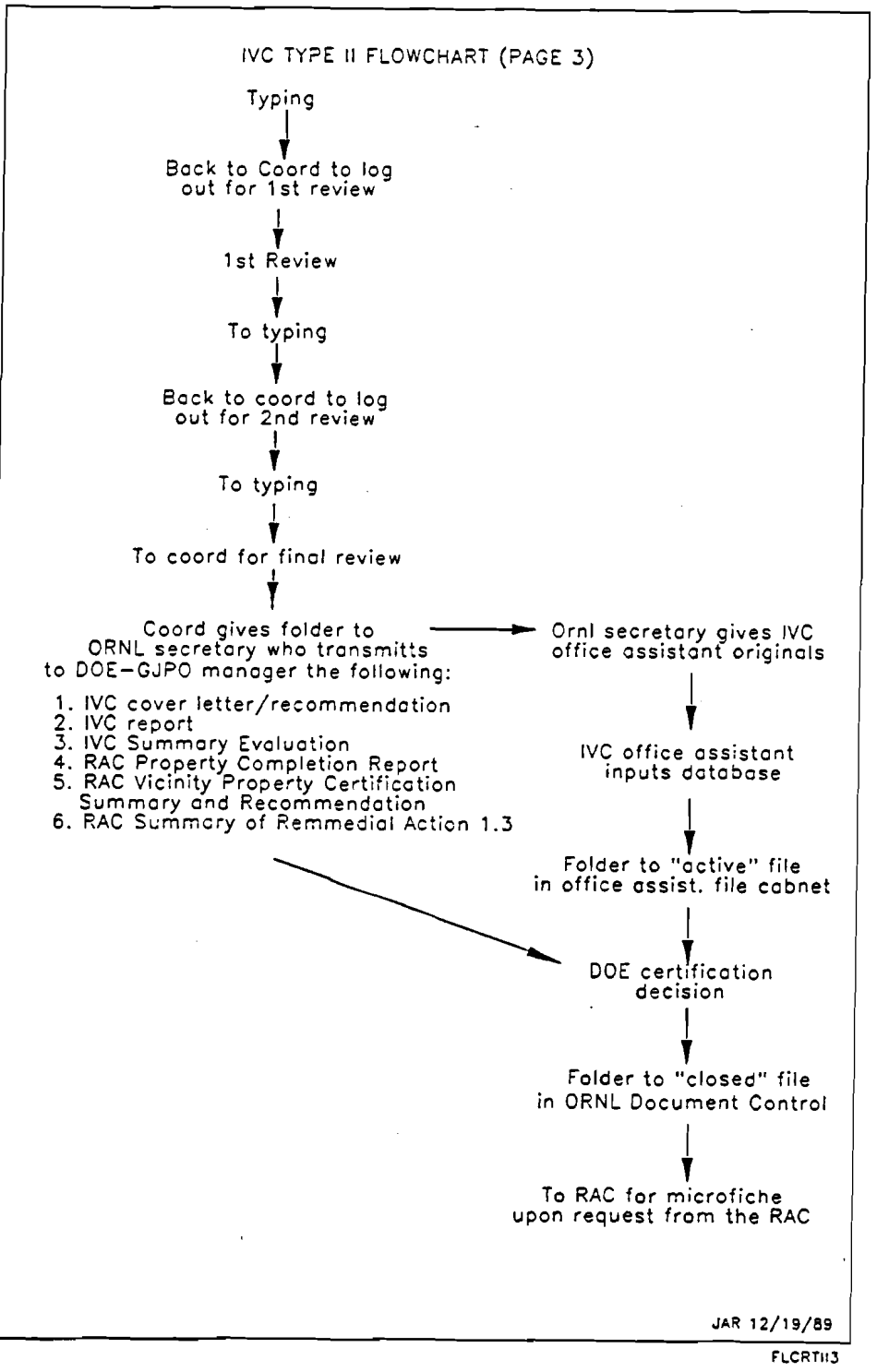
Appendix 10. Type II verification flow of work



Appendix 10. Continued



Appendix 10. Continued



Appendix 11. Delta gamma field data sheet

VICINITY PROPERTY INDEPENDENT VERIFICATION

DELTA GAMMA FIELD DATA SHEET

PROPERTY ADDRESS:_____ LOCATION NUMBER_____

_____ INSTRUMENT GJAO #_____

_____ CALIBRATION EXPIRES_____

TECHNICIAN NAME :_____ DATE _____

RESULTS CALCULATED BY:_____

****

ALL COUNT TIMES ARE 120 SECONDS UNLESS NOTED OTHERWISE

SAMPLE LOCATION	TOTAL COUNT	DELTA COUNT	%UNCERTAINTY (<15%)	Ra-226 pCi/g	DEPTH cm	COMMENTS (OPTIONAL)

UCN17173(8/90)

Appendix 12. Gamma screening summary

VICINITY PROPERTY INDEPENDENT VERIFICATION
GAMMA SCREENING SUMMARY

LOCATION:_____ SHEET__OF__
ADDRESS :_____
_____
_____

POST RDC's REQUIRED: YES____NO_____
BACKGROUND GAMMA EXPOSURE RATE FOR PROPERTY-Range_____Ave____
BACKGROUND DETERMINED BY REA: YES__NO__OTHER_____

Area Identifier	Kcpm	uR/h	Area (m²)	uR/h from REA	Exterior/Interior
VISIT #	TECH/INITS		ORNLINST #	DATE	
VISIT	TECH/INITS		ORNLINST #	DATE	
VISIT	TECH/INITS		ORNLINST #	DATE	
VISIT	TECH/INITS		ORNLINST #	DATE	
VISIT	TECH/INITS		ORNLINST #	DATE	
VISIT	TECH/INITS		ORNLINST #	DATE	

Appendix 13. Alpha Track Detector Placement and Retrieval form

Alpha Track Detector Placement and Retrieval

Sheet ____ of ____

Location # _____
Address _____
_____

Choose one: _____ Inclusion Survey _____ Verification Survey

Detector ID # _____ _____ _____

Type of detector: Tech/Ops Landauer Radtrak™ Alpha-Track (Radon Gas) Monitors

PLACEMENT

Start date _____ Projected retrieval date _____
ORNL technician _____ RAC technician _____
Building _____ Room _____
Exact location in room _____
Region _____, Gamma range _____ μR/h, average _____ μR/h, area _____ m^2

	YES	NO
1. Placement Location		
a. Habitable room on the lowest level?	____	____
b. Indoor area of removal (verification only)?	____	____
c. Room with the highest gamma exposure rate?	____	____
d. Room with the least ventilation?	____	____
2. Placement Requirements		
a. Sealed bags intact before opening?	____	____
b. Number on bag same as number on detector?	____	____
c. Is the detector filter undamaged?	____	____
d. Detector placed away from direct sunlight, heat sources, doors, windows, or vents?	____	____
e. Placed at least 18 inches off the floor?	____	____
f. Out of reach of children?	____	____
g. Not in humid room (laundry or bathroom)?	____	____
3. Noted location on map?	____	____
4. Consent current for 1 year (inclusion survey only)?	____	____
5. Meets all requirements listed above? If "no", explain below.	____	____

RETRIEVAL

End date _____
ORNL technician _____
RAC technician _____

1. Are the filters undamaged?	____	____
2. Have the detectors been moved?	____	____
3. Was the detector properly sealed after retrieval?	____	____
4. Meets all requirements listed above? If "no", explain below.	____	____

COMMENTS

_____

_____

_____

Appendix 14. WLM method form

INDEPENDENT VERIFICATION CONTRACTOR
Radon Verification Check Sheet
WLM Method

DOE Prop. ID # _____ Inst. # _____
Address _____
_____ SHEET ____ OF ____

Calibration of WLM up-to-date? _____

OPERATIONAL CHECK DATA SHEET
--Before Measurement--

Date _____ Initials _____
Efficiency _____ Is this within +/- 3% of cal. sticker? _____
Air Flow Rate _____ lpm Is this within 0.008 lpm of cal. sticker? _____

MEASUREMENT

Structure _____ Remarks _____
Room _____ _____

Setup Parameters:
Sample Interval _____ Start: Mo ____ Day ___ Yr ____ Hr ____
Sample Quantity _____ Stop: Mo ____ Day ___ Yr ____ Hr ____
Tail Interval _____
Tail Quantity _____ Calibration Constant _____
(From Sticker)

Inst. Placement: Date _____ Time _____ Verified by: _____

Detector placed in habitable room where maximum RDC is expected? (in order of priority)	YES	NO
a) Room with lowest elevation?	____	____
b) Room with highest gamma exposure rate?	____	____
c) Room with least ventilation?	____	____

[Explain deviations from this guideline and reasons on back]

Instrument Retrieval: Date_____ Time _____ Verified by: _____

Measurement Results:
Average WL _____ Maximum Wind Speed_____ mph
Measurement Period
12 Hour WL _____
Maximum WL _____ Date _____ Time _____

Date _____ Time _____ Source _____

OPERATIONAL CHECK DATA SHEET
--After Measurement--

Date _____ Initials _____
Efficiency _____ Is this within +/- 3% of cal. sticker? _____
Air Flow Rate _____ lpm Is this within 0.008 lpm of cal. sticker? _____

Appendix 15. Verification survey field notes

VERIFICATION SURVEY NOTES

LOCATION NUMBER_____ SHEET _____ OF _____

ADDRESS _____

_____

_____

_____

	SITE VISIT ___	SITE VISIT___	SITE VISIT___
RAC VERIFICATION PERSONNEL:			
IVC PERSONNEL:			
STATE PERSONNEL:			
OTHERS:			

ARE POST EXCAVATION RDG'S REQUIRED? YES____NO____ WHY?_____

SURVEY NOTES: (Record Site Visit #, Date and Initial after each entry)

Appendix 16. Soil analysis worksheet

5/88

IVC SOIL ANALYSIS WORKSHEET

LOCATION # _____

SAMPLE NBR(S)	REGION SMPLD	(LAB) RA-226 CONC. pCi/g		(BKG) RA-226 CONC. pCi/g	REP. AREA SQUARE METERS	SOIL SAMPLE THICKNESS IN (m)	FORMULA	ORNL NET RA-226 CONC. pCi/g	SPLIT NET RA-226 CONC. pCi/g	NET CRITERIA pCi/g	RMKS.
		ORNL	RAC SPLIT								

UCN17170(8/90)

LOCATION NUMBER _____

RADON CALCULATIONS WORKSHEET

DETECTOR NO.	EXPOSURE pCi/l – days	NUMBER DAYS	Rn CONC. EXPOS./DAYS	WL Rn CONC./200	AVERAGE WL

HCN17177(8/00)

Appendix 17. Radon calculations worksheet

Appendix 18. Verification report skeleton

Location Number: _____

Revised 2/4/92 (hat)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF VERIFICATION SURVEY AT LOCATION _____
_____
_____

Investigation Team

C.A. Little - PAG Program Manager
D.K. Halford - Radiologic Projects Manager
J.A. Rice - PAG/UMTRA Verification Project Coordinator

_____(author)

_____DATE

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY

Appendix 18. Continued

Location Number:

INTRODUCTION

Property location _____ was selected for verification by Oak Ridge National Laboratory, the Independent Verification Contractor (IVC). A review of the initial radiologic and engineering assessment was performed, and surveys were conducted at the time of the remedial action. The Completion Report was reviewed upon receipt. The review and survey were conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the applicable portions of the PAG Procedures Manual (February 1992). General location information is provided in Table 1, a comparison of pre-remedial and post-remedial gamma screening results is provided in Table 2, Table 3 provides a soil sample summary, and Table 4 is a RDC data summary. Supporting graphics are provided in Figure 1 (a and b). All measurements are gross readings; background has not been subtracted.

(Insert for Direct Conversion)
The conversion formula used is $y = x/CF$, where 'y' equals the exposure rate in $\mu R/h$, 'x' equals the scintillometer measurements in kcpm, and 'CF' equals the conversions factor determined in the field through a direct correlation between PIC and scintillometer measurements in kcpm/$\mu R/h$. For this property, CF equals x.xx for uncontaminated regions, x.xx for contaminated regions, and x.xx for indoor/other regions.

(or Insert for Conversion Equation):
The conversion formula used is $y = mx + b$, where 'y' equals the exposure rate in $\mu R/h$, 'x' equals scintillometer measurement in kcpm, and 'm' and 'b' are predetermined constants. On this property, 'm' equals 1.69 and 'b' equals 3.45.

SIGNIFICANCE OF FINDINGS

A field verification was conducted on the *outdoor/indoor* remediation of location _____ on _____ prior to backfilling the excavation (Figure 1).

The outdoor excavation had a gamma scan exposure rate range of _____$\mu R/h$ for the designated area(s) identified as _____ (Figure 1). The Remedial Action Contractor (RAC) and the IVC gamma exposure rates are shown in Table 2. Composite sample(s) _____ were collected to document radium-in-soil concentrations over the approximate 100 m^2 excavation(s). The IVC, RAC, and split (X) composite samples are below EPA standards and are recorded in Table 3.

Appendix 18. Continued

Interior excavation(s), designated _____ had a gamma exposure rate range(s) of _____μR/h, respectively (Figure 1). RAC and IVC gamma exposure rates are shown in Table 2.

Terradex Radtrak[R] detectors were placed _____ _____ to monitor for radon (Figure 1). Analysis *verified/did not verify* that the annual average radon daughter concentration is less than the EPA standard of 0.02 WL (see Table 4). An ORNL/IVC representative *was/was not* present at the placement *and/or* retrieval of detectors.

The IVC and RAC data are within EPA limits. The data presented in the RAC's property completion report was reviewed and *found/not found* to comply with EPA standards. (If not, explain)_____

Based on these findings, it is recommended that location _____ be certified by the DOE.

Based on these findings, it is recommended that location _____ be certified pending resolution of the deficiencies described above.

Based on these findings, it is recommended that location _____ have additional measurements taken and/or additional information supplied in the Completion Report as described above.

Based on these findings, it is recommended that location _____ undergo additional remedial action.

Appendix 18. Continued

Location Number: _____

RECOMMENDATION

RECOMMENDED FOR:	Certification
RECOMMENDED FOR:	Certification pending resolution of the deficiencies described in the report
RECOMMENDED FOR:	Further study requiring additional measurement or information as described in the report
RECOMMENDED FOR:	Further remediation
RECOMMENDATION BASIS:	Ra-226 is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Indoor gamma is >20 $\mu R/h$ above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is <1 standard deviation or 20% above background in all rooms
RECOMMENDATION BASIS:	Annual average radon daughter concentration is >0.02 WL
RECOMMENDATION BASIS:	Annual average radon daughter concentration is <0.02 WL

Appendix 18. Continued

Location Number: _____

Table 1. Location Information

Property Information

LOCATION: _____

_____

PROPERTY CLASSIFICATION _____

STRUCTURES ON PROPERTY _____

_____

_____

OWNER INFORMATION

OWNER: _____

ADDRESS: _____

_____

TELEPHONE: _____(H)

_____(B)

Appendix 18. Continued

Location Number: _____

Table 2. Comparison of Pre- and Post Remedial Action Gamma Screening Results

Outdoor Data

Area Identifier IVC/RAC	RAC (Pre-Remedial)	RAC (Post-Remedial)	IVC (ORNL) (Post-Remedial)
Gamma Exposure Rate Range In Area Identifier(s) (micro-R/hr)			

Indoor Data

IVC Area Identifier	RAC (Pre-Remedial)	RAC (Post-Remedial)	IVC (ORNL) (Post-Remedial)
Gamma Exposure Rate Range In Area Identifier(s) (micro-R/hr)			

Appendix 18. Continued

Location Number: _____

Table 3. Composite Soil Samples
Comparative Results

Outdoor Data

Area Identifier IVC/RAC	Composite Sample Number IVC/RAC	Sample Depth (cm)	IVC 226-Ra Conc. (pCi/g)	RAC 226-Ra Conc. (pCi/g)	IVC Split Sample Number	Split Sample Conc. (pCi/g)	RAC Ticket Number

* designates that the composite sample was not taken by ORNL/IVC.
X designates a split of the sample taken by the RAC Verification Group, reanalyzed in the ORNL Soils Lab.
V designates the sample aliquots removed by ORNL/IVC in the proximity of the RAC sample and verification area identifier.
B designates a bias sample collected by ORNL/IVC.

Appendix 18. Continued

Location Number: _____

Table 4. Radon Daughter Concentration (RDC) Summary

The RAC personnel are required to place a Radon or Radon progeny measuring device in all habitable structures on the remediated property. An ORNL representative verified the placement and retrieval of the device. This table is a restatement of the RAC's data.

Radon Daughter Concentration (RDC) Data Summary

Bldg. ID	Room ID	Date	RDC (WL)	Annual Average RDC (WL)***

*** Formula used: $WL = \frac{(WLR)\ (Rn)}{100}$

where: WL - Working Level
WLR - .5 (WL ratio as per VPMIM assuming 50% equilibrium)
Rn - Average daily ^{222}Rn concentration in pCi/l as reported by vendor (Terradex Radtrak^{R} Detector)

Appendix 18. Continued

Location Number: _____

Table 5. Net Estimated Area Weighted Average Calculation

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, CAW)

$$*\text{Formula used } C_{AW} = \frac{\sum_{i=1}^{n} C_i A_i D_i}{(100)\ (.15)}$$

where: C_{AW} = area-weighted ^{226}Ra concentration in [pCi/g]
C_i = net ^{226}Ra concentration in [pCi/g] and
(C_i = $C_{analysis}$ - $C_{background}$)
A_i = area of region that sample represents in [m^2]
D_i = thickness of sample in [m]
100 = threshold area in [m^2], and
.15 = threshold thickness in [m]

Appendix 19. Type II and Type III letter of recommendation

Mr. Michael K. Tucker, Manager
U.S. Department of Energy
Grand Junction Area Office
P.O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below do not exceed the U.S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on a review of the Remedial Action Contractor's completion report. Further evaluation is based on pre-restoration site visits for indoor and outdoor criteria of the U.S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix E, and/or other criteria stated below.

Other: _____

_____

This recommendation is based upon the Independent Verification Contractor's assessment of the ^{226}Ra concentration in the soil, indoor radon daughter concentration, and indoor gamma exposure rate at this property.

Therefore, this property is recommended for

(choose one)

certification by the U.S. Department of Energy.

certification upon resolution of the deficiencies described in the ORNL/IVC Certification Summary and Decision.

further study by the Uranium Mill Tailings Remedial Action Project.

further remedial action by the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C.A. Little, Ph.D.
Independent Verification Contractor

Location Number: _____
Location Address: _____
_____
Property Owner: _____
Owner Address: _____

Appendix 20. Vicinity property certification summary and decision

Location Number _____

Vicinity Property Certification Summary and Decision

1.0 SUMMARY EVALUATION

The data presented in the property portfolio indicate:

	IVC ORNL			U.S. Depart. of Energy (DOE)		
	Yes	No	N/A	Yes	No	N/A
1. The ^{226}Ra concentration in the top 15cm of soil averages <5 pCi/g above background over 100 m^2.	[]	[]	[]	[]	[]	[]
2. The ^{226}Ra concentration in any 15cm layer of soil below the top 15cm surface layer averages <15 pCi/g above background over 100m^2.	[]	[]	[]	[]	[]	[]
3. The indoor gamma readings are <20 $\mu R/h$ above background in every habitable room	[]	[]	[]	[]	[]	[]
4. The radon daughter concentration in any habitable room is <0.02 working levels, or at most 0.03 WL's.	[]	[]	[]	[]	[]	[]
5. Supplemental standards were applied in accordance with EPA standards 192.21.*	[]	[]	[]	[]	[]	[]

COMMENTS: _____

_____

_____

_____

_____

Appendix 20. Continued

Location Number _____

2.0 ORNL's RECOMMENDATION

Based on ORNL's evaluation of the [] completion report [] completion report and field survey data, I recommend this property for:

[] Certification

[] Certification pending resolution of the deficiencies described below

[] Additional measurements and/or additional information in the completion report below

[] Additional remedial action

_____ _____

C. A. Little, Ph.D. Date
Independent Verificaiton Contractor

2.1 ORNL's EVALUATION

Appendix 20. Continued

Location Number _____

3.0 DOE/UMTRA EVALUATION

DOE Decision: [] Certify

[] Requires additional measurements prior to certification

[] Requires additional remedial action

Comments: _____

_____

_____

_____

_____

_____

_____ _____

U.S. Department of Energy Date

Certification Official

*Certification concurred on by NRC on _____

(date)

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-046 Page: 1 of 5 Revision: 0 Date: 08/19/91

TYPE B FIELD VERIFICATION ACTIVITIES FOR LARGE AREAS

1.0 PURPOSE

This procedure describes the protocol for conducting Type B independent field verifications of large remediated areas.

2.0 APPLICABILITY

Type B independent field verification of large remediated areas are performed on excavations that are greater than 2,000 m^2 (21,530 ft^2).

3.0 OTHER DOCUMENTS

3.1 References

3.1.1 Procedure TE-028, Site Preparation for Radiological Surveying.
3.1.2 Procedure TE-021, Gamma Scintillation Detector Operation.
3.1.3 Procedure TE-024, Delta Counter Operation.
3.1.4 Procedure TE-025, Alpha Radiation Measurement.
3.1.5 Procedure TE-026, Beta-Gamma Radiation Measurement.
3.1.6 Procedure TE-034, Chain of Sample Custody.
3.1.7 Procedure TE-055, Opposed Crystal System (OCS) Van Analysis.

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Measuring tape
4.1.2 Gamma scintillometer
4.1.3 Sampling tools
4.1.4 Camera
4.1.5 Calculator
4.1.6 Survey flags or other marking devices
4.1.7 Weedsprayer with clean water
4.1.8 Wire brush
4.1.9 Hard hat
4.1.10 Steel toe safety shoes

Approved by:

Jon Jack K. Holford 8/30/91 (Date)

Craig A. Little 8/14/91 (Date)
C.A. Little

4.1.11 Safety glasses
4.1.12 Engineering scale

4.2 MATERIALS

4.2.1 Field data forms
4.2.2 Chain of custody forms
4.2.3 Pens/pencils
4.2.4 Felt tip markers
4.2.5 Ziplock bags
4.2.6 Field map
4.2.7 Paper towels

5.0 RESPONSIBILITY

5.1 The site project manager is responsible for determining if this procedure is applicable to the site.

5.2 The team leader is point of contact on the verification with the other agencies involved and is responsible for implementation of the procedure. The team leader performs necessary calculations and is responsible for mapping of the areas.

5.3 Team members are responsible for carrying out the procedure and may assist the team leader in the mapping of the areas.

6.0 DEFINITIONS:

6.1 **Aliquots:** equal parts of a composite sample taken from representative areas to be verified.

6.2 **Composite sample:** soil sample composed of several aliquots blended together and analyzed as one sample.

6.3 **HOG:** High outdoor gamma reading.

6.4 **RAC:** Remedial Action Contractor

7.0 SAFETY:

7.1 Wear steel-toed shoes and hard hats during verification.

7.2 Wear safety glasses and gloves when necessary.

7.3 Wear orange vests when working near heavy equipment or roads.

7.4 Wear personal dosimeter badge at all times.

8.0 PROCEDURE:

8.1 Perform a gamma scan of the area to be verified.

8.1.1 The Remedial Action Contractor's (RAC) grid may be followed if appropriate.

a. If necessary, use the gridding method outlined in Procedure TE-028.

8.1.2 Mark the grid sections on the field map.

8.1.3 Scan each grid section using a gamma scintillometer.

a. See Procedure TE-021 for details.

b. Note the HOG for each area and place a pin flag or other marker at the HOG.

8.1.4 Record the range and average gamma exposure rate for each section on the field map.

8.1.5 Further investigate any area with anomalous gamma exposure rate readings by post-holing, taking delta counter measurements, or by taking one or more biased samples.

8.1.6 Perform delta counter measurements in areas of emanation according to Procedure TE-024.

a. Note delta counter measurement locations on the field map.

8.1.7 Record data on appropriate field sheets for the project.

8.1.8 Photograph the area of remediation and verification using a polaroid camera.

a. Label the back of any photographs with the date, direction, area identifier, and initials.

8.2 When covered under the specific project, perform alpha radiation and\or beta radiation scans according to Procedures TE-025 and TE-026 if surface contamination is suspected.

8.3 Sample the soil of the verification area.

8.3.1 Take composite samples each consisting of 8-12 aliquots from the HOG of each grid block.

a. These samples should be taken in the same areas sampled by the RAC in order to obtain comparable data.

b. Place the samples in plastic bags and seal.

8.3.2 Label the sample according to the requirements of the specific project.

8.3.3 Fill out a sample chain-of-custody form and appropriate field data sheets. See Procedure TE-034.

8.3.4 Analyze the sample using the Opposed Crystal Spectroscopy (OCS) van if available. See Procedure TE-055.

8.3.5 Submit samples to the ORNL/PAG soils laboratory for analysis and/or archival.

8.4 Inspect and decontaminate equipment and personnel.

8.4.1 Inspect sample collection equipment for visible contamination after collecting each sample.

a. Remove contamination using a brush, paper towels, and/or water before returning the equipment tot the survey vehicle.

8.4.2 Inspect all instrumentation for visible contamination and decontaminate if necessary.

8.4.3 Inspect all personnel involved in the survey for visible contamination.

a. Remove visible contamination using a brush, paper towels, and/or water.

b. Following a verification performed during muddy conditions, wash shoes, boots, and/or coverings to remove visible contamination using water, paper towels, or a brush as appropriate.

8.4.4 Following any field work or sample handling, wash hands before smoking, eating, or drinking.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-050 Page: 1 of 18 Revision: 1 Date: 02/03/92

SURPLUS FACILITIES MANAGEMENT PROGRAM ACTIVITIES

1.0 INDEPENDENT VERIFICATION ACTIVITIES AT MONTICELLO, UTAH

1.1 INTRODUCTION

The Oak Ridge National Laboratory (ORNL) Pollutant Assessments Group (PAG) at the Grand Junction Office was contracted to be the Independent Verification Contractor (IVC) for the Department of Energy's Surplus Facilities Management Program (SFMP) for the Monticello Vicinity Properties Project (MVP). The purpose of independent verification is to ensure that properties for which the SFMP is responsible are cleaned in order to meet pertinent standards. Public Law 95-604 required that the Environmental Protection Agency (EPA) promulgate standards of general application to be utilized under the Uranium Mill Tailings Remedial Action (UMTRA) Project. In March 1983, EPA published Standards for Remedial Action at Inactive Uranium Processing Sites (40 CFR Part 192). The EPA standards established guidelines for the control of tailings piles, cleanup of buildings, and cleanup of open lands. The Department of Energy (DOE) has adopted the concentration limits and associated requirements of the EPA standards into the Department's guidelines for residual radioactive material, and as a result, the standards applied to the MVP remedial actions are consistent with EPA standards for UMTRA sites.

SFMP was established by DOE in 1978. SFMP is responsible for managing the numerous DOE-owned radioactively contaminated facilities that have been declared surplus and for conducting a program leading to the ultimate disposition of those facilities. The SFMP is administered by the Department of Energy Headquarters (DOE/HQ). The Monticello mill site was declared surplus in 1981 and is currently awaiting remedial action to bring its condition up to present standards.

1.2 OBJECTIVE

The objectives of the IVC task are to confirm that the surveys, sampling, and analyses conducted prior to, during, and following remedial action and the associated documentation provide an accurate and complete description of the

Approved by:

2/3/92 (Date)

Craig Little 2/4/92
C.A. Little (Date)

radiological condition of the property and confirm that remedial action has been effective in reducing radiation levels to EPA guidelines.

SFMP follows the U. S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program Sites [Revision 2, March, 1987]. The authorized limits being applied pursuant to those guidelines for the MVP are:

1.2.1 Cleanup of buildings

a. Indoor radon decay products shall not exceed .03 Working Levels (WL) in any case and, to the extent practicable, achieve .02 WL.

b. Indoor gamma radiation shall not exceed 20 μR/h above background.

1.2.2 Cleanup of land

a. Surface levels shall not exceed 5 pCi/g above background in any 15 cm surface layer over any 100 square meter area.

b. Buried deposits shall not exceed 15 pCi/g above background in any 15 cm layer below the surface layer over any 100 square meter area.

c. The Hot Spot criteria defined in the October 19, 1987 memo from G. R. Grandbouche, Project Engineer to W. E. Murphie, will be applied to independent verification. However, surface alpha contamination will not be included in the verification. Application of the Hot Spot guideline is described in Section 3.4.

1.3 DESCRIPTION OF WORK

For the most part, SFMP/MVP has incorporated and respects all protocol outlined in UMTRA Vicinity Properties Management and Implementation Manual (VPMIM) and in this manual. SFMP Verification Types A, B, and C parallel UMTRA Verification Types I, II, and III respectively.

Properties to be verified fall into three categories: (1) those at which remedial action has been completed (Type A); (2) those where the remedial action process has been initiated but not completed (Type B); and (3) special requests from the DOE (Type C). Type A verification includes a review of the remedial action, a review of the remedial action contractor's (RAC) radiological data, and confirmatory analysis of split samples. This

verification is conducted on 100% of the Monticello vicinity properties. Type B verification includes on-site surveys involving direct measurements and sampling in addition to the tasks outlined in Type A verifications. Approximately 10% of the properties which have not yet been remediated are subject to Type B verification. Additional properties are subject to site survey in the event difficulties are encountered in providing verification for the original 10% of the properties. Type C investigations are special requests for the IVC to examine some aspect of a property for any reason deemed necessary by the DOE. This includes the verification of the RAC's survey effort at any time during the remedial action process.

Types are further defined in the Formerly Utilized Sites Remedial Action Program Verification and Certification Protocol, Supplement No. 2 to the FUSRAP Summary Protocol, November 1985, Revision 1. The IVC task is accomplished under the direction of the Department of Energy Headquarters (DOE/HQ) in coordination with the Grand Junction Project Office (GJPO) under the SFMP-MVP Project.

The actual measurement protocol and equipment used are described in Procedure TE-040 of this manual. The following sections describe the project management of providing independent verification.

1.3.1 Properties at Which Remedial Action is Complete (Type A)

ORNL/PAG performs Type A verifications on all remediated Monticello Vicinity Properties. Completion reports, RAC property folios, and split sample analysis results are examined under the Type A review.

The GJPO-DOE will forward the completion reports for the vicinity properties to ORNL/PAG. The work flow is parallel to that of a Type I IVC survey described in this manual. Upon receipt of the completion reports, ORNL/PAG requests a copy of the radiological and engineering assessment (REA) from the remedial action contractor (RAC). ORNL/PAG reviews the REA to become familiar with the property and the remedial action plan. ORNL/PAG also requests from the RAC splits of verification soil samples tabulated in the completion reports from each property. The IVC selects and analyzes split samples from the tabulated samples in the RAC's property completion reports to verify the adequacy of the RAC analysis. If vicinity properties are related and can be grouped for verification and if analysis of samples from some of the properties verify the adequacy of the RAC analysis, ORNL/PAG need not analyze samples from each property.

Samples are to be selected randomly by use of an electronic random number generator. Confirmatory analysis is performed using ORNL/PAG's well-crystal system, and the results are compared to the RAC's results to confirm the accuracy of the RAC's analytical procedures.

All split samples are assigned a unique sample identification number, and a chain-of-custody is initiated and maintained upon obtaining the samples from the RAC. These steps are followed in requesting ORNL SFMP IVC cross check samples from the RAC:

1. Verification coordinator submits a RAC and an ORNL Chain of Custody form to the RAC's sample plant with a list of the samples requested.

2. Sample excess is requested if at least 500 g are present.

3. If less than 500 g are present, the sample is removed from the list.

4. When the samples are picked up, the RAC receives the pink copy of the ORNL Chain of Custody, and ORNL receives the pink copy of the RAC's Chain of Custody form.

The samples are archived in accordance with the "Verification and Certification Protocol–Supplement No. 2 to the FUSRAP Summary Protocol" November 1985. The IVC retains all archived samples for a minimum of five years beyond the notice of certification in the Federal Register in accordance with the published protocols.

Following review of the REA, the completion report is reviewed for completeness and accuracy. Field results are checked, and average radium-in-soil concentrations are recalculated when deemed necessary. All results are tabulated and reported with the verification statement.

If significant deficiencies exist in the completion report, the IVC writes a letter to the DOE describing the deficiencies and recommending that they be corrected. Significant deficiencies are those that mar the report but that do not appear to reflect inadequate remedial action. Such deficiencies would include missing text, missing figures, or missing tables. The DOE requests the appropriate changes from the RAC, and further review of the completion report awaits receipt of the changes from the RAC.

If no significant report deficiencies are discovered, a Vicinity Property Summary and Decision form is filled out and signed by an ORNL/PAG representative. A letter is written to the DOE including a "verification statement" or, in the event that the completion report reflects inadequate remedial action, recommending further measurements. A final verification report is published in Oak Ridge and forwarded back to ORNL, Grand Junction for technical review. After review, the final report is transmitted to the DOE/HQ and filed.

In addition to the transmittal of the documents mentioned above, ORNL/PAG provides DOE/HQ with copies of all correspondence and reports generated as a part of the IVC tasks.

1.3.2 Properties Where the Remedial Action Process has been Initiated (Type B)

Approximately 10% of all properties to be remediated for the SFMP are verified under the Type B verification which parallels the flow of work of a Type II UMTRA/IVC survey as described in this manual. This independent verification includes a visit to the property by ORNL/PAG at the post-excavation/pre-restoration stage of remedial action. At some reasonable time between REA approval and bid package completion, the RAC provides a list of properties selected for the construction season. ORNL/PAG selects approximately 10% for independent verification site visits and notifies the DOE and the RAC of the selected properties by letter.

Site visits to properties are scheduled at the post-excavation/pre-restoration stage of remedial action. The RAC notifies ORNL/PAG of the pending need for a verification survey at least 72 hours in advance of the survey or, if this is not feasible, notifies ORNL/PAG at the time of the remediation starting date. As much advance notice as possible is then to be given to ORNL/PAG when the actual verification field survey is scheduled.

Every effort is made to establish an open communication system between the RAC and the IVC to avoid delays or interruption of the construction schedule.

ORNL/PAG performs independent measurements and samples portions of the area to be verified. Typically, the independent survey covers the entire remediated area but depends upon such factors as site history and previous radiological data. For larger areas, independent surveys are conducted on 10-25% of the remediated area. During the field activities, the scope of the survey may be increased

or decreased based on findings as the work progresses. The IVC may extend its surveys beyond the bounds of the remedial action if necessary to verify that RAC characterization surveys have identified all contaminated areas needing remediation.

Independent measurements typically include:

1. a walkover gamma screening survey with portable gamma scintillation detectors at 1-2 m intervals in selected excavations and areas within 1-2 m of the excavation;

2. a complete gamma screening survey of the lowest habitable level of any structures where interior work has been performed;

3. a collection of composite samples from selected excavations of 100 square meters or less, following the chain of custody, analysis, and archival procedures described above for split samples;

4. visual observation of the placement and/or retrieval of any RDC device placed by the RAC.

   Note: The results of this measurement are sometimes not received for six months to one year after placement of the device.

The RAC forwards the completion report to ORNL/PAG when remedial action is complete. All portions of a Type A verification are then applied.

A verification statement will be submitted to DOE/HQ within three weeks of the transmittal of the completion report to ORNL/PAG. A verification report is prepared for each property where the remedial action process is complete. This report contains a gamma-scan map showing all ORNL/PAG samples and aliquot locations, results of soil analyses and confirmatory analysis, and a summary of radiological data.

If the Type A or Type B verifications suggest that the procedures or data collected by the RAC are not sufficient, or that authorized limits have not been met, the DOE/HQ and the DOE/GJPO is notified immediately that the property cannot be verified. Minor discrepancies are documented and directed to the RAC to be solved before the IVC can verify the property.

In addition to the verification statement and report, the DOE/HQ receives copies of all correspondence relating to the task. Trip reports and/or monthly reports are prepared for the DOE/HQ.

1.3.3 Properties Where the DOE Requires Special Investigation (Type C)

When uncertain about some aspect of a vicinity property, the DOE may request that the IVC take the measurements needed to solve discrepancies in the radiological data. These investigations will incorporate applicable portions of Type A and Type B verifications or inclusion surveys.

To streamline the MVP Program, the RAC will perform both inclusion surveys and REA's on properties inside the 5 pCi/g windblown line. The DOE/HQ has directed ORNL to review 10% of these inclusion/exclusion survey documents, to perform independent surveys, and to obtain split samples for 10% of the properties. The properties are randomly selected. These are Type C verifications.

Each site selected will have a document review and a limited site visit. An unscheduled visit to the RAC's survey will be made on a percentage of the Type C properties. The RAC will provide a schedule showing the dates the properties will be surveyed so that a field check can be made on some of the properties during the RAC's survey. After the site survey, the RAC provides a copy of the REA to ORNL for the properties selected. A review of the RAC's findings is performed. After site surveys, REA review, and split sample analysis, a report of Type C verification is prepared and issued to the DOE/HQ.

The following tasks are carried out in performing a Type C verification:

a. On each property a brief gamma scanning survey is performed, covering only areas of elevated gamma exposure rates.

b. To abbreviate the survey time, the team will not take background measurements or photographs.

c. A sample is collected at the location of the highest outdoor gamma (HOG). Analytical results of this sample will be compared to those of the RAC, along with other significant findings on the property.

d. To simplify the verification documentation, a single report will be issued covering the following information:

   1. property location

   2. owner

   3. indoor and outdoor screening results

   4. a brief significance of findings of the survey and document review

   5. a condensed summary and evaluation of the radiation levels detected on the property.

e. A cover letter will precede the report stating whether ORNL is in agreement with the RAC's inclusion or exclusion decision.

f. A limited number of split samples will be collected to document the adequacy of the RAC's analysis laboratory and procedures. See "Sampling" below.

If ORNL finds some discrepancy in the RAC's survey, findings will be thoroughly defined. Final determination of the radiological condition of the property will rest with the DOE/HQ.

2.0 IDENTIFICATION OF POTENTIALLY CONTAMINATED PROPERTIES

2.1 INTRODUCTION

As the IVC for the Monticello Vicinity Properties Project, ORNL/PAG performs survey work which parallels the ISC work on the UMTRA project. Since there is no separate contract for SFMP/ISC work, it is considered a part of the IVC task, the site being relatively small. ORNL/PAG is referred to as the ISC only for the sake of distinguishing between the two tasks.

The strategy for Inclusion and Designation of Monticello Vicinity Properties will parallel established Uranium Mill Tailings Remedial Action Program (UMTRAP) protocol. Uranium Mill Tailings Radiation Control Action of 1978 (UMTRCA), PL95-604 requires that the DOE "designate" for remedial action any eligible, inactive uranium mills or processing sites together with any vicinity properties which are contaminated with residual radioactive materials derived from such sites.

Since the remedial action of the Monticello Vicinity Properties follows the established UMTRA protocol, the following description is directly adapted from the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988).

2.2 PROPERTY IDENTIFICATION

Vicinity property designation is the process by which potentially contaminated properties are identified and listed as candidates for remedial action as part of the SFMP (Surplus Facilities Management Program). Properties are identified in one of the following ways:

1. by historical data from previous surveys;
2. by proximity to the millsite for potential windblown contamination;
3. by historical van scanning;
4. by request from property owner with valid suspicion of contamination;
5. by spillover contamination from previously designated property;
6. by response to advertisement.

The Inclusion Survey Contractor (ISC) is responsible for surveying all properties that are designated by one of the above methods. The DOE/HQ provides direction for the survey of these properties. Consent-for-access to the properties is acquired from the owners prior to any survey activities.

2.3 CONSENT FOR ACCESS

Consent-for-access is acquired from property owners before any survey is conducted. DOE/HQ is notified of these surveys within a reasonable time period. Typically, the ISC is responsible for acquiring consent-for-access properties for radiological surveys. In some situations, this responsibility may be shared by the RAC, for instance when a spillover deposit is encountered during remedial action. When survey teams from either the ISC or the RAC are in the field and are requested by owners to survey properties, attempts should be made to honor these requests.

The ISC or RAC stipulates the need for a signed consent-for-access form before any site survey work can be accomplished and identifies a contact within the DOE/HQ or DOE/GJPO if the property owner desires to learn more about the project or has specific questions. The ISC or RAC makes

clear that consentforaccess is requested for the DOE and its representatives for inclusion surveys. The tenants of the property are also contacted at the discretion of the property owner if the owner and the tenant are not the same party. If it is not feasible for the owner to notify the tenant, tenant consent can be obtained by the ISC or RAC at the owner's request.

The consent-for-access form outlines the rationale, approach, and authority for the survey. The time estimate to complete this consent process is approximately six weeks, beginning with the transmittal of a consent form to the property owner. After initial contact with the property owner/tenant and prior to the signing of the consent-for-access agreement, a specified amount of follow-up by the responsible agency may be required. When consent-for-access is obtained, the owner is contacted by the ISC (or RAC), the SFMP is explained, and the appropriate project participants are introduced. The first contact may be a phone conversation, a letter, or a property visit. If a signed consent form is not received or is refused, the contractor will forward the request to the DOE/HQ for final action.

If a spillover deposit on an adjacent property is encountered during either the REA or Remedial Action (RA) stages, the following procedures apply:

1. the RAC is responsible for contacting the ISC to determine if the property has already been scheduled for a survey or has been included;

2. if the property has not already been addressed, then the ISC forwards the property information to the DOE for an expedient decision;

3. the DOE directs the ISC to conduct a survey if it is warranted;

4. if the RAC has sufficient information indicating that the property contains an includable deposit based on spillover information, the RAC is responsible for preparing a spillover recommendation to the DOE for an expedient decision.

When includable deposits are encountered under paved streets or along utility lines parallelling the street, the contractor is required to record the location of the deposit. These deposits will be reported to DOE/HQ for decision.

When a property is included without entering the property boundary (i.e., historical review, or mobile van validation, or where adjacent surveyed property is observed by the RAC), the RAC is responsible for acquiring the consent forms prior to conducting the REA surveys.

Formal advertising by the ISC for survey requests will take place before closure of the repository. The response to these ads should be directed to either the ISC or the DOE/HQ. The ISC will proceed immediately on all responses and advise the DOE regarding the number of requests before surveying. This "last and final" offer for survey of non-designated properties will have a cut-off date which will be cited as the last day that requests for this type of survey will be honored.

2.4 HISTORICAL RADIOLOGICAL DATA

Radiological data are currently available from numerous studies previously performed in the vicinity of the Monticello Mill Site. Sources of these data include:

1. Lucius Pitkin 1971-72 (field work), 1973 (report)

2. Bendix 1980 (field work), 1982 (report)

3. ORNL 1983 (field work and mobile scan), 1983 (report)

4. EPA 1984 (Billig Report)

5. Bendix 1985 (Environment Assessment of Remedial Action at Monticello Uranium Mill Tailings Site)

6. UNC 1986-present (Completion Reports and Remedial Action Assessments)

7. ORNL 1988-present (Independent Verification Type B surveys and inclusion surveys, reviews, and reports)

This pertinent, vicinity property survey data is available for use and analysis by the ISC.

All properties where residual radioactive materials are suspected are scheduled for on-site inclusion surveys except those few properties where adequate historical information shows the presence of contamination which exceeds the applicable standards. These are referred to as "historical inclusions".

All properties where residual radioactive materials are suspected are assigned a property location number. A data base of property location numbers and pertinent property information is maintained by the RAC. The RAC is responsible for assigning the location numbers.

3.0 INCLUSION PROCESS

Vicinity property "inclusion" is the process of identifying residual radioactive material suspected to originate from the designated mill site at levels greater than EPA and DOE standards. Properties whose levels of radiation do not exceed the standards are considered "exclusions" and are not eligible for remedial action.

The ISC will perform inclusion surveys and prepare survey reports to document survey results. These surveys will consist of sufficient radiological data for the inclusion process.

Inclusion surveys generate the data necessary to include or exclude a property. As a result, properties are surveyed to varying degrees with more comprehensive survey procedures reserved for properties with marginal contamination. Data from the on-site surveys are compared to the applicable standards, and DOE/HQ authorizes those properties which exceed the standards for remedial action. Owners of surveyed properties are notified by DOE/HQ of the inclusion/exclusion decision by mail.

In some instances, property owners will allow only limited access to their property or deny access completely. In these circumstances, the property will be handled as an owner refusal and will be the direct responsibility of the DOE/GJPO.

3.1 ON-SITE SURVEY PROCEDURES

Inclusion surveys provide the additional data necessary to evaluate designated properties which cannot be included by historical data. Gamma scanning measurements will be employed to expedite the overall process. When these measurements fail to provide adequate data for inclusion or exclusion of a property, extended measurements are performed.

The ISC surveys will be conducted using methods as defined in this manual and the Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program (April 1987) and the U. S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) (Revision 2, March, 1987). Radiological surveys may include:

1. a gamma scan of the entire ground surface outdoors and indoors;

2. samples of outdoor soil;

3. evaluation of historical data when present.

The gamma scans will be conducted using a Victoreen Portable Ratemeter, Model 490, which is a gamma scintillometer.

3.2 SAMPLING

3.2.1 Background Samples

If no areas of elevated gamma exposure rates are found when surveying, background samples are taken and reported on the soil analysis worksheet. It is not necessary to take background samples when other samples have been taken due to elevated gamma readings.

3.2.2 Soil sample custody and archival

SFMP requires using "Chain of Custody" protocol for all soil samples. The Chain of Custody procedure described in this manual is applied to this project. Chain of Custody forms must be completed and signed off on when the samples are transferred from the field team to the soils lab.

SFMP samples will be stored and archived separately from UMTRA and IVC-Grand Junction samples. The samples will be archived for a minimum of five years.

3.3 POINT SOURCES

The DOE/HQ considers a "point source" as mill related unless proven otherwise. Therefore, a property can be included on a point source using the Hot Spot Guideline described below.

Point sources should be removed when encountered. If the source has crumbled and/or leached into the subsurface, it may be impossible to remove and is therefore subject for remediation by the RAC.

3.4 HOT SPOT GUIDELINE

The method for determining hot spot limits, which is based on the 100 mrem/year dose limit described in the FUSRAP procedures manual, shall still be applicable for determining allowable concentrations. However, an alternative approach, more appropriate for field applications, may be used in place of the dose limit method and is recommended for general applications.

1. Using the alternative approach, basic hot spot limits for Monticello are calculated in the following way:

$$S_{hg} = S_g \times (100\ m^2/A)^{1/2}$$

where

S_{hg} = the hot spot limit, pCi/g
S_g = the authorized limit for Monticello, pCi/gram
5 pCi/g for surface soil
15 pCi/g for subsurface soil
A = the area of the hot spot, m^2.

2. Subtract the backgroung ^{226}Ra concentration for the applicable site (2 pCi/g for MVP) from the gross average concentration and compare the result with the hot spot limit derived from the equation above (S_{hg}) to determine if the hot spot exceeds the limits.

3. Areas less than one square meter are to be averaged over the one square meter and that average shall not exceed ten times the authorized limit.

4. Since the average authorized limit is considered adequate to protect the public for areas larger than 25 m^2, hot spot limits are used only for areas 25 m^2 and smaller.

5. The hot spot guideline will be applied to hot spots on an individual basis.

6. Every reasonable effort will be made to identify and remove any source which has a concentration of a radionuclide exceeding 30 times the authorized limit regardless of the area.

See Appendix 1 for Hot Spot Limits.

When two samples are taken from an area for which hot spot limits apply, the average ^{226}Ra concentration of the two samples is compared to the limit rather than the concentration of each sample separately. Both net concentration for ^{226}Ra (NEAWA) and hot spot limit are shown on the soil analysis worksheet.

3.5 MISCELLANEOUS INFORMATION

3.5.1 Monticello Roads-Inclusion Boundaries

The following guidelines are used for instances of contamination that extend onto and under both paved and unpaved roads within Monticello:

1. For paved roads, the inclusion boundary stops at the edge of the curb or pavement.

2. For unpaved roads and/or alleys, the inclusion boundary extends from the boundary of the block and/or the individual residence to the midpoint of the road. These roads will be remediated.

3.5.2 Monticello Data Base

A KMAN data base created for the SFMP-Monticello Vicinity Properties Project is used to track consent, property, and survey information.

3.5.3 Vicinity Properties Map (Monticello city map)

A map developed by the RAC and revised by the IVC reflects the comprehensive status of the Monticello Vicinity Properties. It is used extensively to estimate the cost of remedial action and to project schedules by the DOE, the RAC, and the IVC. This map may be used in lieu of the plat map for locating properties and for finding identification numbers for specific properties when writing reports. It is updated monthly by the RAC.

3.5.4 Zip Code/Area Code

The zip code for Monticello is 84535.

The telephone area code and prefix is (801) 587-.

3.5.5 Conversion Formula for Monticello

To convert from Kcpm to μR/h, use the following formula:

$$\mu R/h = 1.46(kcpm) + 7.2$$

3.5.6 Background ^{226}Ra Concentration

Background ^{226}Ra concentration for Monticello is 2 pCi/g. This value is consistent with the RAC calculations.

3.6 RADIOLOGICAL SURVEY REPORTS

Data from on-site surveys are submitted in report form by the ISC to the DOE. The size and format of the reports may vary in regard to extent of the survey. Abbreviated surveys will be reported in a condensed format. Typically, a survey report will include:

1. A boiler plate identifying the SFMP program, a description of survey findings, and radiological data tables;

2. A property map showing property boundaries, structure outlines, status of surrounding properties, and extent of contamination, including samples locations and gamma measurements;

3. A photograph of the property;

4. A summary and evaluation checklist, addressing the applicable standards;

5. A feedback portion directed to DOE/HQ for comments and for approval to proceed with remedial action;

6. A cover letter summarizing the extent of the survey; and

7. The consent-for-access form if present.

If the report is in condensed format, only a few of the above items will be present.

The original radiological survey report and the consent-for-access form will be forwarded to DOE/GJPO for archival purposes. DOE/HQ will maintain copies of the reports with which to make the final decision.

The final decision for inclusion or exclusion will be made by DOE/HQSD after evaluating the findings of the ISC (or RAC in some cases). The property will be officially included or excluded by the DOE/HQSD by means of a form memo. If a property is a spillover inclusion, this will be noted in the form memo.

Once a decision has been made, notification will be sent by the DOE to property owners.

4.0 REPORTING

A monthly report is submitted to the DOE/HQ outlining the progress of properties assigned to ORNL/PAG for verification and designation/inclusion surveys, as well as year-to-date operating expenditures.

Appendix 1. Hot Spot Limits

SURFACE SOILS		SUB-SURFACE SOILS	
Area (m^2)	Limit (pCi/g)	Area (m^2)	Limit (pCi/g)
1.0	50.0	1.0	150.0
1.5	41.0	1.5	122.0
2.0	35.0	2.0	106.0
2.5	32.0	2.5	95.0
3.0	29.0	3.0	87.0
3.5	27.0	3.5	80.0
4.0	25.0	4.0	75.0
4.5	24.0	4.5	71.0
5.0	22.0	5.0	67.0
5.5	21.0	5.5	64.0
6.0	20.0	6.0	61.0
6.5	20.0	6.5	59.0
7.0	19.0	7.0	57.0
7.5	18.0	7.5	55.0
8.0	18.0	8.0	53.0
8.5	17.0	8.5	51.0
9.0	17.0	9.0	50.0
9.5	16.0	9.5	49.0
10.0	16.0	10.0	47.0
11.0	15.0	11.0	45.0
12.0	14.0	12.0	43.0
13.0	14.0	13.0	42.0
14.0	13.0	14.0	40.0
15.0	13.0	15.0	39.0
16.0	13.0	16.0	38.0
17.0	12.0	17.0	36.0
18.0	12.0	18.0	35.0
19.0	11.0	19.0	34.0
20.0	11.0	20.0	34.0
21.0	11.0	21.0	33.0
22.0	11.0	22.0	32.0
23.0	10.0	23.0	31.0
24.0	10.0	24.0	31.0
25.0	10.0	25.0	30.0

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-051 Page: 1 of 8 Revision: 0 Date: 02/03/92

ULTRASONIC RANGING AND DATA SYSTEM (USRADS) OPERATION

1.0 PURPOSE

This procedure describes the method for measuring gross gamma radiation and collecting geophysical data using the Ultrasonic Ranging and Data System (USRADS). For detailed information, refer to the manufacturer's operating manual, Reference 3.1.1.

2.0 APPLICABILITY

This procedure applies to the use of USRADS for collecting gamma radiation and geophysical data.

3.0 OTHER DOCUMENTATION

3.1 REFERENCES

3.1.1 *USRADS™ User's Manual*, Chemrad Tennessee Corp., Oak Ridge, TN, 1991.
3.1.2 Procedure TE-021, Gamma Scintillation Detector Operation.

3.2 EXHIBITS

3.2.1 Exhibit 1. Stationary Receiver Placement
3.2.2 Exhibit 2. Using USRADS in the Field

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Battery charger
4.1.2 Data pack
4.1.3 EM31 Geophysical instrument
4.1.4 FM radios
4.1.5 Gamma check source
4.1.6 Hand-held terminal
4.1.7 Host computer

Approved by:

Jack K. Halford 2/3/92
(Date)

Craig Little 2/4/92
C.A. Little (Date)

4.1.8 Master receiver
4.1.9 Portable gamma scintillometer
4.1.10 Stationary receivers (SRs)
4.1.11 Top hat
4.1.12 USRADS software

4.2 **MATERIALS**

4.2.1 Field instrument logbook

5.0 RESPONSIBILITY

5.1 It is the responsibility of the computer operator to:

5.1.1 boot the software and

5.1.2 operate the host computer in performing the equipment check, set-up, and survey routines.

5.2 It is the responsibility of the surveyor to:

5.2.1 set up the SRs,

5.2.2 perform the set-up routine,

5.2.3 operate the handheld terminal, and

5.2.4 perform the survey by walking the grid block and swinging the gamma scintillation detector probe.

6.0 DEFINITIONS

6.1 **Battery charger**: an instrument used to charge the batteries for the data pack and SRs.

6.2 **Data pack**: a pack attached to a pack frame and carried by the surveyor during set up and survey operations. The function of the pack is to locate the surveyor by sending ultrasonic pulses to the SRs and also to transmit location and gamma data to the host computer.

6.3 **EM31 Geophysical instrument**: an auxiliary instrument that can be attached to the data pack used to record the conductivity of the surface soils.

6.4 **FM radios**: voice-activated radios used for verbal communication between the surveyor and the computer operator.

6.5 **Gamma check source**: a registered gamma source used for scintillometer calibration checks.

6.6 **Handheld terminal**: a calculator-size terminal attached to the data pack used to communicate with the host computer.

6.7 **Host computer**: an IBM-compatible PC that performs the location calculations and stores the survey data for subsequent analysis.

6.8 **Master receiver**: receiver located within the survey vehicle that receives transmissions from both the data pack and the SRs.

6.9 **Stationary receivers (SRs)**: receivers placed within the survey grid block used to locate the data pack by transmitting time-of-flight for ultrasonic transmissions to the host computer.

6.10 **Time-of-flight**: the amount of time for an ultrasonic signal to travel from the transmitter to any given receiver within the array.

6.11 **Top hat**: an accessory ultrasonic crystal used during the set up routine to locate the relative positions of SRs within the grid to the baseline SRs.

6.12 **USRADS software**: computer code written for the instrument set up, data collection, and data analysis.

7.0 PROCEDURE

7.1 Perform an equipment check of the system.

7.1.1 Attach each SR with a microphone and antenna to a tripod and turn the switch to the "On" position.

7.1.2 Place the data pack near the group of SRs and switch on.

7.1.3 Boot up the USRADS software.

7.1.4 Select the "Check Equipment" operation from the main menu.

7.1.5 Monitor responses from each SR and the data pack on the master receiver and the host computer to determine if a carrier signal and time-of-flight pulse data are present.

7.2 Set up equipment for surveying.

7.2.1 Place SRs within the area to be surveyed as shown in Exhibit 1.

7.2.2 Place two SRs along an arbitrary survey baseline and measure the distance between the two microphones.

a. This measurement will be used to determine the speed of sound calibration under the conditions that the survey will be conducted.

7.2.3 Select the "Set Up" operation from the main menu.

7.2.4 Attach the top hat to the data pack.

7.2.5 Place the top hat on top of an SR.

a. Do not stand between the SR and the host computer.

7.2.6 Key in the appropriate SR number on the hand-held terminal and follow the instructions given on the hand-held terminal.

7.2.7 Repeat the above steps for each SR used within the survey array.

7.2.8 Enter a zero (0) into the hand-held terminal.

a. This invokes the host computer to calculate the matrix of time-of-flight data and calibrate the speed of sound.

7.2.9 Once the matrix calculation is complete, the host computer will display the grid block scale and relative SRs locations. Study this setup file carefully to determine if the setup is valid.

7.2.10 Select the "Perform Site Survey" option from the main menu.

7.2.11 Turn the power switch on the data pack to the "Off" position.

7.2.12 Remove the top hat from the data pack.

7.2.13 Connect the ultrasonic crystal located on the pack frame.

7.3 Collect radiation data.

7.3.1 Perform an operation check of the scintillometer as outlined in Procedure TE-021.

7.3.2 Connect the gamma scintillation detector to the data pack.

7.3.3 Turn on the gamma scintillation detector and remove the probe from handle.

7.3.4 Invoke the host computer, selecting an average gamma threshold relative to the location of the survey.

7.3.5 Turn the power switch on the data pack to the "On" position.

7.3.6 Begin traversing the survey grid block in either a north to south or an east to west direction in parallel paths.

7.3.7 Survey the grid block according to Procedure TE-021.

a. Walk at a slower than average pace to allow the gamma instrument an adequate response to potential contamination.

7.4 Collect geophysical data.

7.4.1 Connect the EM31 geophysical instrument to the data pack and suspend it from the pack with two auxiliary straps.

7.4.2 Change a switch within the software to collect geophysical data.

a. Type "USRADCFG".

b. Select menu option "Survey Parameters".

c. Change the toggle switches to read:

1. Counter Disabled
2. Analog 1 Enabled
3. Analog 2 Enabled

d. After setting these options press the escape key to go back to the main menu.

7.4.3 Begin traversing the survey grid block in either a north to south or an east to west direction in parallel paths.

a. Walk at a slower than average pace to allow the instrument an adequate response to potential conductivity variations in shallow surface soils.

7.5 Upon completion of the survey, use the ALT F1 keys on the host computer to terminate the survey mode and data collection to the host computer.

7.5.1 The computer closes the data file and is ready to analyze data or continue with the next survey grid block.

7.6 Move the SRs to the next grid block and repeat the above steps for each subsequent block within the area of concern.

7.7 For data analysis procedures, refer to the manufacturer's operating manual, Reference 3.1.1.

7.8 Charge the batteries for the data pack and SRs at the end of every survey day according to procedures in the manufacturer's operating manual.

Exhibit 1. Stationary Receiver Placement

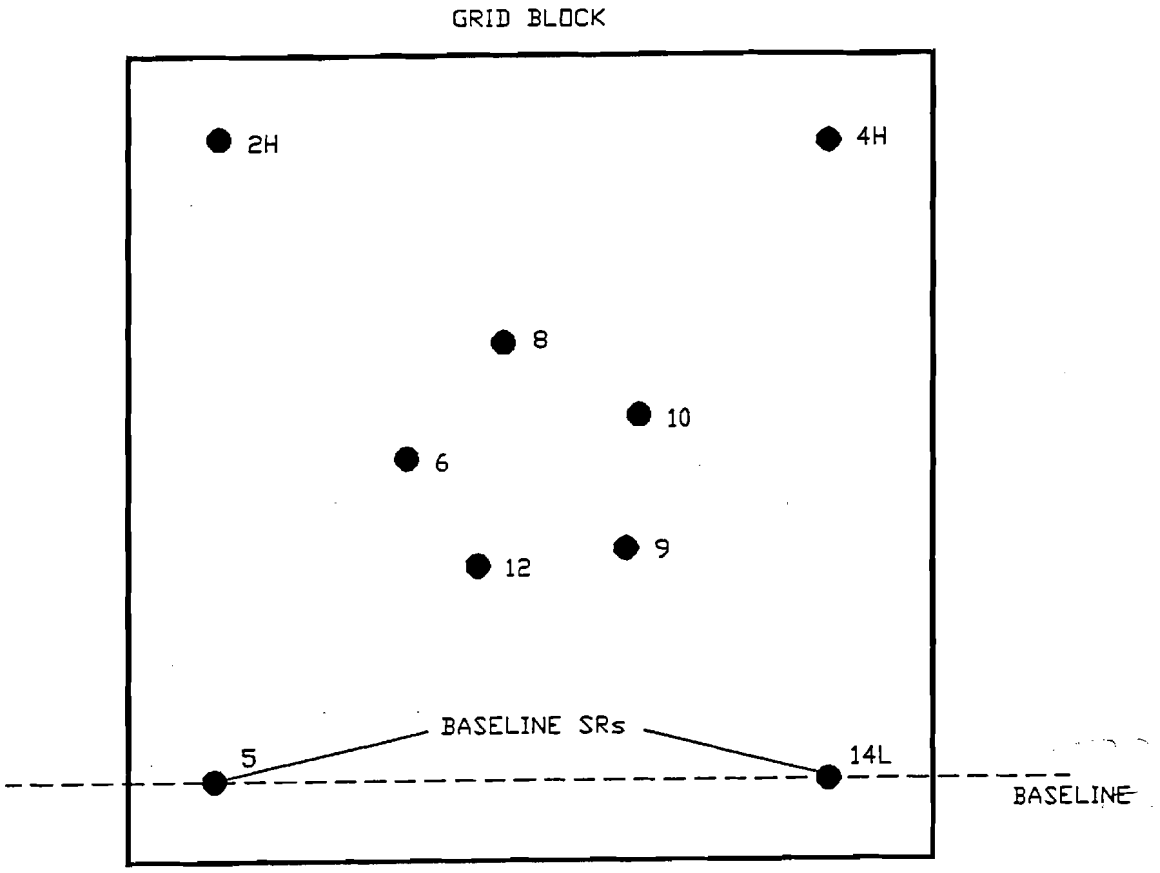


Exhibit 2. Using USRADS in the Field

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-055 Page: 1 of 6 Revision: 0 Date: 10/01/90

OPPOSED CRYSTAL SYSTEM (OCS) VAN ANALYSIS

1.0 PURPOSE

This procedure describes the use of the OCS van for field analysis of radionuclides.

2.0 APPLICABILITY

The OCS system is designed for rapid, on-site analysis of ^{226}Radium on Grand Junction and Monticello vicinity properties. The analyses are particularly useful for radiological verification surveys but may be used during inclusion surveys also.

3.0 EQUIPMENT DESCRIPTION

The OCS system is housed inside a GSA van. The system itself consists of a Nucleus multi-channel analyzer housed inside a Compaq computer. The mca quantifys the net gamma counts observed in the 609 Kev ^{214}Bismuth peak. ^{214}Bismuth, as one of the radon daughters, serves as an indirect measurement of the ^{226}Radium parent.

4.0 PROCEDURE

4.1 PROCEDURE FOR ADJUSTING AMPLIFIER GAIN

The purpose of this procedure is to set each amplifier's fine gain by using a Cesium source. The Cesium check source provides a distinct and quickly acquired peak. This procedure is performed prior to leaving for a site survey.

4.1.1 Without computer installed:

a. Place Compaq laptop next to expansion base.

b. Plug mouse into rear of computer.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

c. Slide computer into socket in expansion base.

d. Plug expanded keyboard into expansion base.

e. Power up the expansion base first, then the computer.

4.1.2 **With computer installed:**

a. Turn on the NIM bin and Hi-voltage power supply. High voltage should read 890 volts.

b. Switch off both S2 toggle switches on UNC switchboard.

c. With main menu displayed on computer, hit enter key to choose.

d. Type ALT-S for setup.

e. Choose conversion gain, then pick 1024.

f. Use mouse to move cursor to channel 110.

g. Remove ^{137}Cesium sources from lead pig; place each one in a lead pig.

h. Hit F1 to begin acquiring a spectrum.

i. Adjust vertical scale and display to isolate Cesium peak. With the cursur in channel 110, an imaginary line should split the peak into two equal halves. If the peak is offset to either side, the amplifier fine gain must be adjusted.

j. Hit F1 to stop spectrum acquisition.

k. Then adjust the fine gain knob a small amount in the direction the spectrum needs to move to center the peak. Continue adjusting until cursur is centered above peak.

l. Switch S1 off and S2 on, and repeat acquisition and adjustment of S2.

m. Adjust fine gain on both sets of amplifiers, and lock gain adjustment knobs when finished.

4.2 WEEKLY DETERMINATION OF A CALIBRATION FACTOR

This procedure will be done once each week, on the first working day of the week.

4.2.1 Install computer, attach power source to van.

a. Turn on expansion base, computer, NIM bin and Hi-voltage power supply.

b. From main menu, choose first selection to start DMR software.

c. Type alt-s, pick conversion gain of 1024, F3 to set acquire time of 500 seconds.

4.2.2 Adjust amplifier fine gain; see section 4.1.

4.2.3 Calibrate using standards.

a. Place 15 and 50 pCi/g standards in lead pigs.

b. Begin acquiring in each input by picking F1.

c. Set a region of interest (ROI) around the 609 Kev peak when acquisition is complete.

d. Record the ROI net value in the appropriate space in the calibration data sheet.

4.2.4 Collect calibration data.

a. Run each sample three times in each pig.

b. Switch samples and repeat process until a total of six values are obtained in both pigs.

c. Fill out the calibration data sheet and calculate the calibration factor for each pig.

4.3 PREPARE VAN PRIOR TO A SITE SURVEY

4.3.1 Place computer and keyboard in drawer and lock drawer.

4.3.2 Check to insure an adequate supply of sample cans and lids.

4.3.3 Lock all drawers, lay down chair, check and secure any loose items.

4.3.4 Ensure sampling buckets and equipment are in van and decon sprayer is full.

4.4 ON-SITE SURVEY START-UP

4.4.1 Plug in power cord to generator, and start generator.

4.4.2 Remove computer and keyboard; then install mouse, computer and keyboard.

4.4.3 Turn on NIM bin and Hi-voltage power supply.

4.4.4 Check/adjust amp fine gain.

4.5 SAMPLE ANALYSIS

4.5.1 Mix sample(s) in sample bucket.

a. Adjust scale for weight of empty can and lid.

b. Place samples in respective cans, put on lid, weigh and record wet weight.

c. Place samples in pigs.

4.5.2 Analysis software

a. Chose selection two from the main menu.

b. Visually check the mca settings, then hit any key.

c. Hit any key to start acquiring data in pig 1; then hit any key to acquire in pig 2.

d. Visually confirm data acquisition in both pigs, then hit esc or wait 12 seconds.

e. Type in property and sample data for each pig at OCS input screen.

f. When analysis is complete, type ALT-O, select "Run a Batch File".

g. The software defaults to :ocs.nbe. Move the cursur under s, type in a "2", and strike return. Now hit any key to calculate both samples activity.

h. Enter the moisture correction per cent; see section 4.6 for a description of this procedure.

i. Enter the appropriate calibration factor when prompted.

j. Record each samples activity on the OCS data sheet, and report the values to the survey team leader.

k. Visually check and confirm or edit the data screen, then save all data.

l. Exit the DMR software and check the OCS database to confirm the sample data has been saved.

4.6 SAMPLE MOISTURE TESTING

4.6.1 Remove the Speedy moisture tester and set up the scale.

4.6.2 Weigh out 6 g of the sample material.

a. For clayey soil:

1. Pour two even scoops of absorbent/reagent into Speedy body. Then add two steel balls into the body.

2. Put the sample material into the Speedy cap.

3. Carefully hold the Speedy body horizontal to prevent mixing of sample and absorbent/reagent before the Speedy is sealed. Place cap in position to seal Speedy.

4. Place cap into body gently. Bring stirrup around and tighten top screw.

5. Hold Speedy vertically so the sample material falls into the body.

6. Then holding Speedy horizontally, rotate it approx. 10 seconds to put the steel balls into motion around the body. Then rest for about 20 seconds. Repeat the

rotate-rest cycle until the value on the gage is constant. This will take about 3 minutes.

7. Enter the final value on the gauge for the moisture correction.

b. For sandy soil:

1. Place the sample into the body.

2. Pour two even scoops of absorbent/reagent into Speedy cap.

3. Carefully hold the Speedy body horizontal to prevent mixing of sample and absorbent/reagent before the Speedy is sealed. Place cap in position to seal Speedy.

4. Place cap into body gently.

5. With the gauge facing down, shake the Speedy vigotously for 5 seconds, then quickly rotate so gauge is facing up. Tap the body to ensure that contents fall into cap.

6. Hold Speedy in this position for about 1 minute. Repeat cycle 3 times.

7. Again shake Speedy, then hold horizontally and take reading. This value is the one to enter for the sample moisture correction.

4.6.3 Once the moisture determination is complete, point the directions release arrow arrow from the operator. Slowly release the pressure by unscrewing the stirrup.

4.6.4 Clean out the Speedy with the provided brush.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-060 Page: 1 of 25 Revision: 0 Date: 10/01/90

WATER QUALITY PARAMETERS: pH, SPECIFIC CONDUCTANCE, DISSOLVED OXYGEN, AND ALKALINITY

All following procedures are adapted from Procedures for Field Chemical Analyses of Water Samples, Korte and Ealey, 1983.

1.0 AVAILABLE EQUIPMENT

1.1 YSI Model 3500 pH, conductivity, temperature, and millivolt meter

This instrument has automatic temperature compensation for both pH electrode slope and conductivity. Conductivity ranges and accuracy are 0 to 2000 and 0 to 20,000 µmho/cm ± 3% of full scale, and 20,000 to 50,000 µmho/cm ± 6% of full scale. When the cell is platinized, an accuracy of ± 6% of full scale from 50,000 to 100,000 µmho/cm can be achieved. Temperature measurement range is -5.0 to 50.0°C with an accuracy of ± 0.4°C. The Model 3500 comes with an in-line flow-through sample cell which connects to the pump outlet tubing.

1.2 Orion Model SA250 Ph, temperature, and millivolt meter

The Orion Model SA250 is a field instrument with autocalibration and automatic temperature compensation for pH electrode slope. The manufacturer's stated accuracy is the greater of ± 0.01 pH units or 0.05%, and ± 1°C.

1.3 Amber Science Model 604 conductivity meter

The Model 604 has automatic temperature compensation and ranges of 0 to 2, 0 to 20, 0 to 200, 0 to 2000, 0 to 20,000, and 0 to 200,000 µmhos/cm. The manufacturers stated accuracy ranges from 0.10% to 0.30% of full scale.

1.4 Horiba Model U-7

The Horiba Model U-7 measures five parameters of water: pH, temperature, dissolved oxygen, conductivity, and turbidity. All of the measurement-sensing elements are housed in one assembly which is connected to the

Approved by:

9/25/90 (Date)

C.A. Little 9/26/90 (Date)

instrument body by a 32-ft cord. This sensor assembly can be submerged in the sample water (such as a river or pond). Groundwater samples should be measured in a closed container (such as a flow-through cell).

Note: For pH and conductivity, the Horiba model U-7 should be used as a backup instrument only. For pH measurements, the sample chamber requires larger amounts of buffer solution for calibration, whereas a single combination electrode with accompanying temperature compensation probe can fit inside a smaller container. In measurements of conductivity, the manufacturer's stated accuracy of the U-7 is $\pm$ 500 µmhos/cm with a range of 0 to 10,000 µmho and $\pm$ 2500 µmhos/cm for the 0 to 50,000 µmho model. Also, the Horiba lacks an automatic temperature compensation (ATC) feature; the conductivity reading must be corrected mathematically to 25° C.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 D. Langmuir, "Eh-pH Determinations," pp. 597-634 in Procedures in Sedimentary Petrology, ed. R. E. Carver, John Wiley and Sons, Inc., New York, 1971.

2.1.2 National Handbook of Recommended Methods for Water Data Acquisition, Chapter 2, U.S. Department of the Interior, Office of Water Data Coordination, U.S. Geological Survey, 1977.

2.1.3 Standard Methods for the Examination of Water and Wastewater, 16th ed., American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1985.

2.1.4 Annual Book of Standards, Part 31: Water, American Society for Testing and Materials (ASTM), Philadelphia, 1980.

2.1.5 Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdmann, D.E., and Duncan, S. S. (eds.), 1979, Methods for Determination of Inorganic Substances in Water and Fluvial Sediments: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-03177-9.

2.1.6 Wastewater Analysis Handbook, Hach Chemical Co., Loveland, Colorado, 1981.

2.1.7 Nic Korte and Dennis Ealey, Procedures for Field Chemical Analyses of Water Samples, GJ/TMC-07, U.S. DOE Technical Measurements Center, 1983, pp. 5-10, 11-18, 25-29.

2.1.8 D. A. Skoog and D. M. West, Analytical Chemistry, Holt, Rinehart and Winston, New York, 1965.

2.2 APPENDICES

2.2.1 Appendix 1: Relationship of Temperature and Specific Conductance for 0.01 N Potassium Chloride

2.2.2 Appendix 2: Water Sample Data Record

2.2.3 Appendix 3: Dissolved Oxygen Saturation Values at Various Temperatures

2.2.4 Appendix 4: Correction Factors for Dissolved Oxygen Saturation Values as Determined by Pressure or Altitude

3.0 pH

3.1 DISCUSSION

pH is used to predict and interpret the reactions and migration of dissolved species. Temperature, atmospheric contamination, and ionic strength affect pH measurement. The presence of color, turbidity, or colloids will not affect pH measurements.

3.2 MEASUREMENT PROBLEMS

3.2.1 Temperature

The temperature compensation on a pH meter only permits adjustment of the electrode slope. It does not compensate for changes in the potential of the reference electrode, the asymmetry potential of the glass electrode, or the liquid junction potential. Nor does it compensate for changes in pH due to temperature.

3.2.2 Atmospheric contamination

Atmospheric contamination can be a significant problem for groundwater samples. Dissolved oxygen (DO) and carbon dioxide can be evolved or dissolved when the sample is exposed to air. A considerable change in pH may result. For best results, a groundwater

sample is pumped through a closed container in which pH and temperature probes are immersed. The measurements are not recorded until both temperature and pH have stabilized. The sampling pump should be stopped before recording the data because a streaming potential results with flowing sample.

3.2.3 Ionic strength

Because of errors due to ionic strength (generally not worth correcting in the field), pH measurements should be accompanied by a measurement of specific conductance. pH is a measure of the hydrogen ion activity. An ideal solution is assumed in which other ions do not affect hydrogen activity. This assumption deteriorates if the ionic strength is too high. Some remedial action investigations include sampling waste ponds or other highly contaminated water. Since buffer solutions used in the field are not made with a similar concentration of dissolved ions, the pH measurement will be inaccurate. Similarly, samples with very low ionic strength cause difficulties because the resistance of the sample approaches that of the glass electrode. For best results, samples with very low ionic strength should be stirred for a few seconds before reading. Even then, it may require several minutes for the reading to stabilize.

High sodium and alkalinity may also produce errors in pH measurement. For a pH >9 and a sodium concentration of 10 moles/L, a special electrode is needed. One can be purchased from any principal electrode manufacturer. Similarly, any pH value that is <1 or >9 will have a greater uncertainty because the electrode response is non-Nernstian in these regions (see Reference 2.1.1).

3.3 EQUIPMENT

The following apparatus are recommended for the field measurement of pH:

3.3.1 pH meter,

3.3.2 buffer solutions of pH 4.00, 7.00, and 9.00,

3.3.3 combination pH electrode,

3.3.4 reference electrode filling solution,

3.3.5 thermometer,

3.3.6 distilled water and wash bottle, and

3.3.7 disposable beakers.

3.4 STANDARDS

Commercially prepared buffer solutions are used for calibration. Solutions traceable to the National Bureau of Standards (NBS) are inexpensive and can be purchased from any major laboratory supply house. These solutions are certified with an accuracy of $\pm$ 0.01 pH units at a specific temperature, usually 25° C.

3.5 CALIBRATION PROCEDURES

3.5.1 YSI 3500

According to the manufacturer, the working life of the YSI KCl gel electrode is 3 to 6 months. However, the Ross electrode supplied with the Orion meter works equally well with the YSI, and has a longer working life.

Regardless of which electrode is used, calibration checks should be made at each sampling site. The following calibration procedure applies to the YSI 3500.

a. Zero the instrument.

1. Before connecting the pH electrode, zero the electronics with the shorting cap attached to the 3500. Turn on the instrument and set the pH function switch to pH.

2. Connect the shorting cap to the pH input jack and set the manual temperature compensation knob to 25° C.

3. Adjust the CAL control to indicate 7.00 $\pm$ 0.01 on the pH-mV display.

4. Disconnect the shorting cap from the pH input and connect it to the mV input jack. The monitor is now zeroed.

b. Test the pH electrode for noise and offset before going to the field.

1. Rinse the electrode and temperature probe with pH 7.00 buffer to remove any contaminants.

2. Connect the pH electrode to the pH input jack and the temperature probe to the TEMP input jack.

3. Pour pH 7.00 buffer into a sample cup, then immerse both of the sensors into the buffer at 25.0 $\pm$ 0.1°C. Allow the sensors to equilibrate. A display value other than 7.00 $\pm$ 0.2 at 25.0°C indicates electrode background noise. A spare electrode in good condition should always accompany the instrument to the field.

c. **Perform a two-point calibration.**

1. Rinse the pH electrode and temperature probe with pH 7.00 buffer and connect to pH and TEMP input jacks.

2. Pour pH 7.00 buffer into a sample cup and immerse both sensors in the buffer. Allow time for the temperature to equilibrate until a stable reading is obtained.

3. Read the temperature and adjust the pH manual temperature compensation knob to the same value.

4. Adjust the CAL control knob for 7.00 $\pm$ 0.01 pH units on the display and discard the buffer.

5. Rinse the sensors with deionized water followed by a rinse with the next desired buffer (typically pH 4.00 or 10.00.)

6. Pour the next buffer into a new sample cup and immerse the sensors. Allow time for the temperature to equilibrate.

7. Adjust the SLOPE control until the display is within 0.01 pH units of the buffer's stated value.

The pH system is now calibrated and ready for use.

d. **Temperature compensated pH**

Follow the pH instructions above, with the following modifications:

Set the pH function switch to pH ATC and connect the temperature probe to the pH ATC input jack. While the temperature probe will work in either the TEMP or Ph ATC location, the pH ATC function will not work unless the temperature probe is connected

to the pH ATC input. Temperature compensation is automatic in this mode.

3.5.2 Orion SA250

a. Calibrate the meter with two buffer solutions. The slope cannot be adjusted with a one-point calibration. The slope check is the best way to determine if the electrodes are in working order.

b. The two buffers used for calibration should bracket the anticipated sample pH (i.e., for an anticipated pH of 6, calibrate with pH 4.00 and 7.00 buffers). When significant time lapses between samples, as in the case of sampling monitoring wells, calibration should be performed before each measurement.

c. Ensure that the buffers are the same temperature as the sample ($\pm$ 5°C).

d. Check the stored value for ISO before calibration (see the operator's manual for illustrations of controls). Unless the isopotential point of the electrode is known, verify that the display reads 7.00. If not, scroll until 7.00 is displayed, and press ENTER.

e. There are two ways of calibrating the meter--autocalibration or manual calibration:

f. Autocalibration with two buffers:

1. Connect the electrode(s) to the meter. Slide the mode switch to either pH.1 or pH.01, depending on the accuracy required. Choose either 4.00 and 7.00, or 7.00 and 10.00 buffers, whichever will bracket the expected sample range.

2. Place electrode(s) into either 4.00, 7.00, or 10.00 buffer.

3. Press CAL. The display will alternate between .1. and the pH value of the buffer, indicating that this is the first buffer and a value has not been entered. Wait for a stable pH display and press ENTER. The correct display will freeze for 3 s, then advance to .2., indicating the meter is ready for the second buffer.

4. Rinse electrode(s) in deionized water and place into a second buffer. Wait for a stable pH display and press ENTER.

5. Rinse electrode(s) in deionized water and place them into the sample. Record the pH directly from the meter's display.

g. Autocalibration with one buffer:

1. Check the slope term by pressing SLOPE. If necessary, scroll and enter the correct value. If the slope value is unknown, either enter 100.0 or go on to a two-buffer calibration (single buffer calibration does not change the slope term).

2. Connect the electrode(s) to the meter. Slide the MODE switch to either pH.1 or pH.01, depending on required accuracy.

3. Place electrodes into either 4.00, 7.00, or 10.00 buffer.

4. Press CAL. The display will alternate between .1. and the pH value of the buffer, indicating this is the first buffer and a value has not been entered.

5. Wait for a stable pH reading and press ENTER. After ENTER is pressed, the correct display will freeze for 3 s, then advance to .2., indicating the meter is ready for the second buffer. Pressing SAMPLE displays the letters pH indicating the meter has advanced into the sample mode.

6. Rinse the electrode(s) in deionized water and place them in the sample. Read the pH directly from the display.

h. Manual calibration with two buffers:

1. Connect the electrode(s) to the meter. Slide MODE switch to either pH.1 or pH.01, depending on the required accuracy. Choose two buffers that will bracket the expected sample range.

2. Place electrode(s) into the first buffer.

3. Press CAL. The display will alternate between .1. and the pH value of the buffer, indicating this is the first buffer and a value has not been entered.

4. Wait for a stable pH display. Using the scroll or X10 keys, scroll in the correct value and press ENTER. The display will freeze for 3 s, then advance to .2., indicating the meter is ready for the second buffer.

5. Rinse the electrode(s) and place them into the second buffer. Wait for a stable pH display. Scroll in the correct value and press ENTER. After the second buffer value has been entered the letters pH will be displayed. The meter is now calibrated and automatically advances to the SAMPLE mode.

6. Rinse electrodes(s) in deionized water and place them in the sample. Record pH directly from the meter's display.

i. Manual calibration with one buffer:

1. Verify the slope by pressing SLOPE. If necessary, scroll in the correct value and press ENTER. If the correct slope is unknown, either enter 100 or perform a two-buffer calibration.

2. Connect the electrode(s) to meter. Slide the MODE switch to either pH.1 or pH.01, depending on the required accuracy.

3. Place electrodes in the buffer.

4. Press CAL. The display will alternate between .1. and the pH value of the standard, indicating that this is the first buffer and a value has not been entered. Wait for a stable pH display, scroll until the correct value is displayed, and press ENTER. The display will freeze for 3 s, then advance to .2., indicating the meter is ready for the second buffer. By pressing SAMPLE the letters pH will be displayed. The meter is now calibrated and automatically advances to the SAMPLE mode.

5. Rinse the electrode(s) in deionized water and place them in the sample. Read the pH directly from the display (NOTE FOR MANUAL CALIBRATION: In the event that scrolling was started but the value was not entered and the mode switch was changed, either a P1 or a P2 will be displayed upon returning to the pH mode. P1 indicates that a value has not been entered for the first buffer while P2 indicates a value has not been entered for the second buffer).

6. Theoretically, buffer solutions are indefinitely stable. However, they are susceptible to contamination. Hence, old, partially full bottles are often contaminated and should be replaced.

j. Temperature Mode:

Sliding the MODE switch to TEMP will display the temperature in °C. When the temperature is outside of the operating range (-5.0 to 105.0°C), an operator assistance code will be displayed (E-1 for below -5°C, E1 for above 105°C).

During a pH calibration or a sample measurement, the MODE switch can be changed to TEMP. When an ATC probe is connected, the temperature can be monitored and automatic temperature compensation will take place.

To use manual temperature compensation:

1. Use a thermometer accurate to $\pm$ 1°C and determine the temperature of the solutions to be measured.
2. Slide the MODE switch to TEMP.
3. Scroll until the correct temperature value is displayed.
4. Press ENTER.
5. Return the MODE switch to either pH.1 or pH.01.

When an ATC probe is not connected, the last entered value of temperature is displayed. If a temperature value has not been entered since the removal of an ATC probe, a default value of 25°C is displayed.

3.6 MEASUREMENT/SAMPLE PLAN

Samples should not be filtered before analysis. A submersible pump or bladder pump is preferred for obtaining groundwater samples because degassing of the sample is minimized. The pH measurement must be made in the field.

If the sample is being pumped through a closed container, wait for the temperature and pH to stabilize. Stop sample flow to prevent the streaming potential and record the pH.

3.7 QUALITY ASSURANCE

The following information about pH measurement must be logged on the water sample data record for Quality Assurance (QA) documentation (see Appendix 2):

3.7.1 instrument used,

3.7.2 time,

3.7.3 measurement conditions,

3.7.4 time of last two-buffer calibration,

3.7.5 buffer temperature at calibration,

3.7.6 sample temperature, and

3.7.7 sample pH.

4.0 SPECIFIC CONDUCTANCE

4.1 DISCUSSION

Specific conductance is a widely used indicator of groundwater quality. It is a simple indicator of change within a system and provides useful information to lab analysts performing other measurements on the sample.

Numerous adequate specific conductance meters are available. Any meter used in remedial investigation programs should also measure temperature, be equipped with a temperature compensator, and read directly in µmhos/cm corrected to 25° C. The probe type unit, more rugged than the pipet type, should be used in the field. A relative accuracy of $\pm$3% is adequate for this type of measurement.

The meter should be of rugged construction. A foam-lined carrying case is essential. Battery operation with easy recharge and/or battery replacement is required.

4.2 MEASUREMENT PROBLEMS

The principal problem areas for specific conductance measurements are temperature effect, determination of the cell constant, and allowance for very high ionic strengths. A change in temperature of 10° C can cause an approximate 20% change in the measured specific conductance. Generally,

reported data do not note whether the temperature correction has been applied, either automatically or manually. To ensure uniform readings, the data should be corrected to 25° C.

Field personnel must be aware of the cell constant used in specific conductance measurements. A significant change in the cell constant indicates that the electrodes require cleaning or replatinizing. Since the cell constant is usually figured into the factory calibration of the instrument, frequent field checks with conductivity standard solutions will give an indication of the instrument's performance.

Specific conductance varies linearly with ion concentration up to a specific conductance of about 5,000 µmhos/cm (see Reference 2.1.2). Relative measurements are useful up to about 50,000 µmhos/cm. Samples collected at remedial investigation sites seldom have a specific conductance greater than 10,000 µmhos/cm. Most are less than 5,000 µmhos/cm.

4.3 EQUIPMENT

The following apparatus are necessary for field measurement of specific conductance:

4.3.1 specific conductance meter,

4.3.2 distilled water and wash bottle,

4.3.3 disposable beakers,

4.3.4 operator's manual, and

4.3.5 conductivity standards.

Note: The YSI 3500 and the Amber Science model 604 have automatic temperature compensation; the Horiba model U-7 does not. Consequently, it is necessary to use a conversion chart such as the one in Appendix 1 to correct the Horiba's reading to 25° C. The temperature coefficient of most waters only approximately the same as that of standard KCl. The more the sample temperature deviates from 25° C , the greater the uncertainty in applying the temperature correction. The following formula approximates the corrected conductivity (see Reference 2.1.3):

$$\text{conductivity (µmho/cm) at 25° C} = \frac{\text{conductivity at t° C x cell constant}}{1 + 0.0191\ (t - 25)}$$

If the cell constant has been incorporated into the factory calibration, delete it from the numerator.

4.4 STANDARDS AND CELL CONSTANT

4.4.1 Standards

Reagent-grade potassium chloride (KCl) is universally used for the standardizing specific conductance equipment. Purer grades of KCl are available but not worth the additional expense because of the errors already inherent in the measurement.

Standard solutions are made up at 0.001 N, 0.01 N, 0.1 N, or 1 N KCl. A concentration of 0.01 N is used for most work because its specific conductance is closest to most natural samples.

4.4.2 Cell constant

The instrument's measuring circuit is calibrated either by the manufacturer or with a calibrating resistor. The manufacturer's instructions should be followed since they will be specific for the particular instrument. More detailed information can be found in the operator's manual.

The electrodes are calibrated by reading the specific conductance of standard KCl solutions. Individual manufacturers may use slightly different terminology, but the following general guidelines will always apply:

a. Prepare 0.01 N KCl by dissolving 0.745 g of pure, dry KCl in 1 L of deionized water.

b. Measure the temperature of the standard solution and of the water used for the dilution. They should be the same.

c. Use Appendix 1 to determine the expected specific conductance of the 0.01 N KCl at that temperature.

d. Measure the specific conductance of the water (C_2) and of the 0.01 N KCl solution (C_1). These readings can be used to check the cell constant (K) that was specified by the manufacturer using the equation

$$K = \frac{C_T + C_2}{10^6 \times C_1}$$

where C_T is the theoretical conductance of the standard solution (from Appendix 1).

e. Large changes in the cell constant generally indicate that the electrodes are dirty. Cleaning and replatinizing instructions can be found in the instrument manual or in Reference 2.1.4. The cell constant should be checked before taking the instrument to the field. Field checks of the cell constant are generally unnecessary.

4.5 MEASUREMENT/SAMPLE PLAN

Samples should not be filtered before analysis. A submersible pump or bladder pump is preferred for obtaining groundwater samples because degassing of the sample is minimized. The specific conductance measurement must be made in the field.

4.6 MEASUREMENT PROCEDURE

4.6.1 Check the instrument response against known conductivity standards; if possible, select two which will bracket the expected conductivity of the sample. Record the temperature of the standards and, if necessary, correct the reading to 25° C.

4.6.2 Measure and record the temperature of the sample.

4.6.3 Immerse the probe in the sample and record the reading. (Note that the probe should be several inches from large rocks because they can bias the reading.) Multiply the sample reading by the cell constant to obtain the sample specific conductance; EC = cell constant instrument reading in µmhos. If the cell constant is incorporated into the factory calibration, read directly from the display and record the temperature compensated conductivity.

Note: Although the Amber Science model 604 has a measurement range of 0 to 200,000 µmhos, the linearity begins to fall off above approximately 5,000 µmhos. For greater linearity at high concentrations of dissolved solids, use a platinum-coated cell. However, platinum is somewhat soft and tends to abrade, requiring more frequent checking of the cell constant.

4.7 PRECISION

The number of significant digits reported depends upon the range setting for the measurement. Usually only two significant digits are reported. For

example, values of 760 or 1100 are appropriate, whereas 757 and 1130 are not.

4.8 QUALITY ASSURANCE

The following information about the field measurement of specific conductance must be logged on the water sample data record for QA documentation (see Appendix 2):

4.8.1 instrument used,

4.8.2 measurement conditions,

4.8.3 time of last calibration check,

4.8.4 buffer temperature at calibration, and

4.8.5 specific conductance at 25° C.

5.0 DISSOLVED OXYGEN

5.1 DISCUSSION

A measurement of DO is needed to accurately characterize the oxidation/reduction (Eh) conditions of a hydrologic system. For example, an Eh measurement should not be made or interpreted without knowledge of DO values. This section describes the use of a DO probe to obtain measurements. Although acceptable results can be obtained with the Winkler volumetric method, it is not the method of choice for several reasons. The main difficulty is its sensitivity to oxidizable substances such as ferrous iron. According to several sources (References 2.1.5 and 2.1.6), 1 mg/L Fe renders the method unacceptable. This concentration of iron is common in highly polluted samples often encountered at remedial investigation sites. Finally, the probe method is much more rapid and efficient for field use.

5.2 MEASUREMENT PROBLEMS

Other available calibration procedures suffer from distinct disadvantages. For example, the Winkler method used to calibrate the DO meter is excessively tedious, particularly under field conditions.

Calibration with air-saturated water is undesirable because it is more difficult to prepare air-saturated water than it is to prepare water-saturated air.

Instrument drift is a problem in cold weather for samples containing less than 1 ppm DO. A drifting measurement should be noted in the remarks section of the QA documentation.

Atmospheric contamination must be prevented. Thus, groundwater measurements are made with a closed, flow-through container.

5.3 EQUIPMENT

The field measurement of DO requires the following equipment:

5.3.1 DO meter and probe (Horiba model U-7),

5.3.2 spare membranes,

5.3.3 electrolyte, and

5.3.4 Horiba operator's manual.

5.4 STANDARDS

Calibration is performed with water-saturated air, air-saturated water, and solution in which all oxygen is removed.

5.5 CALIBRATION PROCEDURE

Calibration procedures specific to the Horiba Model U-7 are found on pp. 10-20 of the operator's manual, which should accompany the instrument to the field. Calibration is performed with a standard solution supplied with the instrument and includes simultaneous calibrations for DO, pH, and turbidity. The Horiba Model U-7 has a sample chamber which attaches to the probe and contains a stirrer which keeps the sample agitated during the appropriate measurements.

5.6 MEASUREMENT/SAMPLE PLAN

Samples should <u>not</u> be filtered before analysis. A submersible pump or bladder pump is preferred for obtaining groundwater samples because it minimizes degassing of the sample. The DO measurement must be made in the field.

5.7 MEASUREMENT PROCEDURE

The following steps outline the procedure for field measurement of DO using the Horiba Model U-7:

5.7.1 Rinse the sample chamber and electrodes with deionized water to remove any contamination.

5.7.2 Pour the sample into the sample chamber until it reaches the fill line (approximately 1 in. from chamber bottom).

5.7.3 Use the aerator (porous stone with black squeeze bulb) to saturate the solution with oxygen by submersing the stone ball into the sample and squeezing the bulb five times.

5.7.4 Couple the sensor section to the sample chamber, taking care to line up the two index marks.

CAUTION: The electrodes are fragile. Avoid striking them against the sample chamber.

5.7.5 Turn the instrument power "ON" and turn the selector switch to "TEMP." Read the temperature of the solution on the digital display.

CAUTION: DO NOT turn POWER switch ON when the sensor section and instrument case are disconnected.

5.7.6 Press and release the stirrer switch located on the bottom of the chamber and check to see that the stirrer is rotating by looking through the sight glass on the side.

5.7.7 Turn the selector switch to "D.O.". (Refer to Table 1.4.1 to determine the value for DO at the temperature observed in Step 5.7.5.)

5.7.8 Record DO concentration.

5.7.9 Rinse probes and sample chamber with deionized water and return them to the storage case.

5.8 PRECISION

Report DO values to the nearest 0.1 mg/L. The combination of errors possible in reading the meter and in calibration make more precise readings impractical.

5.9 QUALITY ASSURANCE

The following information about the field measurement of DO must be logged on the water sample data record for QA documentation (see Appendix 2):

5.9.1 date and time zero check last performed,

5.9.2 atmospheric pressure,

5.9.3 temperature of calibration chamber,

5.9.4 DO saturation value from Appendix 3,

5.9.5 DO saturation corrected for pressure from Appendix 4,

5.9.6 calibration value, and

5.9.7 measured DO.

6.0 FIELD MEASUREMENT OF CARBONATE AND BICARBONATE (ALKALINITY)

6.1 DISCUSSION

The inorganic-carbon-species balance controls many reactions in environmental systems. Alkalinity is often used as a measure of these species and as a general indicator of water quality. This procedure describes methods for obtaining a value for carbonate, bicarbonate, and alkalinity by direct measurement and for calculating dissolved carbon dioxide (see Reference 2.1.7).

6.2 pH METER/BURET METHOD

The pH meter/Buret Method is the method of choice when accuracy and reproducibility are critical (as in the case of geochemical modeling). A complete description of the method is in Reference 2.1.2. The following field methods are taken from Reference 2.1.7.

6.3 TEST KITS

An alkalinity test kit is convenient and, for routine monitoring purposes, provides an adequate representation of the carbonate system. However, it may not be sufficiently accurate or reproducibile when the data are to be used for modeling.

6.4 MEASUREMENT PROBLEMS

Consult Sect. 3.2 for a discussion of the difficulties encountered in measuring pH.

6.5 EQUIPMENT

The field measurement of alkalinity requires the following apparatus:

6.5.1 Hach Alkalinity Test Kit Model AL-DT, and

6.5.2 all equipment and reagents necessary for determining pH (see 3.3).

6.6 STANDARDS

Primary standard sodium carbonate can be purchased at a moderate price from several supply houses. Carbon-dioxide-free water, prepared by boiling for several minutes, is necessary for dissolution of the sodium carbonate. Water in equilibrium with the atmosphere contains only 1.5×10^{-5} formula weight of CO_2 per liter (see Reference 2.1.8), a negligible concentration in most applications. Distilled water, however, is often supersaturated with CO_2, and removal is essential.

Standard acids can be prepared by standardizing diluted, concentrated reagent-grade acid. An acid concentration of approximately 0.02 N is used for most applications.

6.7 PROCEDURE FOR CALIBRATING WITH SODIUM CARBONATE

Field kits are sold with standard acid. Using a sodium carbonate standard is recommended not only to check the field kit but also to check the operator's technique.

The usual method for calibrating with sodium carbonate is a laboratory calibration based on Skoog and West (see Reference 2.1.8). Dry a quantity of primary-standard sodium carbonate for 2 h at 150°C and cool in a desiccator. For standardization of 0.02 N solutions, weigh 0.1 to 0.15 g of the salt (to the nearest 0.1 mg) into 250 mL flasks and dissolve in 25 to 50 mL of water. Add 3 drops of bromcresol green and titrate until the solution just begins to change from blue to green. Boil the solution for 2 to 3 min, cool to room temperature, and complete the titration. During the heating process, the indicator should change back to blue. If it does not, an excess of acid was added originally; back-titrate this excess with standard base. Determine an indicator blank by titrating a similar volume of distilled water containing approximately equal amounts of sodium chloride and indicator as are present at the end point in the solution being titrated.

The standard acid is made by diluting approximately 0.5 mL of concentrated H_2SO_4 to 1 L with distilled water. The actual concentration is then determined by titration of the sodium carbonate. It may be convenient to adjust

the titrant to exactly 0.01639 N since 1.00 mL of titrant would then equal 1.00 mg HCO_3.

6.8 MEASUREMENT/SAMPLE PLAN

Samples should not be filtered before analysis. A submersible pump or bladder pump is preferred for obtaining groundwater samples because degassing of the sample is minimized. The alkalinity measurement must be made in the field.

6.9 MEASUREMENT PROCEDURES USING A HACH TEST KIT

6.9.1 Attach a clean, straight-stem delivery tube to a sulfuric acid titration cartridge. If the expected alkalinity is below 100 mg/L as $CaCO_3$, use a 0.16 N H_2SO_4 titration cartridge. If it is above 100 mg/L as $CaCO_3$, use a 1.6 N H_2SO_4 titration cartridge. Twist the cartridge onto the titrator body.

6.9.2 Flush out the delivery tube by turning the small knob until a few drops of titrant are ejected. Wipe the tip and reset the counter to zero.

6.9.3 Take a water sample by filling a clean 100-mL graduated cylinder to the 100-mL mark. Pour the sample into a clean 250-mL Erlenmeyer flask.

6.9.4 Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix.

6.9.5 If the color turns pink, titrate with the sulfuric acid standard solution to a colorless end point. If the pink color does not develop, proceed with Step 6.9.7.

6.9.6 Read and record the milliequivalents of acid added.

$$CO_3\ (mg/L) = (meq\ acid)\left(\frac{1000\ mL/L}{mL\ sample}\right)\left(\frac{60\ mg/CO_3}{meq}\right)$$

6.9.7 Add the contents of one Bromcresol Green-Methyl Red Indicator Powder Pillow to the same sample and swirl to mix.

6.9.8 Continue to titrate with the sulfuric acid standard solution to:

- light greenish blue-gray (pH 5.1) if alkalinity is approximately 30 mg/L,
- light bluish pink-gray (pH 4.8) if alkalinity is approximately 150 mg/L,
- light pink (pH 4.5) if alkalinity is approximately 500 mg/L.

6.9.9 Read and record the milliequivalents of acid used:

$$HCO_3\ (mg/L) = (meq\ acid)\left(\frac{1000\ mL/L}{mL\ sample}\right)\left(\frac{61\ mg/HCO_3}{meq}\right)$$

6.9.10 Carbon dioxide values can then be determined if the original sample pH is between 6 and 9.

Free CO_2 (mg/L) = $1.6 \times 10^{(8.0-pH)}$ x mg/L HCO_3

Alkalinity is determined from the equation

$$\text{Alk (meq/L)} = \frac{\text{(mL of std. acid used)(normality of acid)}}{\text{mL sample}}$$

6.10 PRECISION

The Hach test-kit measurement should be reported to the nearest 10 mg.

6.11 QUALITY ASSURANCE

The following information about the field measurement of alkalinity must be logged on page 2 of the water sample data record (Appendix 2) for QA documentation:

6.11.1 normality of titration cartridge,

6.11.2 temperature of sample,

6.11.3 phenolphthalein alkalinity, and

6.11.4 total alkalinity.

Appendix 1. Relationship of Temperature and Specific Conductance for 0.01N Potassium Chloride

Temperature (°C)	Specific conductance (µmhos/cm)
15	1141.5
16	1167.5
17	1193.6
18	1219.9
19	1246.4
20	1273.0
21	1299.7
22	1326.6
23	1353.6
24	1380.8
25	1408.1
26	1436.5
27	1463.2
28	1490.9
29	1518.7
30	1546.7

Appendix 2. Water Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

WATER SAMPLE DATA RECORD

PROJECT _____ FIELD NO. _____

STATION NO./LOCATION _____

SAMPLING DATA DATE _____ TIME: START _____ END _____

GROUNDWATER

NO. OF COMPLETIONS _____ DEPTH TO WATER FROM TOP OF CASING _____ WELL DEPTH _____

WELL CONSTRUCTION MATERIAL _____ WELL DIAMETER _____ WELL VOLUME _____

SCREENED INTERVAL(S) _____ VOLUME PURGED _____

SAMPLING EQUIPMENT USED _____

SURFACE WATER

DEPTH OF WATER AT SAMPLE LOCATION _____ TYPE OF SAMPLE _____

STREAM VELOCITY MEASUREMENTS ☐ YES ☐ NO SAMPLE METHOD _____

NO. OF BOTTLES	BOTTLE SIZE/DESCRIPTION	FILTERED	PRES./VOL.	ANALYSES REQUESTED

FIELD PARAMETERS

SAMPLE APPEARANCE: CLEAR ____ COLORED ____ SEDIMENT ____

(SOME NARRATIVE DESCRIPTION MAY BE NECESSARY)

1. SAMPLE TEMPERATURE _____

2. pH
TIME _____ MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
TIME OF LAST TWO-BUFFER CALIBRATION _____ BUFFER TEMPERATURE AT CALIBRATION _____
SAMPLE pH _____

3. SPECIFIC CONDUCTANCE
MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
BUFFER VALUE (μmho) _____ _____ SPECIFIC CONDUCTANCE AT 25°C _____
MEASURED VALUE (μmho) _____ _____ BUFFER TEMPERATURE AT CALIBRATION _____

4. CARBONATE AND BICARBONATE (ALKALINITY)
TEST KIT: NORMALITY OF TITRATION CARTRIDGE _____
PHENOLPHTHALEIN ALKALINITY _____ TOTAL ALKALINITY _____

5. PID (ppm) _____ INST. NUMBER _____ HEADSPACE _____

UCN 17190 (9/90)

Appendix 3. Dissolved Oxygen Saturation Values at Various Temperatures

Temp (°C)	Sat. value (ppm)	Temp (°C)	Sat. value (ppm)
0	14.6	23	8.7
1	14.2	24	8.5
2	13.9	25	8.6
3	13.5	26	8.2
4	13.2	27	8.1
5	12.8	28	7.9
6	12.5	29	7.8
7	12.2	30	7.7
8	11.9	31	7.5
9	11.6	32	7.4
10	11.3	33	7.3
11	11.1	34	7.2
12	10.8	35	7.1
13	10.6	36	7.0
14	10.4	37	6.8
15	10.2	38	6.7
16	9.9	39	6.6
17	9.7	40	6.5
18	9.5	41	6.4
19	9.3	42	6.3
20	9.2	43	6.2
21	9.0	44	6.1
22	8.8	45	6.0

Appendix 4. Correction Factors for Dissolved Oxygen Saturation Values as Determined by Pressure or Altitude

Pressure (mm)	Altitude (ft)	Correction factor
775	-540	1.02
760	0	1.00
745	542	0.98
730	1094	0.96
714	1688	0.94
699	2274	0.92
684	2864	0.90
669	3466	0.88
654	4082	0.86
638	4756	0.84
623	5403	0.82
608	6065	0.80
593	6744	0.78
578	7440	0.76
562	8204	0.74
547	8939	0.72
532	9694	0.60
517	10472	0.68
502	11272	0.66

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-070 Page: 1 of 5 Revision: 0 Date: 10/01/90

SOIL SAMPLING WITH A BARREL AUGER

1.0 PURPOSE

This procedure describes the method used for collecting surface and shallow subsurface soil samples with manually operated barrel augers with and without a thin-walled tube sampler. The method is best suited to nongravelly soil.

2.0 APPLICABILITY

2.1 BARREL AUGER

A barrel auger is used to obtain a sample at a desired soil depth. It consists of a section of tube or pipe (the barrel portion) attached to an orchard bit. The bit cuts the soil and forces cuttings into the barrel, which holds the soil cuttings and presents contact with the borehole sidewalls, thus minimizing sample contamination by soil from other parts of the borehole. If the barrel auger is used to collect samples, cuttings from the top of the barrel and soil lodged in the bit must be discarded in order to guarantee that no cross-contamination occurs.

2.2 BARREL AUGER USED WITH A THIN-WALLED TUBE SAMPLER

The thin-walled tube sampler consists of a metal tube with an inside diameter of typically 1 in. or less, which is manually pressed into the soil to obtain a relatively undisturbed core. It is used to sample soil below the bottom of the borehole. It may also be used in conjunction with an auger after the auger bores to the desired depth. The chief advantage of using a barrel auger with the sampler over use of the auger alone is that cross-contamination is virtually eliminated. The chief disadvantage is the small volume of the sample (Reference 3.1.1).

Approved by:

Nic Kreis 9/25/90
(Date)

Craig Little 9/26/90
C.A. Little (Date)

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 P.E. Ford, P.J. Turina, and D.E. Seely, "Subsurface Solid Sampling with Auger and Thin-Walled Tube Sampler," pp. 5-7 in Characterization of Hazardous Waste Sites -- A Methods Manual, Vol. 2, Meth. II-2, EPA-600/4-83-040, U.S. EPA, Office of Research and Development, Las Vegas, Nevada, 1983.

3.1.2 Procedure TE-073, "Equipment Decontamination"

3.1.3 Procedure TE-072, "Soil Sample Packaging and Preservation"

3.1.4 Procedure TE-071, "Sample Documentation"

3.2 APPENDICES

3.2.1 Appendix 1: "Soil/Sediment Sample Data Record"

4.0 EQUIPMENT

4.1 barrel auger;

4.2 thin-walled tube sampler;

4.3 stainless steel spoon;

4.4 stainless steel knife;

4.5 dowel (up to 5 ft long, 0.5 to 1 in. diam);

4.6 disposable surgical gloves;

4.7 leather gloves;

4.8 metal trays;

4.9 metal tape measure (12 ft);

4.10 JMC Backsaver Handle or similar tool;

4.11 Dyalon mallet;

4.12 sample containers; and

4.13 sample labels.

5.0 PROCEDURE

5.1 Clear the sampling area of any surface debris or litter.

5.2 Begin augering, periodically removing any accumulated material from the auger barrel. If the soil is loose and runs through the bottom of the auger, use the dowel to lightly compact the soil in the barrel before lifting it out of the hole.

5.3 For inorganic analysis samples only.

When the desired depth is reached, remove the auger and clean it according to Reference 3.1.2. Measure and record the depth with a metal tape measure. Lower the auger into the hole, being careful not to loosen the soil on the sidewalls, and drill one full barrel length, usually 6 to 9 in. Use a dowel to compact the soil in the barrel if the soil is loose and runs out the bottom of the auger. Carefully remove the auger from the hole. Use the spoon to remove and discard the upper 1 or 2 in. of soil from the top of the barrel and remove exposed soil in the bit below the barrel to minimize cross-contamination. Measure the depth of the sample with a tape measure and record on the soil/sediment sample data record (Appendix 1).

5.4 For organic analysis samples only.

When the desired depth is reached with the barrel auger, measure the depth of the hole with a tape measure. Carefully lower the thin-walled tube sampler into the hole. Gradually press the sampler into the soil, being careful to avoid any contact with the walls of the hole by the sampler extension rods. If the soil resists penetration, use the JMC Backsaver handle or drive with the Dyalon mallet. When the coring is complete, twist the sampler gently to break the core at the base. Remove the sampler and discard the upper 2 in. of the core.

5.5 Transfer sample from the auger or tube sampler to the sample container over a metal tray. Use a knife to remove the packed soil from the barrel auger if necessary. Transfer any soil falling on the metal tray to the sample container; package and store the sample according to Reference 3.1.3.

5.6 Document the sample according to Reference 3.1.4.

5.7 Decontaminate trays, spoon, knife, and any other equipment in contact with the soil according to Reference 3.1.2. When used for auger sampling, the

auger needs to be cleaned only immediately prior to taking a sample. It is not necessary to clean the auger when it is only used for drilling the hole.

5.8 Specialized augers may be obtained for loose, sandy soil and heavy, clayey soil. A barrel auger for clay soil is typically open-sided to facilitate removal of the clay cuttings. Such an auger should be used only for penetration and not for sampling.

Appendix 1. Soil/Sediment Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

SOIL/SEDIMENT SAMPLE DATA RECORD

FIELD NO. _____

LOCATION _____

TIME SAMPLED _____ ☐ AM ☐ PM DATE _____

FIELD INFORMATION _____

_____

_____

NO. OF CONTAINERS	CONTAINER SIZE/ DESCRIPTION	PRESERVATIVE	ANALYSES REQUESTED

SAMPLER _____

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-071 Page: 1 of 7 Revision: 0 Date: 10/01/90

SAMPLE DOCUMENTATION

1.0 DISCUSSION

This procedure applies to all samples collected for outside laboratory analysis. Sample documentation begins with a 17-character description written in black, permanent ink in the project logbook. This sample numbering system is for Oak Ridge National Laboratory/Pollutant Assessment Group (ORNL/PAG) tracking and identification only. A four-digit number is used to interface with the analytical lab. The four-digit number appears in the project logbook, sample label (Appendix 1), soil/sediment sample data record (Appendix 2), chain of sample custody form (Appendix 3), and the ORNL/CAT data base.

2.0 OTHER DOCUMENTS

2.1 Appendix 1: Sample Label

2.2 Appendix 2: Soil/Sediment Sample Data Record

2.3 Appendix 3: Chain of Sample Custody

3.0 PROCEDURE

3.1 SAMPLE IDENTIFICATION SYSTEM

3.1.1 Each sample is identified according to the following description:

AA	AA	NNN	AA	NN NN NN	NNN
Site ID	Sample source	Well, Borehole #	Matrix	(MM DD YY) Date	Sample # or depth

A = Alpha

N = Numeric

Approved by:

Nic Kato 9/25/90
(Date)

Craig Little 9/26/90
C.A. Little (Date)

3.1.2 Site ID:

Two letters signify the installation or project.

Sample Source:

BH = Borehole	SD = Sediment
MW = Monitoring well	VG = Vegetation
SF = Surface soil	OT = Other
FB = Field blank	ER = Equipment rinse
TB = Trip blank	SW = Surface water

3.1.3 Well or borehole number:

Each sampling location is given a unique sequential number beginning with 01. Multiple completion wells are designated according to the completion that was sampled, where U = upper, M = middle, and L = lower. This designation is placed immediately after the monitoring well number (see examples).

3.1.4 Matrix:

GW = Groundwater	SR = Soil replicate
SO = Soil	WR = Water replicate
RI = Rinsate	WT = Water
SL = Sludge	DI = Deionized water
GR = Grab	MB = Matrix Blank

3.1.5 Event date:

The date of the sampling event is recorded as part of the sample number by using two-digit numeric designations for the month and day and year (e.g., March 14, 1990, is shown as 031490).

3.1.6 Sample number from borehole or monitoring well:

Sequential numbers signifying the depth at which the sample was taken are assigned to each soil sample as it is collected from a particular borehole. Groundwater samples are noted according to the number of samples taken from a particular well on the same day. For example, if the well was sampled once during the day, the final digits are 01. If it was sampled twice, the second sampling event would have the digits 02, etc.

3.1.7 Examples:

1. ABBH003SO-031490-19

   AB: Site abbreviation is AB.
   BH: Sample is from a borehole.
   03: Borehole is labeled 003.
   SO: The sample collected is soil.
   031490: The sample was collected on March 14, 1990.
   19: The sample was taken at a depth of 19 ft.

2. ABTB-000DI-031290-01: Signifies a trip blank taken for site abbreviated AB, it is deionized water bottled on September 23, 1987, and it is the first trip blank of the sampling trip.

3. ABER001RI-031490-01: Site AB, equipment rinse, taken at location 001 (borehole or monitoring well, etc.) on 3/14/90, the first rinsate collected at site 01 on that day.

4. ABMW001WR-031490-02: Site AB, monitoring well 01, replicate, taken on March 14, 1990. The original sample would be labeled ABMW001GW-031490-01.

5. ABMW-27LGW-031490-01: Site AB, monitoring well MW027, collected from the lower completion (L), groundwater, March 14, 1990, the first sample from MW027 (L) on that day.

3.1.8 A numeric segment which does not apply to a particular sample is designated 000.

3.1.9 Circumstances may arise in which portions of the labeling system need to be modified to accommodate a sample. Changes must be documented in the appropriate field logbooks and brought to the attention of the site project manager (SPM).

3.2 SOIL/SEDIMENT SAMPLE DATA RECORD

The purpose of the Soil/Sediment Sample Data Record (Appendix 2) is to document the collection of soil samples taken at locations other than a borehole. Borehole soil samples are documented on the well summary information sheet.

3.3 CHAIN OF SAMPLE CUSTODY FORM

3.3.1 The chain of custody procedure creates an accurate written record that can be used to trace the handling and possession of the sample from its collection through analysis and, if necessary, its introduction as evidence.

3.3.2 A sample is in "custody" if:

1. it is in one's actual possession; or
2. it is in one's view, after being in one's possession; or
3. it is in one's physical possession and then locked up so that no one can tamper with it; or
4. it is restricted and kept in a secured area.

3.4 TRANSFER OF CUSTODY AND SHIPMENT

3.4.1 When transferring the samples, the transferee must sign and date the chain of custody record (Appendix 3). Every person taking custody must fill in the appropriate section of the form. Although couriers are not considered custodians, a copy of the airbill must be obtained by everyone who relinquishes custody.

3.4.2 The completed form is placed in a plastic bag, sealed and taped to the underside of the cooler lid placed on top of the samples. The original accompanies the samples to the laboratory; the carbon copy is retained by the sampling team.

Appendix 1. Sample Label

UCN 17186 8/90

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 μ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other_____

Analysis _____

Field Information_____

_____

Collector _____

Appendix 2. Soil/Sediment Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

SOIL/SEDIMENT SAMPLE DATA RECORD

FIELD NO. _____

LOCATION _____

TIME SAMPLED _____ ☐ AM ☐ PM DATE _____

FIELD INFORMATION _____

_____

_____

NO. OF CONTAINERS	CONTAINER SIZE/ DESCRIPTION	PRESERVATIVE	ANALYSES REQUESTED

SAMPLER _____

Appendix 3. Chain of Sample Custody

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address:
P.O. Box 2567
Grand Junction, CO 81502

Street Address:
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody

Page _____ of _____

Date _____

1. Project No. _____ 2. Project Name _____

3. Sample No.	4. Sample Type	5. Remarks

6. Relinquished By	Date	Dept.	Received By	Date	Dept.

7. Company Name _____
Received By _____
Date _____

Distribution: Original accompanies samples, copies to relinquishers.

UCN 17189 8/90

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-072 Page: 1 of 4 Revision: 0 Date: 10/01/90

SOIL SAMPLE PACKAGING AND PRESERVATION

1.0 PURPOSE

Once a sample has been collected, steps must be taken to preserve the sample's chemical and physical integrity during transport and storage before analysis. The type of preservation required varies according to the sample type and the parameter to be measured. Any deviations from this procedure must be described in an approved sampling plan.

2.0 APPLICABILITY

This method applies to packaging and preserving dry or wet soils, sludges, sediments, and cores.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Handbook for Sampling and Sample Preservation of Water and Wastewater, U.S. Environmental Protection Agency.

3.1.2 Procedure TE-071, "Sample Documentation"

3.1.3 Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July 1990.

4.0 EQUIPMENT AND MATERIALS

To prevent the introduction of extraneous organic compounds, glass or Teflon containers must be used for samples being analyzed for organic compounds. The rigid plastic screw caps for the bottles must be Teflon-lined to prevent artificial contamination.

4.1 wide-mouth, glass bottles with Teflon-lined caps;

4.2 insulated chests;

Approved by:

N. Kuto 1/8/91 (Date)

Craig Little 1/8/91 C.A. Little (Date)

4.3 Blue Ice™ or equivalent;

4.4 ballpoint pen (permanent ink);

4.5 felt tip marker pen (permanent ink);

4.6 strapping tape;

4.7 disposable surgical gloves (latex, PVC, or other suitable plastic or rubber);

4.8 disposable wipes;

4.9 sample labels; and

4.10 padding for packaging of samples.

5.0 PROCECURE

5.1 PACKAGING AND PRESERVATION OF SAMPLES FOR ORGANIC ANALYSES

5.1.1 Before using, the glass bottles for organic samples must be cleaned to Environmental Protection Agency (EPA) specifications for organic sample collection (see Section 5.3). Precleaned sample bottles can be purchased from any of several chemical supply houses.

5.1.2 While wearing surgical gloves, fill the bottle as full as possible with the soil sample. Wet soils should have enough head space to allow for expansion. Extreme care must be taken to avoid contamination of the bottles or caps. The cap should be removed just before filling and replaced as soon as possible after filling. Any contact with the inside of the bottle or cap by anything other than the sample must be avoided. Gloves are discarded after packaging each sample.

Optional: If the sampling plan or legal considerations require, the sample bottle should be sealed with evidence tape or other special sealing tape and wrapped so that it simultaneously adheres to both the lid and the bottle. The sampler's initials should be written across the overlap end of the tape. If required by sampling plan or the analytical laboratory, paraffin strips should be used for sealing. This is particularly important for samples with volatile organic contaminants.

5.1.3 Label sample bottles according to Procedure TE-071.

5.1.4 Place a layer of frozen Blue Ice coolant packs on the bottom of an insulated ice chest. Stack sample bottles upright on the coolant

packages. Take care to pad the bottles from each other to avoid breakage. More coolant packs can be placed on top of the sample bottles to ensure adequate cooling.

5.1.5 If samples are not delivered daily to the laboratory, ice chests and insulated boxes should be checked every 24 hours and any thawed Blue Ice packs replaced with frozen packs as needed.

5.1.6 If samples are to be analyzed for volatile organics, ensure that the samples are not frozen.

5.2 PACKAGING AND PRESERVATION OF SAMPLES FOR INORGANIC ANALYSES

Samples for inorganic analysis can also be packaged the same as those for organic analysis.

5.3 SAMPLE CONTAINER CLEANING PROCEDURES

5.3.1 In general, glass bottles with Teflon-lined lids are used for both organic and inorganic soil samples. Polyethylene is used for water samples to be analyzed for metals and other inorganics. The following specifies the bottle cleaning required (see Reference 3.1.3). Typically, bottles are purchased pre-cleaned from I-Chem Research, which also uses these cleaning methods.

5.3.2 Cleaning procedures for glass bottles:

Note: As defined in the 1986 Annual Book of ASTM Standards, Type I deionized water has a resistivity $\geq$16.67 megaohm-cm at 25°C (conductivity <0.06< µmho/cm at 25°C). Total solids $\leq$0.1 mg/L, and total organic carbon <0.05 mg/L.

a. Wash glass bottles, Teflon liners, and caps in hot tap water with laboratory-grade nonphosphate detergent.

b. Rinse three times with tap water.

c. Rinse with 1:1 nitric acid (one part metals-grade HNO_3, one part ASTM Type I deionized water).

d. Rinse three times with ASTM Type I deionized water.

e. Rinse with pesticide-grade methylene chloride using 20 mL for 1/2 gal container and 5 mL for 8- and 4-oz containers.

f. Oven dry at 125° C and allow to cool to room temperature in an enclosed, contaminant-free environment.

g. Place liners in lids and cap containers.

h. Store in contaminant-free area (amber glass containers shall not be exposed to sunlight).

5.3.3 Cleaning procedure for bottles used for volatile organics (40 mL glass):

a. Wash glass vials, Teflon-backed septa, Teflon liners, and caps in hot tap water using laboratory-grade nonphosphate detergent.

b. Rinse three times with tap water.

c. Rinse three times with ASTM Type I deionized water.

d. Oven dry vials, septa, and liners at 125° C.

e. Allow vials, septa, and liners to cool to room temperature in an enclosed contaminant-free environment.

f. Seal 40-mL vials with septa (Teflon side down) and cap.

g. Store in contaminant-free area.

5.3.4 Cleaning procedure for polyethylene bottles:

a. Wash polyethylene bottles and caps in hot tap water with laboratory-grade nonphosphate detergent.

b. Rinse with 1:1 nitric acid (one part metals-grade HNO_3 to one part ASTM deionized water).

c. Rinse three times with ASTM Type I deionized water.

d. Invert and air dry in contaminant-free environment.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-073 Page: 1 of 3 Revision: 0 Date: 10/01/90

EQUIPMENT DECONTAMINATION

1.0 PURPOSE

Decontamination is necessary for all equipment that comes in contact with a sample such as sampler, trowel, hand spade, spoon, straight bar, and pan.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 Matteoli, Robert J. and John M. Noonan. Decontamination of Rubber Hose and Teflon Tubing for Ground Water Sampling. Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring, and Geophysical Methods. May 18-21, 1987. Published by NWWA.

2.1.2 Fink, Michael J. and Ralph T. Boyajian. Decontamination Procedure for Groundwater Sampling Equipment. Proceedings of the Third National Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring, and Geophysical Methods. May 22-25, 1989. Published by NWWA.

3.0 EQUIPMENT AND MATERIALS

3.1 five-gal water jugs filled with tap water;

3.2 plastic tub or bucket;

3.3 three stainless steel baths;

3.4 scrub brushes (plastic or fiber bristles);

3.5 wire brush;

3.6 disposable wipes;

Approved by:

Nic Kotte 9/14/90 (Date)

Craig Little 9/19/90 C.A. Little (Date)

3.7 laboratory detergent;

3.8 plastic trash can liners;

3.9 distilled water in wash bottle;

3.10 pesticide-grade hexane and pesticide-grade methanol or ethanol (in Teflon wash bottles);

3.11 aluminum foil.

4.0 PROCEDURE

Note: If the equipment is muddy, wash it in tap water in a plastic bucket or tub and then with soapy water in a stainless steel bath. Rinse with tap water and dry with a disposable wipe. A different scrub brush should be used with each bath.

4.1 The following decontamination procedures are acceptable for all sampling equipment:

4.1.1 wash and scrub with laboratory-grade detergent (low phosphate if phosphate is an analyte);

4.1.2 tap water rinse;

4.1.3 a methanol or ethanol rinse followed by hexane rinse;

4.1.4 deionized or distilled analyte-free water rinse;

4.1.5 air dry;

4.1.6 wrap in aluminum foil.

4.2 If organics are not being sampled, step 4.1.3 can be omitted. Solvents must be specified as pesticide-grade or better. Equipment should be cleaned once a day in a batch so that the final rinsate may be collected for field equipment rinsate blanks. After cleaning, field equipment may be placed temporarily on polyethylene sheeting but must ultimately be wrapped in aluminum foil. Care must be taken when choosing the site of the decontamination area to avoid fugitive dust, fuel oils, oils, gasoline, organic solvents, or any potential airborne contamination.

4.3 All drilling equipment, well screens and casing, backhoes, dredges, augers, and other heavy equipment must be steam cleaned before use.

4.4 Alternative procedures:

The use of solvents, particularly hexane, is coming under increasing criticism because of the health risks involved. Also, recent studies have shown that steam cleaning and/or copious rinsing with deionized water following a detergent wash are adequate for most situations (see References 2.1.1 and 2.1.2).

4.5 Deviations from this procedure should be documented in the sampling plan and approved by the appropriate agencies before beginning the field work.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-074 Page: 1 of 4 Revision: 0 Date: 10/01/90

STREAM SEDIMENT SAMPLING USING A PISTON-TYPE CORE SAMPLER

1.0 PURPOSE

This procedure describes how to sample streambed material with a hand-operated, piston-type core sampler, specifically the US BMH-53 sampler.

2.0 APPLICABILITY

It applies to sampling fine-grained bed material and sediment for the purposes of characterizing density, particle size, and/or chemical composition.

The National Handbook of Recommended Methods for Water-Data Acquisition suggests the US BMH-53 sampler for use in sampling streambed material. The US BMH-53 sampler consists of a stainless steel cylinder with a rod-mounted piston attached to an aluminum frame and handle. The rod-mounted piston assists in retaining the core when the tube is retracted from the streambed and in ejecting the core from the tube. Use of the sampler itself is limited to shallow streams. However, extension rods and couplings can be added to facilitate sampling in pools. Its use will be severely limited in streams with gravel or sand bottoms.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 National Handbook of Recommended Methods for Water Data Aquisition, U.S. Department of Interior, Office of Water Data Coordination, 1977.

3.1.2 Procedure TE-072, "Soil Sample Packaging and Preservation"

3.1.3 Procedure TE-073, "Equipment Decontamination"

3.1.4 Procedure TE-071, "Sample Documentation"

Approved by:

9/17/90 (Date)

C.A. Little 9/19/90 (Date)

4.0 EQUIPMENT AND MATERIALS

4.1 US BMH-53 bed-material sampler with extension rods;

4.2 camera and film;

4.3 screwdriver;

4.4 small trowel, knife, or putty knife;

4.5 stainless steel spoon;

4.6 metal tape measure;

4.7 rubber hip waders;

4.8 rubber gloves;

4.9 stainless steel sample trays and bowls;

4.10 scrub brush for 2 in. inside diam cylinder;

4.11 sample labels;

4.12 sampling logbook; and

4.13 sample containers.

5.0 DEFINITIONS

5.1 BED MATERIAL: The sediment mixture composing the streambed. In alluvial streams, bed-material particles are likely to move at any moment or during some future flow condition.

5.2 COMPOSITE SAMPLE: A sample created by combining two or more samples, or representative portions thereof.

5.3 SEDIMENT: Particles derived from rocks or biological materials transported by water, or solid material (sludges) suspended in or settled from water.

6.0 PROCEDURE

6.1 Wade to the sampling point in the stream channel. Push the cylinder into the bed material using the frame handle. It may be necessary to pull up on

the operating handle to activate the piston while forcing the cylinder into the streambed. Push the sampler to the desired depth.

6.2 To retract the sampler, rotate it clockwise with the frame handle and break the sediment core at the base. Pull slowly upward using the frame handle. Hold the piston handle steady to prevent losing the core.

6.3 To extract the core, push the piston handle downward. Extract any unwanted length of core and slice it off with the putty knife. Extract the remaining amount and save in a sample tray. For example, if only the upper 3 in. of core is desired, extract the lower 5 in., slice it off, and save the remainder.

6.4 To clean the cylinder wall, submerge the cylinder in the stream water and move the piston its full stroke (8 in.) several times.

6.5 If a composite sample is desired, repeat the above steps to collect additional samples. Place each in a sample tray. Mix and store in appropriate containers.

6.6 Package the sample as described in Reference 3.1.2.

6.7 Before decontaminating, repeat step 6.4. Use a scrub brush to wash mud off the cylinder in the stream. This brush should be dedicated to this one operation and not used for any other decontamination procedure.

6.8 Disassemble the sampler as follows:

6.8.1 Remove the screws and brass plate at base of the piston.

6.8.2 Remove the rubber O-ring.

6.8.3 Invert the sampler, and brace the T-handle.

6.8.4 Remove the stainless steel cylinder by turning it counter-clockwise.

6.9 Decontaminate the sampler as described in Reference 3.1.3. Pour clear water into the frame tube and piston rod of the inverted sampler to flush out any sediment.

6.10 Reassemble the sampler.

6.11 The brass plate on the base of the piston presses against and partly flattens the O-ring, which, in turn, contacts the cylinder wall. The piston's ease of movement can be controlled to some extent by adjusting the screws in the brass plate.

6.12 The US BMH-53 piston-type bed-material hand sampler is manufactured by Product Manufacturing Co., Maplewood Industrial Park, 2515 Highway 61 North, St. Paul, Minnesota 55109.

6.13 Document samples according to Reference 3.1.4.

6.14 Maintain a sampling logbook describing the location of each new sample site and any prominent landmarks. Take photographs of upstream and downstream views and record them in the logbook. Label photographs with the site number or designation and the date. Record other pertinent information such as bottom conditions, flow conditions, difficulties in sampling, etc., in the logbook. The log entry should also contain a list of sample numbers and analyses requested.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-075 Page: 1 of 4 Revision: 0 Date: 10/01/90

STREAM SEDIMENT SAMPLING USING A SCOOPING DEVICE

1.0 PURPOSE

This procedure describes a method for sampling bed material in streams using a scoop, trowel, or other similar device.

2.0 APPLICABILITY

It is intended for reconnaissance-scale sampling to characterize the chemical composition of stream sediments when it is impossible or impractical to use a piston-type core sampler (see Reference 3.1.1).

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 H.L. Fleischauer and P.R. Engelder, Procedures for Reconnaisance Stream-Sediment Sampling, GJ/TMC-14, U.S. DOE, Technical Measurements Center, Grand Junction Projects Office, 1985.

3.1.2 Procedure TE-073, "Equipment Decontamination"

3.1.3 Procedure TE-072, "Soil Sample Packaging and Preservation"

3.1.4 Procedure TE-071, "Sample Documentation"

3.2 APPENDICES

3.2.1 Appendix 1: Soil/Sediment Sample Data Record

4.0 EQUIPMENT AND MATERIALS

4.1 camera and film;

4.2 polyethylene or metal scoop, trowel, or similar device;

Approved by:

9/25/90 (Date)

C.A. Little 9/26/90 (Date)

4.3 sieve (2-mm openings, U.S. Standard Sieve Series No. 10);

4.4 sample trays;

4.5 Kimwipes or clean cloths;

4.6 sample labels;

4.7 soil/sediment sample data record;

4.8 sample containers; and

4.9 sampling logbook.

5.0 DEFINITIONS

5.1 BED MATERIAL: The sediment mixture composing the streambed. In alluvial streams, bed material particles are likely to move at any moment or during some future flow condition.

5.2 COMPOSITE SAMPLE: A sample created by combining two or more samples or representative portions thereof.

5.3 SEDIMENT: Particles derived from rocks or biological materials transported by water, or solid material (sludges) suspended in or settled from water.

6.0 PROCEDURE

6.1 FLOWING STREAM

6.1.1 Decontaminate the scoop according to Reference 3.1.2.

6.1.2 Rinse the scoop in stream water.

6.1.3 Collect a scoopful of sediment from the bed material below the water surface.

6.1.4 Remove the larger pebbles by hand.

6.1.5 (Omit for volatile organics.) Sieve to remove particles larger than 2 mm.

6.1.6 (Omit for volatile organics.) If a composite sample is desired, repeat the above steps. Collect the requisite number of samples to comprise the composite. Mix together in the sample tray.

6.1.7 Package and store the sample according to Reference 3.1.3.

6.2 DRY STREAM

6.2.1 Decontaminate the scoop according to Reference 3.1.2.

6.2.2 Where eolian contribution might be significant, scrape away the upper 2 or 3 cm of bed material to avoid eolian material in the sample. Wipe the scoop clean with a Kimwipe or clean cloth.

6.2.3 Collect a scoopful of the sediment.

6.2.4 Remove the larger pebbles by hand and sieve to remove particles larger than 2 mm.

6.2.5 If a composite sample is desired, repeat steps 1 through 4. Collect the requisite number of samples to comprise the composite. Mix in the sample tray.

6.2.6 Package and store the sample according to Reference 3.1.3.

6.2.7 If laboratory analyses include volatile organics, do not sieve or composite the sample.

6.3 DOCUMENTATION

6.3.1 Document the samples according to Reference 3.1.4.

6.3.2 Maintain a sampling logbook. Describe the location of each new sample site and any prominent landmarks. Photograph the upstream and downstream views, record them in the logbook, and label them with site number or designations, flow conditions, difficulties in sampling, etc. The log should also contain a list of sample numbers, associated laboratories, and analyses requested.

Appendix 1. Soil/Sediment Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

SOIL/SEDIMENT SAMPLE DATA RECORD

FIELD NO. _____

LOCATION _____

TIME SAMPLED _____ ☐ AM ☐ PM DATE _____

FIELD INFORMATION _____

_____

_____

NO. OF CONTAINERS	CONTAINER SIZE/ DESCRIPTION	PRESERVATIVE	ANALYSES REQUESTED

SAMPLER _____

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-076 Page: 1 of 2 Revision: 0 Date: 10/01/90

SOIL-GAS AND WATER FIELD SCREENING SYSTEM

1.0 PURPOSE

The environmental field screening equipment is designed to allow the measurement of subsurface soil-gas and liquid volatile contaminants without the need for actual drilling of the location.

2.0 PROCEDURE

2.1 PROCEDURE FOR DRIVING THE PROBE

2.1.1 Attach 1/8 in. Teflon tubing to the filter well point securely and slide the tubing through 2-1/2 ft probe from the non-threaded end.

2.1.2 Attach "T" handle to down-hole hammer with bolt. Attach 6 in. union adapter to hammer head and slide tubing through side port of hammer head.

2.1.3 Place the hammer and the probe with a point into the soil and hammer the probe until the joint of the probe and union is 6 in. above ground level.

Caution: Use a "T" handle when slide hammering.

2.1.4 Unscrew the hammer and union from 2-1/2 ft probe, pull the tubing out of the hammer head, and add 3-ft probe extension(s) to the required depth.

2.1.5 When the required depth is reached, slide the SST tube union into the tubing coming out of the hammer-head side port and attach the union to the side port. Tighten the tube compression nut to form a gas-tight seal at the side port and hook up the tubing to the pump. Hammer up 3 in. to expose the gas vents in the filtered well point.

Approved by:

9/17/90 (Date)

C.A. Little 9/19/90 (Date)

2.2 SUBSURFACE PROBE POWER ADAPTERS

2.2.1 To drive a subsurface probe into soil with a jack hammer, attach a 6 in. jack-hammer adapter to a 2-1/2 ft probe.

2.2.2 To remove the probe, replace 6 in. union adapter or jack-hammer adapter with a Hi-Lift jack adapter. Attach a truck jack to the Hi-Lift adapter and jack the probe from the soil.

2.3 SURFACE PROBE ASSEMBLY AND USE

2.3.1 Attach "T" handle and 3-ft SST surface probe to the down-hole hammer.

2.3.2 Place the well point into the probe and hammer the probe to the desired depth. Then hammer up 2 in. to remove the well point.

2.3.3 Attach the tube fitting to the hammer-head side port, and attach 1/8 in. Teflon tubing to the tube fitting.

2.4 SOIL-GAS AND SOIL-LIQUID SAMPLING

2.4.1 Follow steps 1 through 4 in Sect. 2.1 for driving the probe.

2.4.2 After reaching the required depth, slide the SST tube union into the tubing coming out of the hammer-head side port and attach the union to the side port. Tighten the tube compression nut to form a gas-tight seal at the side port. Hook up the tubing to the pump, and pump the liquid into a pre-cleaned headspace sample bottle, leaving sufficient headspace for syringe injection.

a. It is critically important that no liquid is injected into the GC; it is designed for analysis of gas only.

b. The concentration of analyte found in the headspace of a water sample is a relative value used for screening purposes only (degassing of the volatile analyte occurs during suction lift pumping).

2.4.3 For soil-gas sampling, the same procedure applies except that a syringe is inserted through a septum in the tubing. Rather than pumping soil-gas into a headspace sample bottle, take an aliquote by syringe after sufficient air has been evacuated from the sample tubing.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-077 Page: 1 of 4 Revision: 1 Date: 02/03/92

SOIL AUGERING USING A LITTLE BEAVER MECHANICAL EARTH DRILL

1.0 PURPOSE

This procedure describes the operation of a mechanical earth drill system used to auger a hole for soil sampling.

2.0 APPLICABILITY

These operation instructions apply to the Little Beaver mechanical earth drill system.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-078, Subsoil Sampling Probe.

3.2 EXHIBITS

3.2.1 Little Beaver mechanical earth drill

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Little Beaver, including:

a. Briggs and Stratton engine assembly
b. Torque tube assembly (3 pieces)
c. Operator handle and flexible drive shaft assembly

4.1.2 Carbide and pengo cutting points, 1 each
4.1.3 Auger flights
4.1.4 Leather gloves
4.1.5 Flathead shovel

Approved by:

2/5/92
(Date)

C.A. Little 2/5/92
C.A. Little (Date)

4.1.6 Slip shoe
4.1.7 Metal tape measure
4.1.8 Pipe wrenches and general tools
4.1.9 Steam cleaning machine
4.1.10 Decontamination trough
4.1.11 Auger flight A-frame
4.1.12 Bucket auger

4.2 MATERIALS

4.2.1 Disposable surgical gloves

5.0 DEFINITIONS

5.1 **Clutch:** located at the juncture of the flexible drive shaft and the engine. The clutch prevents damage to the engine should the drive shaft stop while the engine is running at full throttle. The clutch assembly may overheat if this situation is continued for more than a short time.

5.2 **Cutting bit:** attachment to the auger that actually cuts the soil. Two cutting bits are available for different augering conditions. The broad carbide cutting bit is suggested for use with clayey and/or compact soils.

5.3 **Flexible drive shaft:** a rubber-coated shaft leading from the clutch assembly on the engine to the transmission in the operator handle.

5.4 **Torque bar assembly:** connects the engine to the operator handle so that the torque occurring from the auger flight will be counteracted by the torque bar and the weight of the engine.

5.5 **Transmission:** located on the underside of the operator handle; transfers power from the flexible drive shaft to the auger flights. The transmission should be serviced daily according to maintenance instructions.

6.0 PROCEDURE

6.1 Be sure the area is clear of any underground utilities. Also be sure to check for any overhead obstructions which may be encountered when pulling the auger flights out of the hole.

6.2 Attach the torque tube assembly (larger end) to the engine bracket and thread the tube pieces together.

6.3 Attach the other end of the torque tube to the operator handle. Check that all snap pins are locked in the corresponding holes.

6.4 Check to make sure the stop switch is in the ON position and that all engine fluids are full before starting the engine. Allow 2 to 3 minutes for the engine to warm up before augering.

6.5 Slide the auger top into the adaptor at the bottom of the transmission. Important: Be sure the spring-loaded button snaps into the mating hole to hold it in place.

6.6 Hold the operator handle with left index finger on the throttle lever and right hand on the handle bar. The leg pad should be placed against left leg when starting the auger.

6.7 Pull the throttle in completely and allow the auger to turn at full speed. Allow the auger to cut into the soil with little or no pressure applied to the operator handle. Increase or decrease the pressure on the operator handle once the auger has started a hole and as soil conditions dictate.

Note: If the auger strikes an immovable object or cuts too fast to clean the hole, the centrifugal clutch will slip to protect the mechanical components and the operator from kickback. If the auger flight will not turn it may be necessary to use a pipe wrench to "unscrew" the auger from the hole.

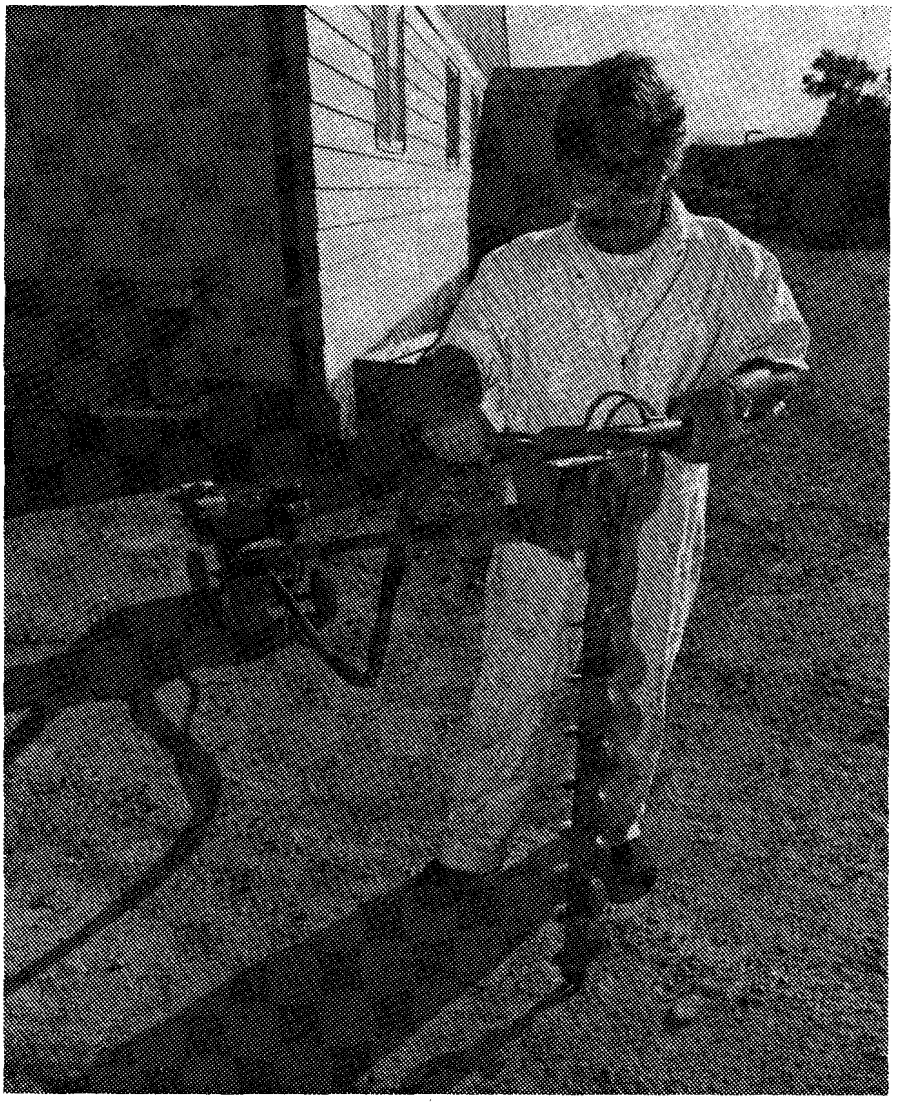
6.8 To add additional auger flights do not remove the auger from the hole, but disconnect the handle by pushing the spring-loaded snap button. Snap the additional flight onto the top of the auger flight and the handle onto the extension. Resume drilling.

6.9 When the hole has reached the desired depth and the auger has stopped turning, disconnect the handle and remove the auger from the hole. If more than one auger flight has been used, it may be necessary to use the "slip shoe" so that the auger flights can be disassembled as they are taken out of the hole.

6.10 All soil should have been removed from the hole; however, if loose soil remains at the bottom, use a bucket auger to remove the rest.

6.11 Sample soil according to Procedure TE-078.

Exhibit 1. Little Beaver Mechanical Earth Drill



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-078 Page: 1 of 4 Revision: 0 Date: 10/01/90

SUBSOIL SAMPLING PROBE

1.0 PURPOSE

This procedure describes the method used for taking subsoil samples with the JMC Environmentalist Subsoil Probe to obtain undisturbed samples for field and laboratory measurements. The JMC Environmentalist system is hand-operated and is composed of three basic parts: the subsoil probe, the drop hammer, and the foot-operated jack for probe retrieval. This system is best suited for use in non-gravely soils.

2.0 EQUIPMENT AND MATERIALS

2.1 Environmentalist Subsoil Sampling Probe;

2.2 12 in. or 36 in. sampling tube;

2.3 drop hammer assembly;

2.4 foot-operated jack;

2.5 wooden dowel;

2.6 copolyester liners;

2.7 stainless steel liners;

2.8 red vinyl caps;

2.9 black vinyl caps;

2.10 Teflon tape;

2.11 metal tape measure;

2.12 leather gloves;

Approved by:

9/17/90 (Date)

C.A. Little 9/19/90 (Date)

2.13 disposable surgical gloves;

2.14 assorted wrenches and tools; and

2.15 Zero Contamination Tube penetration pin.

3.0 DEFINITIONS

3.1 DROP HAMMER: The drop hammer weighs 12.5 pounds and drives the sample probe into the soil.

3.2 FOOT JACK: The foot-operated jack is retrieves the sample probe once the desired sample depth is reached. The foot jack is left in place even while the drop hammer is being used to drive the sample probe.

3.3 ZERO CONTAMINATION TUBE: The Zero Contamination Tube is composed of two parts: the sampling tube and the liners. The sampling tube has a removable top with a retaining pin and is directly attached to the drive rod. The liner is either stainless steel or copolyester and is slipped inside the sampling tube for sample collection. Important: do not use the sampling tube without the liners.

3.4 MASTER EXTENSION: The master extension attaches to the sampling tube.

3.5 REGULAR EXTENSION: Regular extensions cannot be attached to the sampling tube, and are only used to reach a deeper sampling depth.

3.6 STRAIGHT PIN: The straight pins connect the various components of the system and allow re-entry into the previous sampling hole.

3.7 ZERO CONTAMINATION TUBE PENETRATION PIN: The penetration pin is used to link the subsoil sample to the gas chromatograph or photoionization detector probe for field measurements and screening purposes.

4.0 PROCEDURE

4.1 Insert a liner (stainless or copolyester) into the top of the sampling tube.

4.2 Sheathe the guide rod (the long rod with a larger diameter section on one end) inside the drop hammer (the long heavy piece with the welded collar).

4.3 Insert the aluminum end of the guide rod into the top of the sampling tube.

4.4 Push the probe into the soil as far as comfortably possible. If sampling on a hillside, place the foot pedal on the downhill side.

4.5 When the probe can be pushed no farther into the ground, depress the foot pedal slightly and lock the foot pedal into position by flipping down the holding screw. Important: To avoid equipment damage, be sure the foot pedal is in position two while using the drop hammer.

4.6 Grip the drop hammer and raise it 12 to 18 in. above its resting position and drive it sharply against the top of the sampling tube or extension. The tube should move with each blow. If this does not occur, discontinue hammering, as a rock may be obstructing the tube.

Continue driving the tube until the drop hammer collar meets the top ofthe probe body.

4.7 Depress the foot pedal so the holding screw can be swung out of the way. The jack will not work with the holding screw in place. Release the jack lever by lifting the black plastic handle and pushing the jack lever away from the probe. The jack should then move into a position roughly similar to that of the foot pedal.

4.8 To extract the sample, put one foot on the jack lever and the other on the ground. Now, step down on the jack lever; this will raise the sampling tube and probe approximately 1 in. Next, shift weight from the jack lever to the foot on the ground. While resting one foot lightly on the jack lever, press down on the hand grips. Notice that the jack lever returns to its former position. Repeat this procedure until the sampling tube has been pulled from the soil.

4.9 When the bottom of the drop hammer can be seen, stop using the jack and remove the drop hammer. Pick up the probe and lay it horizontally on the ground. Insert the wood dowel into the cutting end of the sampling tube. Push the sample and liner out where you can grasp them. Remove by hand and put Teflon tape and caps over both ends of the liner.

4.10 Label the tube by listing hole number, sample interval, sample number, uphole direction (top), etc.

4.11 Once the sampling operations are completed, clean the sample tube and any portions of the sampler coming in contact with the soil with a wire brush, inspect for contamination and damage, and decontaminate if necessary.

4.12 After the first 3 ft have been sampled, the extensions may be used to reach a deeper sample depth. Put a new liner into the sampling tube. Insert the sampling tube back into the sampler or auger hole. Attach the aluminum adapter to the sampling tube. Remove the pin from the longer end of the

adapter and insert it into the sampling tube. Align the crossholes in both the sampling tube and the adapter, then reinsert the pin through the holes.

If this is the extension which will be closest to the drop hammer during the sampling procedure, make sure that it does not have a solid protrusion at the top. This extension needs to be hollow at both ends so that the end of the drop hammer will fit. For example, if a sample was taken at 6 ft and the next sample will be taken at 9 ft, the equipment is assembled in this order: sampling tube, adaptor, a regular extension (which has a solid piece of steel protruding from one end), master extension (a hollow tube with two crossholes), and drop hammer.

4.13 To obtain GC or PID readings from the liners, cap one end as described in step 4.9, cover the other end of the liner with aluminum foil, and insert a decontaminated penetration pin. The gas chromatograph (GC) or photoionization detector (PID) probe may now be inserted for a field measurement of volatile organic compounds.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-079 Page: 1 of 3 Revision: 0 Date: 10/01/90

COLLECTING SOIL SAMPLES USING BRASS SLEEVES

1.0 PURPOSE

One of the major problems associated with sampling soil for volatile organic compounds (VOCs) is the loss of analytes through volatilization between collection and analysis. The use of brass sleeves in a split spoon sampler reduces volatilization during sample collection by minimizing the amount of time a sample is exposed to the atmosphere. The following procedures apply to collecting samples both for laboratory analysis and for on-site screening with a hand-held PID and portable GC.

2.0 PROCEDURE

2.1 Place brass sleeves, decontaminated according to Procedure TE-073, into clean split-spoon sampler.

2.2 Before a sample is collected, fill out the sample label and, if field GC analysis is required, prepare a pre-cleaned headspace sample bottle (1- L wide-mouth jar with Teflon-lined lid and septum top) by wrapping the jar threads with 2 turns of Teflon tape. Place lid loosely on jar.

2.3 When the split spoon is retrieved from the hole, number the brass sleeves from deepest to shallowest (i.e., the sleeve closest to the drive shoe is No. 1, the sleeve closest to sampler head is No. 4). Quickly place numbers on the sleeves with felt-tipped marker. If one of the sleeves is to be analyzed with a field GC, do not mark that sleeve (volatiles from the ink can be detected by the G.C.). It is important to work quickly at this point, to avoid loss of volatile analytes.

2.4 Discard the No. 4. sleeve (closest to the sampler head); the contents may be mostly cavings from the borehole.

2.5 If one sleeve is to be sent to the laboratory for VOC analysis, place plastic caps with Teflon liners over the ends of the sleeve and seal with silicone tape. Place the sample label on the sleeve, put the sleeve in a plastic bag, and immediately place the sample into an iced cooler.

Approved by:

9/17/90 (Date)

C.A. Little 9/19/90 (Date)

2.6 If field screening for VOCs is to be performed, the following steps apply:

a. Place plastic caps over the ends of the sleeve but omit the Teflon liners.

b. Drive a clean steel spike or 40-penny nail through the plastic cap at least halfway down the length of the sleeve. Remove the spike and quickly insert the probe of the PID meter into the opening, taking care not to pack dirt into the end of the probe.

Allow 5 seconds for the reading to stabilize. Record the value in the sample log book and on the Air Quality Monitoring Record.

c. If sample allocation is such that the same sleeve which was monitored in (b) above is to be analyzed by a field GC, remove the plastic end caps and quickly place the sleeve into a headspace sample bottle. Replace the lid tightly. Place the prepared label on the bottle, indicating borehole number, depth, 4-digit sample number, date and time of collection, and HNU reading.

d. If GC analysis is not performed on the sample as described above, the sample may be returned for geologic logging.

2.7 The disposition of the brass sleeve samples will depend on what parameters are to be determined for individual site investigations. These parameters may consist of chemical analysis (multiple sleeves may be needed for chemical analysis if a large volume is required), field gas chromatography, geologic logging, and various soils engineering parameters, e.g., gravimetric moisture content.

2.8 There are several considerations to keep in mind when deciding which sleeve to use for what purpose:

2.8.1 The deepest sample (No. 1) will have the least exposure to air and sampling tools.

2.8.2 Assuming the sampler is full, sample No. 1 should be used for the most delicate analyses.

2.8.3 Sample No. 2 should have good integrity and provide valid field screening data.

2.8.4 The geologist needs at least one sleeve for the lithologic logging used in well completion planning.

2.8.5 Lithologic logging of field-screened samples (No. 2 sleeve) is an efficient use of the sample.

2.8.6 The top sleeve (No. 4) is the most likely to be contaminated by drilling fluids and/or borehole cavings. It may be used for lithologic logging at geologist's discretion but should not be used for screening or analytical data.

2.8.7 When sample recovery is less than 50%, samples should be used only for lithologic logging.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-080 Page: 1 of 7 Revision: 0 Date: 10/01/90

HEADSPACE SAMPLING WITH A GAS CHROMATOGRAPH

1.0 PURPOSE

After soil samples have been collected according to Sect. 2.10, field screening with a gas chromatograph can give a near real-time indication of the presence of volatiles, and help determine which samples should be submitted for lab analysis. This procedure is not presently designed to quantitate volatiles in soil, as no extraction solvents or purge and trap techniques are used.

2.0 OTHER DOCUMENTS

2.1 APPENDICES

2.1.1 Appendix 1: Detectable Compounds

2.1.2 Appendix 2: Retention Times Relative to Benzene

3.0 PROCEDURE

3.1 BEFORE SAMPLE COLLECTION

3.1.1 Wash headspace sample bottles with Liquinox and water, followed by a tap water rinse. Dry at 50°C in an oven, preferably overnight.

3.1.2 Wipe the lids clean with paper towel or clean cloth. If the lids are washed in water, they must be disassembled to dry since water gets trapped under the Teflon liner. Place in an oven at 50°C, preferably overnight, especially if any contamination was found in the sample.

3.1.3 After removing the lids from the oven, but before the sample collection, replace the lids tightly and run a "bottle blank" by withdrawing an aliquot of air from a bottle and injecting it into the GC. The number of bottle blanks required on a given day will vary according to the amount of contamination found in the previous samples.

Approved by:

Nic Kuta 9/25/90 (Date)

Clair Little 9/26/90 (Date)
C.A. Little

3.2 FOLLOWING SAMPLE COLLECTION

3.2.1 If a sample must be held at the sampling site, place it immediately in an iced cooler. Otherwise, take the sample directly to GC for analysis. In either case, it is important that the sample is placed in jar as quickly as possible and kept out of sunlight.

3.2.2 Begin screening with small injections (~25µL). The HNU reading on the jar label can often be used as a guide for the injection amounts. If contamination is visibly present in the jar, a dilution can be made by withdrawing a small aliquot and injecting it into a 40 mL septum vial, then withdrawing another aliquot from the vial.

3.2.3 There is some indication that heating the sample at 50°C for a maximum of 1 hr increases the quantity of analyte detected. It also appears that the integrity of the airtight seal is lost if the sample is heated too long or at too high a temperature, and the quantity detected begins to decline. Consequently, until more information becomes available, it is recommended that the sample be run first immediately after collection. Then, if the schedule permits, the sample can be placed in a 50°C oven and rerun within an hour.

3.3 OPERATION OF FIELD GC (PHOTOVAC 10S50)

3.3.1 Discussion

The portable GC equipped with a PID can detect many volatile organic compounds in soil vapor and in soil or water sample headspace, as long as the compounds have an ionization potential less than the rated output of the detector lamp (10.6eV). An ultraviolet light in the detector ionizes individual molecules as they emerge from the column. The ions are then attracted to an oppositely charged electrode, causing a current and finally an electric signal to the integrator. Appendix 1 contains a partial list of detectable compounds. Appendix 2 shows retention times relative to benzene using a CPSil5CB capillary column at a flow rate of 5 mL/min. These are typical relative retention times; actual compound identification must be made empirically.

3.3.2 Operating Notes

a. NEVER inject liquid samples, however small, into the 10S50.

b. When transferring the GC from very cold conditions into a warm, humid environment, be alert to the likelihood of condensation on the detector lamp.

c. Always keep approximately 2 cc/min air flow through the column when the GC is not in use. This keeps contaminants from entering the system and saves much time in establishing a clean baseline.

d. The carrier gas consists of purified air with total hydrocarbon content <0.1 ppm as methane.

e. Pre-mixed standards can be purchased inexpensively and have the advantage of being non-combustible, non-explosive, and non-flammable. This simplifies the process of shipping and receiving hazardous materials.

f. The maximum sample size which can be injected into the 10S50 is 1 mL. Where high concentrations of contaminants are suspected, it is prudent to start with small injections (10 to 25 µL).

g. The operating temperature must be within 25° C of the column oven temperature in order for the oven to hold the column at its pre-selected temperature of 30° C, 40° C, or 50° C.

h. Syringes are decontaminated by baking in an oven at 50° C. A blank run of a carrier gas injection can ensure that no contaminants remain in the syringe.

3.3.3 Startup the gas chromatograph

a. Adjust the flow rate to 5 to 15 mL/min. Although a higher flow rate shortens retention times, it is often necessary to reduce the flow rate to achieve a satisfactory separation of peaks.

b. Turn on the isothermal oven and set to 30° C, 40° C, or 50° C. Allow at least 20 minutes to warm up.

c. Enter the current date and time into GC.

d. Adjust the precolumn backflush flow to equal the analytical column flow.

e. Set the gain to the desired sensitivity and establish an acceptable baseline by making a blank run with no injection.

f. Calibrate with the appropriate standards and update retention times and compound libraries.

g. Frequency of calibration varies with operating conditions. Standards should be run at least every 10 samples; sometimes conditions require a standard check every second sample.

3.3.4 Shutdown the GC

a. Turn the isothermal oven off at the temperature selector switch. The oven is electrically independent of the 10S50 and must shut off separately from the GC.

b. Reduce the carrier gas flow to approximately 2 mL/min. If the internal reservoir is supplying the carrier gas, ensure that the reservoir has an adequate supply to last until the instrument is connected to a larger bottle.

c. Turn the instrument off.

Appendix 1. Detectable Compounds

	eV		eV
Acetone	9.69	Cyclopentanone	9.26
Ammonia	10.15	Cyclopentene	9.01
Aniline	7.70	Cyclopropane	10.06
Benzaldehyde	9.53	2-Decanone	9.40
Benzene	9.25	1,2-Dichlorobenzene	9.07
1-Bromo-2-chloroethane	10.63	1,3-Dichlorobenzene	9.12
Bromochloromethane	10.77	1,4-Dichlorobenzene	8.94
n-Butane	10.63	Dichlorodifluoromethane (Freon 12)	11.75
2-Butanone	9.53	1,1-Dichloroethane	11.06
1-Butene	9.58	1,2-Dichloroethane	11.04
cis-2-Butene	9.13	cis-Dichloroethene	9.65
trans-2-Butene	9.13	trans-Dichloroethene	9.66
Butyl cellosolve	8.68	Ethane	11.65
Carbon disulfide	10.13	Ethanol	10.62
Carbon tetrachloride	11.28	Ethene (Ethylene)	10.52
Chlorobenzene	9.07	Ethyl acetate	10.11
Cyclohexane	9.98	Ethyl benzene	8.76
Cyclohexanone	9.14	Ethyl chloride (Chloroethane)	10.98
Cyclohexene	8.95	Freon 11 ($CFCl_3$)	11.77
Cyclopentane	10.52	Freon 12 (CF_2Cl_2)	12.91

Appendix 1. Continued

	eV		eV
Freon 13 (CF_3Cl)	12.08	n-Pentane	10.35
Freon 13 B-1	12.08	1-Pentene	9.50
Freon 14 (neat)	16.25	Phenol	8.69
Freon 22 ($CHClF_2$)	12.45	Phosphine	9.96
Freon 113 (CF_3CCl_3)	11.78	Propane	11.07
n-Hexane	10.18	n-Propanol	10.51
n-Heptane	10.07	Styrene	8.47
1-Hexene	9.46	Tetrachloroethene	9.32
Isobutane	10.57	Toluene	8.82
Isopentane	10.32	1,1,1-Trichloroethane	11.25
Isoprene	8.85	Trichloroethene	9.45
Isopropyl alcohol	10.16	1,2,3-Trimethylbenzene	8.48
Methanol	10.85	1,2,4-Trimethylbenzene	8.27
Methyl n-butyl ketone	9.34	1,3,5-Trimethylbenzene	8.39
Methylcyclohexane	9.85	Vinyl benzene (Styrene)	8.47
4-Methylcyclohexene	8.91	Vinyl chloride	10.00
Methylcyclopropane	9.52	o-Xylene	8.56
Methyl ethyl ketone	9.53	m-Xylene	8.56
Methyl isobutyl ketone	9.30	p-Xylene	8.45
Naphthalene	8.10		

Appendix 2. Retention times relative to benzene at a flow rate of 5 mL/min and using a CPSil5CB capillary column

	Temperature			
Compound	Ambient 20°C	30°C	40°C	50°C
Vinyl chloride	0.288	0.306	0.361	0.413
Freon 11	0.365	0.379	0.428	0.448
Methylene chloride	0.475	0.489	0.539	0.585
trans-1,2-Dichloroethylene	0.517	0.529	0.563	0.580
1,1-Dichloroethane	0.550	0.557	0.611	0.669
Chloroform	0.715	0.720	0.742	0.752
1,2-Dichloroethane	0.840	0.851	0.868	0.872
1,1,1-Trichloroethane	0.948	0.950	0.959	1.000
Benzene	1.000	1.000	1.000	1.000
Carbon tetrachloride	1.095	1.050	1.048	1.086
1,2-Dichloropropane	1.266	1.254	1.214	1.192
Trichloroethylene	1.413	1.396	1.342	1.361
2-Chloroethyl vinyl ether	1.667	1.644	1.551	1.539
1,1,2-Trichloroethane	2.293	2.211	1.976	1.860
Toluene	2.693	2.621	2.358	2.339
Tetrachloroethylene	3.985	3.853	3.314	3.272
Chlorobenzene	5.153	4.962	4.148	4.076
Ethyl benzene	6.223	5.985	4.882	4.743
Bromoform	6.282	5.261	4.713	4.351
m-Xylene	6.767	6.490	5.247	5.071
o-Xylene	8.145	7.826	6.234	5.979
1,1,2,2-Tetrachloroethane	8.311	7.190	5.943	5.345

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-081 Page: 1 of 16 Revision: 0 Date: 10/01/90

SURFACE AND GROUNDWATER SAMPLING FOR INORGANIC, RADIONUCLIDE, AND PHYSICAL PARAMETERS

1.0 DISCUSSION

This procedure describes methods for collecting water samples for inorganic, radionuclide, and physical parameters. Because natural waters are dynamic systems and even the simple insertion of the collection device causes change, it is virtually impossible to maintain a water sample under in situ conditions. Therefore, the goal of these procedures is to ensure that the best water samples practical are obtained in a credible, uniform, and well-documented manner.

2.0 APPLICABILITY

This procedure applies to sampling both surface water and groundwater locations.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-071, "Soil Sample Documentation"

3.1.2 Barcelona et al., Practical Guide for Groundwater Sampling, Illinois State Water Survey, November 1985.

3.1.3 Procedure TE-060, "Water Quality Parameters"

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record

3.2.2 Appendix 2: Sample Label

3.2.3 Appendix 3: Water Sample Preservation

Approved by:

M. Ruto 9/25/90 (Date)

Craig Little 9/26/90 (Date)
C.A. Little

4.0 EQUIPMENT AND MATERIALS

4.1 Bailer, stainless steel or Teflon™,

4.2 Peristaltic, variable-speed sampling pump,

4.3 Silicon tubing,

4.4 Teflon tubing,

4.5 Filter holders, glass fiber filters, and 0.45 µm filter,

4.6 Deionized or distilled water,

4.7 Bladder-type, non-gas-contact lift pump,

4.8 Eh meter and probe with Zobell™ calibrating solution,

4.9 Dissolved oxygen meter and probe with sodium sulfite calibrating solution,

4.10 pH meter and probe with 4.00, 7.00, and 10.00 pH buffers for calibration,

4.11 Conductivity meter and probe with 75, 720, and 2000 µmho/cm calibrating solutions,

4.12 Concentrated or 1:1 HNO_3,

4.13 Pre-cleaned polyethylene bottles,

4.14 Sample labels,

4.15 Water-level indicator,

4.16 Marking pens,

4.17 Water sample data record forms,

4.18 Chain of sample custody forms,

4.19 Blue Ice™ or its equivalent, and

4.20 Insulated coolers.

5.0 PROCEDURE

5.1 DISCUSSION

5.1.1 Surface water

Ponds, streams, and lakes are sampled by the grab-sampling method. The preferred method is to use a peristaltic pump to collect the sample into the collection vessel. The pump should be hooked up in-line with the filter if possible, so that the sample is collected directly from the surface water. If the pump cannot be used due to adverse conditions, the sample may be collected by simply dipping the container into the water, taking care not to disturb the bottom sediments. The sample must then be filtered from the dipping container into the collection bottle. Non-filtered samples should be collected directly in the dipping container.

5.1.2 Groundwater

Filtered samples are taken by connecting the pump-outlet tubing directly to the filter unit. The pump pressure should be decreased so that the pressure build-up on the filter does not blow out the pump bladder or rupture the filter. As a general rule, there should not be more than approximately 20 psi of differential pressure at the .45 µm filter to ensure that particles are not forced through the filter. Non-filtered samples are collected directly from the outlet tubing into the sample bottle.

5.2 SAMPLE COLLECTION AND MEASUREMENTS

5.2.1 Surface waters and wells should be sampled in order, beginning with the sources of least contamination when possible to reduce the risk of cross-contamination between sites.

5.2.2 Before sampling a site, assign a sample number (see Reference 3.1.1). Initiate the water sample data record sheet (see Appendix 1) and sample label (see Appendix 2) for the site with all pertinent information.

a. Record on the label the time, location, sample number, name of collector, type of analysis, and preservative.

b. Permanently affix the label to the bottle.

c. Add preservatives to the bottle before collecting the sample.

d. Use litmus paper to check for adequate pH adjustment when necessary.

5.2.3 Lower the clean water level recorder down the well until the indicator sounds.

5.2.4 Measure (to the nearest 0.01 ft) the depth to water at the mark on the well casing.

a. If the casing is not marked, measure to the north side of the well casing.

b. Record this measurement (h_2 in the formula below) on the water sample data record sheet and in the sample log book.

c. Calculations are performed for the amount of water in the well with the formula

$$\left(\frac{d}{2}\right)^2 \pi \, (h_1 - h_2) \times 7.48 = gal/well\ volume$$

where d = diameter of casing (ft); h_1 = depth of well (ft) from the top of the well casing (i.e., depth of the well on well summary log from ground level plus the height of the casing above ground level); h_2 = depth to water (ft); 7.48 = gal/ft^3; or

$$\left(\frac{d\ (in)}{2}\right)^2 \pi \, (h_1\ (in) - h_2\ (in)) \left(\frac{1\ gal}{231\ in^3}\right) = gal/well\ volume$$

1. If the sampling plan requires a well volume to be defined as the amount of water in the casing plus saturated annulus, the following formula applies:

$$7.48\ gal/ft^3 \left\{(0.30)\ (\pi)\ (h) \left[\left(\frac{d_1}{2}\right)^2 - \left(\frac{d_2}{2}\right)^2\right] + \pi \left(\frac{d_2}{2}\right)^2 h\right\}$$

where 0.30 = approximate porosity of sand pack; h = height of water column (ft); d_1 = diameter of borehole (ft); and d_2 = diameter of casing (ft).

2. In cases where the potentiometric surface of the aquifer is above the screened interval of the well, the casing can contain a signifi-

cant amount of water above the screen. Two calculations are required to derive a well volume: (1) the volume of water in the casing above the screened interval and, (2) the volume of the casing plus the saturated annulus around the screen. It is convenient to calculate a volume per linear foot of (1) and (2) so that a total volume can be found simply by multiplying the height of each water column by its appropriate factor (gal/ft) and then adding the volumes together.

5.2.5 Record the amount of water in the well on the water sample data record.

5.2.6 Lower the pump in the well until the bottom (intake) of the pump is just at the top of the well screen.

5.2.7 Initiate pumping and purge the well.

a. Wells must be purged before sampling. Normally, 3 to 5 volumes of water (casing plus saturated annulus) are considered sufficient to remove stagnant water from the well and to ensure that the samples represent formation water. However, this is a general guideline and may need modifying according to site-specific conditions. For example:

   1. The well may be extremely slow to recharge. Depending on the recharge rate, only one evacuation to dryness may be practical.

   2. If the well is situated in permeable geological material with good recharge from the aquifer, it may be continually purged from natural groundwater flow. The only stagnant water in this case might be found in the unscreened portions of the well.

   3. Check field parameters (pH, temperature, and conductivity) in-line during purging and use them as a guideline for determining well water stabilization. Generally, the sample chemistry is sufficiently stable when the field parameters agree ±10% over two successive well volumes (see Reference 3.1.2).

b. The volume of water purged is most easily measured by the use of large, volume-calibrated collection vessels that may be dumped periodically.

c. The volume of purged water may also be monitored by use of a flow meter.

d. Time pumped, rate of pumping, and volume of water pumped should be noted.

5.2.8 Although surface sites require no pumping before sampling, the equipment must be thoroughly rinsed with sample, usually 2 to 3 L.

5.2.9 Use a bailer to collect the sample in wells that are too muddy, too shallow, or unable to be pumped for any other reason.

a. Remove bore volumes from the well by successive bailings taken from the top of the water column.

b. For sampling, lower the bailer to a depth so that the top of the bailer is at the top of the well screen.

c. Bail samples with an all-Teflon or stainless steel bailer equipped with a stainless steel cable on a reel, mounted on a tripod.

d. Lower the bailer to the depth of the well screen if the water is clean and the well has good recharge, or to the top of the water column if the well is muddy or has a slow recharge.

e. Depth may be measured with the counter on the bailer reel.

f. Empty the bailer into the sample bottle by either pouring it from the top or using a Teflon bottom-emptying device, whichever is more convenient.

5.3 MEASUREMENT OF PHYSICAL PARAMETERS

5.3.1 Procedures for calibrating the instruments used for measuring pH, conductivity, temperature, DO, and alkalinity are described in Procedure TE-060.

a. For optimum performance, the probes must be clean and the meters charged.

5.3.2 Place the required probes in their respective calibrating solutions and check for stability.

5.3.3 Calibrate the pH to the two pH values that most closely bracket the sample.

a. A post-sample calibration is often necessary if the pH or temperature is significantly different from what was assumed in the pre-sampling calibration.

b. Record on the water sample data record sheet the meter reading at calibration, the calibration temperature, and the time of calibration.

5.3.4 Near the end of the bore-volume pumping, connect the flow-through cell to the pump-outlet tube.

5.3.5 Remove the probes from their calibrating solutions and rinse them with deionized water.

5.3.6 Place the probes securely in the sample cell and allow to stabilize.

5.3.7 When the readings have stabilized and purging is complete, record the readings on the water sample data record sheet and in the sample logbook.

a. If necessary, recalibrate the probes at this time.

5.3.8 Physical parameters of surface waters are taken in situ where possible.

a. For inaccessible sites, use a peristaltic pump or bailer to obtain sample water in a flow-through cell containing the various probes.

b. Shelter the tubing and cell from the sun and extreme cold as much as possible to avoid a temperature variance.

5.4 SAMPLE PRESERVATION

5.4.1 The type of analysis for which a sample is being collected determines the type of equipment used. See Appendix 3 for analytical parameters, containers, preservatives, and holding times.

5.5 WATER SAMPLE DATA RECORD

5.5.1 Fill out the water sample data record (Appendix 1) in the following format:

a. Project: name of installation, facility, or locale.

b. Sample no.: see Procedure TE-071.

c. Station no./location: monitoring well no.; name of stream, pond, or other location where water sample was taken. If surface water was sampled, further description is appropriate (e.g., grid coordinates or reference points).

d. Sampling data: time the sampling at the Station No./location started and finished, outside temperature (°C), and a brief description of weather conditions (e.g., cloudy, breezy, light rain, etc.).

e. Groundwater:

1. number of completions done on a particular monitoring well;

2. elevation at the top of the casing - mean sea level elevation surveyed to a pre-established mark on the top of the well casing (not the protective casing) with the casing cover removed, measured to the nearest 0.01 ft;

3. depth to water from top of casing, also measured to nearest 0.01 ft;

4. well depth: measured from ground level to bottom of well screen measured to the nearest 0.01 ft;

5. well diameter: inside diameter;

6. well construction material: PVC, stainless steel, PTFE, etc.;

7. screened intervals: to nearest 0.1 ft from ground level:

   a. dual completion wells: U = upper interval, L = lower interval;

   b. three completion wells: U = upper interval, M = middle interval, L = lower interval;

8. volume purged: calculate the volume of water purged from the well;

9. sampling equipment used: stainless steel or Teflon bailer, bladder pump, etc.

f. Surface water:

1. depth of water at sample location to the nearest 0.01 ft;

2. type of sample: stream, pond, etc.;

3. sample method: grab, composite, etc.;

4. stream velocity measurements: check yes or no.

g. Sample information

Example:

Number of bottles	Bottle size/ description	Filtered	Pres/vol	Analyses requested
2	40 mL glass vial	No	0.2 mL 1-1 HCl	VOC
1	100 mL glass	No	0.5 mL 1-1 HCl	Petroleum hydrocarbons
1	250 mL PE	0.45 µm	2 mL 1-1 HNO_3	Metals

5.6 CHAIN OF SAMPLE CUSTODY

5.6.1 After labeling each bottle, compare the sample bottles with those recorded on the water sample data record sheet before leaving the sampling site.

a. Because of the nature of the data being collected, possession of the samples must be traceable from the time they are collected until their introduction as evidence in legal proceedings.

5.6.2 The procedure for completing the chain of sample custody form is found in TE-071.

5.7 SAMPLE SHIPMENT

5.7.1 Pack samples in coolers with Blue Ice or its equivalent at the time of collection. Deliver or ship the samples to the appropriate laboratory as soon as possible. Store other samples in iced coolers and prevent them from freezing until delivery or shipment to the laboratory.

5.7.2 Any sample shipped by common carrier or U.S. Postal Service must comply with the Department of Transportation Hazardous Materials Regulations, 49 CFR Part 172. The person offering such material for transport is responsible for ensuring such compliance. The Department of Transportation, Materials Transportation Bureau, Office of

Hazardous Materials, has determined that the hazardous materials regulations do not apply to the following preservation materials:

a. hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH $\geq$ 1.96);

b. nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH $\geq$ 1.62);

c. sulfuric acid (H_2SO_4 in water solutions at concentrations of 0.35% by weight or less (pH $\geq$ 1.15); and sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH $\leq$ 12.30).

5.8 DECONTAMINATION

5.8.1 Following a sample collection and preservation, decontaminate the equipment before sampling the next site to prevent cross-contamination. The following steps should provide adequate decontamination.

Note: If fine-grained sediments have been deposited on the filter paper and filtering apparatus, decontaminate the filter holder but precede step a. with a tap water wash containing laboratory detergent followed by tap water rinse.

a. Rinse all filter-holder surfaces thoroughly with deionized or distilled water and place clean filter papers in the unit. Discard disposable filters in an appropriate container.

b. Rinse the pump tubing with 1 to 2 L of deionized water. Wipe the outside of the tubing with clean paper towels. Pump all water out of the tubing.

c. Rinse the electrodes with deionized water and replace in their calibrating solutions.

d. To decontaminate other special equipment, thoroughly rinse and air dry the equipment in a clean place.

Appendix 1. Water Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

WATER SAMPLE DATA RECORD

PROJECT _____ FIELD NO. _____

STATION NO./LOCATION _____

SAMPLING DATA DATE _____ TIME: START _____ END _____

GROUNDWATER

NO. OF COMPLETIONS _____ DEPTH TO WATER FROM TOP OF CASING _____ WELL DEPTH _____

WELL CONSTRUCTION MATERIAL _____ WELL DIAMETER _____ WELL VOLUME _____

SCREENED INTERVAL(S) _____ VOLUME PURGED _____

SAMPLING EQUIPMENT USED _____

SURFACE WATER

DEPTH OF WATER AT SAMPLE LOCATION _____ TYPE OF SAMPLE _____

STREAM VELOCITY MEASUREMENTS ☐ YES ☐ NO SAMPLE METHOD _____

NO. OF BOTTLES	BOTTLE SIZE/DESCRIPTION	FILTERED	PRES./VOL.	ANALYSES REQUESTED

FIELD PARAMETERS

SAMPLE APPEARANCE: CLEAR ____ COLORED ____ SEDIMENT ____
(SOME NARRATIVE DESCRIPTION MAY BE NECESSARY)

1. SAMPLE TEMPERATURE _____

2. pH
TIME _____ MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
TIME OF LAST TWO-BUFFER CALIBRATION _____ BUFFER TEMPERATURE AT CALIBRATION _____
SAMPLE pH _____

3. SPECIFIC CONDUCTANCE
MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
BUFFER VALUE (μmho) _____ _____ SPECIFIC CONDUCTANCE AT 25°C _____
MEASURED VALUE (μmho) _____ _____ BUFFER TEMPERATURE AT CALIBRATION _____

4. CARBONATE AND BICARBONATE (ALKALINITY)
TEST KIT: NORMALITY OF TITRATION CARTRIDGE _____
PHENOLPHTHALEIN ALKALINITY _____ TOTAL ALKALINITY _____

5. PID (ppm) _____ INST. NUMBER _____ HEADSPACE _____

Appendix 2. Sample Label

UCN 17186 8/90

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 μ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other_____

Analysis _____

Field Information_____

_____

Collector _____

Appendix 3. Water Sample Preservation for inorganic, radionuclide, and physical parameters

Parameter	Volume (mL)	Container[a]	Preservation method	Holding time[b]
Physical Properties				
Color	50	P,G	Cool to 4°C	48 hours
Conductance	100	P,G	Cool to 4°C	28 days
Hardness	100	P,G	HNO_3 to pH<2	6 months
Odor	200	G Only	Cool to 4°C	24 hours
pH	25	P,G	None required	Analyze immediately
Residue				
filterable	100	P,G	Cool to 4°C	7 days
nonfilterable	100	P,G	Cool to 4°C	7 days
total	100	P,G	Cool to 4°C	7 days
volatile	100	P,G	Cool to 4°C	7 days
Settleable matter	1000	P,G	Cool to 4°C	48 hours
Temperature	1000	P,G	None required	Analyze immediately
Turbidity	100	P,G	Cool to 4°C	48 hours
Metals				
Dissolved	200	P,G	Filter on site, HNO_3 to pH<2	6 months
Suspended	200	P,G	Filter on site	6 months

Appendix 3. Continued

Total	100	P,G	HNO_3 to pH<2	6 months
Chromium	200	P,G	Cool to 4°C	24 hours
Mercury				
dissolved	100	P,G	Filter, HNO_3 to pH<2	28 days
total	100	P,G	HNO_3 to pH<2	28 days
Inorganics, Nonmetallics				
Acidity	100	P,G	Cool to 4°C	14 days
Alkalinity	100	P,G	Cool to 4°C	14 days
Bromide	100	P,G	None required	28 days
Chloride	50	P,G	None required	28 days
Chlorine	200	P,G	None required	Analyze immediately
Cyanides	500	P,G	Cool to 4°C, NaOH to pH>12, 0.6g Ascorbic acid	14 days
Flouride	300	P,G	None required	28 days
Iodide	100	P,G	Cool to 4°C	24 hours
Nitrogen				
Ammonia	400	P,G	Cool to 4°C, H_2SO_4 to pH<2	28 days
Kjeldahl, total	500	P,G	Cool to 4°C H_2SO_4 to pH<2	28 days

Appendix 3. Continued

Nitrate plus nitrite	100	P,G	Cool to 4°C, H_2SO_4 to pH<2	28 days
Nitrate	100	P,G	Cool to 4°C	48 hours
Nitrite	50	P,G	Cool to 4°C	48 hours
Dissolved oxygen				
Probe	300	G Bottle and Top	None required	Analyze immediately
Winkler	300	G Bottle and Top	Fix on site, store in dark	8 hours
Phosphorus				
Orthophosphate, Dissolved	50	P,G	Filter on site, cool to 4°C	48 hours
Hydrolyzable	50	P,G	Cool to 4°C, H_2SO_4 to pH<2	28 days
Total	50	P,G	Cool to 4°C, H_2SO_4 to pH<2	28 days
Total, dissolved	50	P,G	Filter on site, cool to 4°C, H_2SO_4 to pH<2	24 hours
Silica	50	P Only	Cool to 4°C	28 days
Sulfate	50	P,G	Cool to 4°C	28 days

Appendix 3. Concluded

Sulfide	500	P,G	Cool to 4°C, add 2 mL 1N Zinc Acetate plus NaOH to pH>9	7 days
Sulfite	50	P,G	None required	Analyze immediately

[a] (P) = plastic; of (G) = glass. For metals, polyethylene containers with a polypropylene cap (no liner) are preferred.

[b] Samples should be analyzed as soon as possible. The times listed are the maximum that samples may be held before analysis and still be considered valid.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-082 Page: 1 of 14 Revision: 1 Date: 02/03/92

SURFACE AND GROUNDWATER SAMPLING FOR ORGANIC PARAMETERS

1.0 PURPOSE

This procedure describes the methods and equipment used to ensure collection of a valid water sample for analysis of organic parameters. It applies to collection of samples from groundwater monitoring wells or surface waters.

The importance of proper monitoring well sampling cannot be overemphasized. Even when the wells are correctly located, constructed, and developed, special precautions must be taken to ensure that the sample collected is representative of the groundwater at that location.

Care is also needed to ensure that the sample is neither altered nor contaminated by the sampling and handling procedure. Chemicals can be sorbed and leached from improperly selected materials in the pumps. The effect of the pumping mechanism on the sample, the materials in the pump in contact with the water, and the nature of the delivery tubes should be examined as possible contaminant sources (Note: the use of dedicated, sample-line Teflon tubing for the pump eliminates much of the danger of cross-contamination in this procedure). All bottles and vials used in water sampling for analyses of organics must be cleaned to Environmental Protection Agency (EPA) standards. See Procedure TE-072 for cleaning instructions.

The water-sampling procedure is in accord with current technologies to provide a valid sample for organic analyses.

2.0 APPLICABILITY

This procedure applies to sampling both surface water and groundwater locations.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-072, Soil Sample Packaging and Preservation.

Approved by:

2/5/92 (Date)

C.A. Little 2/5/92 (Date)

3.1.2 N. Korte and P. Kearl, *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells*, 2d ed., GJ/TMC-08, U.S. DOE, Technical Measurements Center, Grand Junction Projects Office, 1985.

3.1.3 Barcelona et al., *Practical Guide for Groundwater Sampling*, Illinois State Water Survey, November, 1985.

3.1.4 Procedure TE-073, "Equipment Decontamination"

3.1.5 Procedure TE-071, "Sample Documentation"

3.2 APPENDICES

3.2.1 Appendix 1: Sample Volumes for Organic Analysis
3.2.2 Appendix 2: Preservation of Water Samples for Organic Analysis
3.2.3 Appendix 3: Sample Label
3.2.4 Appendix 4: Water Sample Data Record
3.2.5 Appendix 5: Chain of Sample Custody

4.0 EQUIPMENT AND MATERIALS

4.1 non-gas-contact bladder pump (with Teflon™ tubing);
4.2 compressor or compressed gas;
4.3 glass bottles with Teflon-lined caps (consult sampling plan for volume requirements);
4.4 glass vials with Teflon septa (40 mL);
4.5 deionized water;
4.6 Teflon bailer;
4.7 bailer tripod and reel;
4.8 concentrated or 1:1 H_2SO_4 (if required);
4.9 concentrated or 1:1 HCl (if required);
4.10 40% NaOH (if required);
4.11 insulated coolers;
4.12 Blue Ice™ or equivalent;
4.13 padding for packaging of samples;
4.14 labels for sample bottles;
4.15 marking pens;
4.16 water sample data record forms;
4.17 chain of sample custody forms.

5.0 PROCEDURE

5.1 SAMPLE COLLECTION METHODS

5.1.1 Samples are collected manually using either a bailer or non-gas-contact gas-operated pump. Whichever method is used, the success of the sampling program is dependent on the care taken in collecting the sample.

a. Surface water samples are collected either by the grab sampling method or with a bailer. In both cases, take care to avoid disturbing bottom sediments and excessive by agitating the sample.

b. Conduct groundwater sampling after well purging using either a bailer or a non-gas-contact pump. The equipment and procedures are described in Reference 3.1.2.

5.1.2 Purging

a. Wells must be purged before sampling. Normally, 3 to 5 volumes of water (casing plus saturated annulus) are considered sufficient to remove stagnant water from the well and to ensure that the samples represent formation water. However, this is a general guideline and may need modifying according to site-specific conditions. For example:

1. The well may be extremely slow to recharge. Depending on the recharge rate, only one evacuation to dryness may be practical.

2. If the well is situated in permeable geological material with good recharge from the aquifer, it may be continually purged from natural groundwater flow. The only stagnant water in this case might be found in the unscreened portions of the well.

3. Check field parameters (pH, temperature, and conductivity) in-line during purging and use them as a guideline for determining well water stabilization. Generally, the sample chemistry is sufficiently stable when the field parameters agree $\pm$10% over two successive well volumes (see Reference 3.1.3).

5.1.3 Bailing

a. Bail samples with an all-Teflon or stainless steel bailer equipped with a stainless steel cable on a reel, mounted on a tripod.

b. Lower the bailer to the depth of the well screen if the water is clean and the well has good recharge, or to the top of the water column if the well is muddy or has a slow recharge.

c. Depth may be measured with the counter on the bailer reel.

d. Empty the bailer into the sample bottle by either pouring it from the top or using a Teflon bottom-emptying device, whichever is more convenient.

5.1.4 Pumping

a. Pumping is more involved than bailing and may not be feasible during adverse field conditions (extreme cold, mud in wells, etc.).

b. If the sample-line Teflon tubing is dedicated to each well, it remains in the well.

c. Pull the tubing up before sampling and attach it to the pump with the Swagelok fitting at the downhole end.

d. Lower the pump down the hole with the stainless steel cable, Teflon air line, and sample line so that the intake (the bottom of the pump) is just above the well screen.

e. Start the pump cycle to deliver the sample to the surface.

f. Adjust the rate with the cycle time so that the flow is not violent yet the sample can be obtained quickly.

5.1.5 Sample Collection Technique

a. Collect samples directly in glass containers cleaned to EPA standards (see Procedure TE-072).

b. The collected sample must remain hermetically sealed until it is analyzed.

c. Preservatives should be added to the bottle before sample collection. See Appendix 2 for details.

d. Do not filter the samples.

e. The procedure for filling and sealing sample containers consists of the following steps:

1. Slowly fill the container to overflowing.

2. Place the cap or septum Teflon-side down on the convex water-sample meniscus.

3. Seal the sample with the screw cap.

4. Test the seal by inverting the sample container and lightly tapping the lid on a solid surface. The absence of entrapped air bubbles indicates a proper seal. If air bubbles are present, open the bottle, add additional sample water, and reseal. The sample must not contain any headspace.

f. The required number and type of bottles and volume of sample will be determined by the analyses to be done. Appendix 1 specifies required sample volume for a number of analytical parameters. These parameters will be established by the site project manager before field sampling.

5.1.6 Order of collection

a. The order in which samples are collected should ensure that (1) sufficient sample is available for the most critical analyses, and (2) the possibility of cross-contamination is minimized.

b. In general, a full suite of samples is collected in the following order:

1. volatile organics;

2. petroleum hydrocarbons;

3. semi-volatiles, PCBs/pesticides;

4. inorganics:

- unpreserved;

- preserved - if samples are to be analyzed for metals and nutrients.

For example, the bottle to which HNO_3 was added should be filled after the bottle which has NO_3 as an analyte; the bottle which has H_2SO_4 as a preservative should be filled after the bottle which has SO_4 as an analyte.

5.2 SAMPLE PRESERVATION

Just before collecting a sample, pretreat the appropriate container as required. Add preservative to the sample container prior to sample collection with a clean transfer pipet. Use a new pipet tip for each type of acid. See Appendix 2 for specified parameters and preservation methods.

5.3 SAMPLE IDENTIFICATION

5.3.1 Fill out the sample label (Appendix 3) for each bottle at the time of collection.

a. The label must include the 4-digit sample number, initials of the collector, time and place (site) of collection, analyses requested, and preservative used.

b. If sample security requires, place a seal over the cap and attach it so that breaking the seal is necessary to open the sample container.

5.3.2 Record all pertinent field information in the field logbook.

5.3.3 Fill out the water sample data record (Appendix 4) in the following format:

a. Project: name of installation, facility, or locale.

b. Sample no.: see Procedure TE-071.

c. Station no./location: monitoring well no.; name of stream, pond, or other location where water sample was taken. If surface water was sampled, further description is appropriate (e.g., grid coordinates or reference points).

d. Sampling data: time the sampling at the Station No./location started and finished, outside temperature (°C), and a brief description of weather conditions (e.g., cloudy, breezy, light rain, etc.).

e. Groundwater:

1. number of completions done on a particular monitoring well;

2. elevation at the top of the casing - mean sea level elevation surveyed to a pre-established mark on the top of the well casing (not the protective casing) with the casing cover removed, measured to the nearest 0.01 ft;

3. depth to water from top of casing, also measured to nearest 0.01 ft;

4. well depth: measured from ground level to bottom of well screen measured to the nearest 0.01 ft;

5. well diameter: inside diameter;

6. well construction material: PVC, stainless steel, PTFE, etc.;

7. screened intervals: to nearest 0.1 ft from ground level:

   a. dual completion wells: U = upper interval, L = lower interval;

   b. three completion wells: U = upper interval, M = middle interval, L = lower interval;

8. volume purged: calculate the volume of water purged from the well;

9. sampling equipment used: stainless steel or Teflon bailer, bladder pump, etc.

f. Surface water:

   1. depth of water at sample location to the nearest 0.01 ft;

   2. type of sample: stream, pond, etc.;

   3. sample method: grab, composite, etc.;

   4. stream velocity measurements: check yes or no.

g. Sample information

   Example:

Number of bottles	Bottle size/ description	Filtered	Pres/vol	Analyses requested
2	40 mL glass vial	No	0.2 Ml 1-1 HCl	VOC
1	100 Ml glass	No	0.5 mL 1-1 HCl	Petroleum hydrocarbons
1	250 mL PE	0.45 µm	2 mL 1-1 HNO_3	Metals

5.3.4 Fill out the chain of sample custody form (Appendix 5) and send the original with the samples to the laboratory.

a. Keep a copy for the sampling team.

5.3.5 Deliver the samples or ship to the laboratory as soon as possible by overnight courier.

5.4 SAMPLE SHIPMENT

5.4.1 Pack the sample bottles in coolers with prefrozen Blue Ice.

a. Use the frozen coolant packages to pad bottles from one another as well as to keep them cold.

b. Vials containing samples for analysis of volatile organics must be protected from freezing.

c. Sample bottles, frozen coolant packages, and padding material should fit tightly in the cooler.

d. Fill any space on top of the samples with packing material.

5.4.2 Put the chain of sample custody form in the cooler and seal the cooler.

5.4.3 Every effort must be made to ensure that the samples remain cool (4°C) until they reach the laboratory.

5.5 DECONTAMINATION

5.5.1 After all samples are collected and preserved, decontaminate the sampling equipment according to Procedure TE-073.

Appendix 1. Sample Volumes for Organic Analysis

Analytical parameter	Volume (mL)
Phenols	500 or 1000
Total organic carbon	25 (may be combined with phenol sample)
Total organic halogens	1000 (for quadruplicate analysis)
Pesticides/herbicides	1000
Coliform	250 (sterile bottle)
Volatile organics	40 (septum vial)
Acids	1000 (may be combined with base/neutrals)
Base/neutrals	1000
PCBs	1000 (may be combined with pesticide/herbicide sample)

Note: these volumes may be modified at the request of the analytical laboratory.

Appendix 2. Preservation of Water Samples for Organic Analysis

Parameter	Container[a]	Preservation method	Holding time extraction/analysis
Cyanide	P,G	Cool to 4°C, 40% NaOH to pH >12, 0.6 g ascorbic acid	/14 days
Coliform, fecal and total	P,G	Cool to 4°C	/6 h
Oil and grease	G	Cool to 4°C, H_2SO_4 to pH <2	/28 days
Organic carbon	P,G	Cool to 4°C, H_2SO_4 to pH <2	/28 days
Phenols	G Only	Cool to 4°C, H_2SO_4 to pH <2	7/40 days
Total organic halogen and purgeable halocarbons	G, Teflon-lined septum	Cool to 4°C	/14 days
Purgeable aromatics	G, Teflon-lined septum	Cool to 4°C, HCl to pH <2	/14 days
Acrolein and acrolonitrile	G, Teflon-lined septum	Cool to 4°C	/14 days
Pesticides	G, Teflon-lined cap	Cool to 4°C, pH 5 to 9	7/40 days
Benzidines	G, Teflon-lined cap	Cool to 4°C	7/40 days
Phthalate esters	G, Teflon-lined cap	Cool to 4°C	7/40 days
Nitrosamines	G, Teflon-lined cap	Cool to 4°C, store in dark	7/40 days

Appendix 2. Continued

PCBs	G, Teflon-lined cap	Cool to 4°C, pH 5 to 9	7/40 days
Nitroaromatics and isophorone	G, Teflon-lined cap	Cool to 4°C	7/40 days
Polynuclear aromatic hydrocarbons	G, Teflon-lined cap	Cool to 4°C, store in dark	7/40 days
Haloethers	G, Teflon-lined cap	Cool to 4°C	7/40 days
Volatile organic	G, Teflon-lined cap	Cool to 4°C, add 0.2 mL 1:1 HCl to pH<2	/14 days

[a]P = polyethylene; G = glass.

Appendix 3. Sample Label

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 μ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other_____

Analysis _____

Field Information_____

_____

Collector _____

UCN 17186 (8/90)

Appendix 4. Water Sample Data Record

OAK RIDGE NATIONAL LAB
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION,CO 81502
(303) 248-6209
(FTS) 326-6209

WATER SAMPLE DATA RECORD

PROJECT _____ FIELD NO. _____

STATION NO./LOCATION _____

SAMPLING DATA DATE _____ TIME: START _____ END _____

GROUNDWATER

NO. OF COMPLETIONS _____ DEPTH TO WATER FROM TOP OF CASING _____ WELL DEPTH _____

WELL CONSTRUCTION MATERIAL _____ WELL DIAMETER _____ WELL VOLUME _____

SCREENED INTERVAL(S) _____ VOLUME PURGED _____

SAMPLING EQUIPMENT USED _____

SURFACE WATER

DEPTH OF WATER AT SAMPLE LOCATION _____ TYPE OF SAMPLE _____

STREAM VELOCITY MEASUREMENTS ☐ YES ☐ NO SAMPLE METHOD _____

NO. OF BOTTLES	BOTTLE SIZE/DESCRIPTION	FILTERED	PRES./VOL.	ANALYSES REQUESTED

FIELD PARAMETERS

SAMPLE APPEARANCE: CLEAR ____ COLORED ____ SEDIMENT ____

(SOME NARRATIVE DESCRIPTION MAY BE NECESSARY)

1. SAMPLE TEMPERTURE _____

2. pH
TIME _____ MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
TIME OF LAST TWO-BUFFER CALIBRATION _____ BUFFER TEMPERATURE AT CALIBRATION _____
SAMPLE pH _____

3. SPECIFIC CONDUCTANCE
MEASUREMENT CONDITIONS: IN-SITU ☐ OPEN CONTAINER ☐ AIR EXCLUSION ☐
BUFFER VALUE (μmho) _____ _____ SPECIFIC CONDUCTANCE AT 25°C _____
MEASURED VALUE (μmho) _____ _____ BUFFER TEMPERATURE AT CALIBRATION _____

4. CARBONATE AND BICARBONATE (ALKALINITY)
TEST KIT: NORMALITY OF TITRATION CARTRIDGE _____
PHENOLPHTHALEIN ALKALINITY _____ TOTAL ALKALINITY _____

5. PID (ppm) _____ INST. NUMBER _____ HEADSPACE _____

UCN 17190 (9/90)

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address:
P.O. Box 2567
Grand Junction, CO 81502

Street Address:
2597 B-3/4 Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody

Page _____ of _____

Date _____

Project No. _____ Project Name _____

Sample No.	Sample Type	Container	Filtered	Preservative	Analysis	Collection date/time	Remarks

Relinquished By	Date	Department

Received By	Date	Dept.

Company Name _____

Received By _____

Date _____

Distribution: Original accompanies samples, copies to relinquishers.

UCN-17189 (Rev. 3/91)

Appendix 5. Chain of Sample Custody

SURFACE AND GROUNDWATER SAMPLING FOR ORGANIC PARAMETERS

Number: TE-082
Page: 14 of 14

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-090 Page: 1 of 3 Revision: 0 Date: 10/01/90

MEASUREMENT OF HYDRAULIC CONDUCTIVITY USING A BAIL TEST

1.0 PURPOSE

This procedure describes the equipment, operation, and data interpretation involved in performing a bail test on a groundwater monitoring well. A bail test is a single-well hydraulic test to measure the hydraulic conductivity of an aquifer.

2.0 APPLICABILITY

The procedure applies to all employees involved with hydrologic investigations. The staff hydrologist trains and field checks any technician assigned to performing bail tests; the project technical supervisor reviews the calculations and results of the bail tests.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 R. A. Freeze and J. A. Cherry, Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, pp. 339-341.

3.1.2 M. J. Hvorslev, Time Lag and Soil Permeability in Groundwater Observations, Bul. 36, U.S. Army Corps of Engineers, 1951.

4.0 DEFINITIONS

4.1 HYDRAULIC CONDUCTIVITY: A constant of proportionality which relates the groundwater velocity (Darcian velocity) to the hydraulic gradient.

4.2 BCL: Below casing level.

5.0 EQUIPMENT AND MATERIALS

5.1 Nitrogen bottle;

5.2 Water level indicator;

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

5.3 Air hose with nozzle, bottle attachment fitting, and air line;

5.4 Crescent wrench;

5.5 Stopwatch.

6.0 PROCEDURE

Two individuals are required to obtain the measurements H (initial water level), H_o (water level at time t = 0), h (actual head readings during the test), e (base of natural logarithms ~ 2.718), and T_o (basic time lag). These measurements are used in the formula presented below for determination of the normalized recovery rate:

$$\frac{H-h}{H-H_o} = e^{-t/T_o} \qquad (1)$$

Once T_o is determined from Equation (1), hydraulic conductivity (K) is calculated using the following formula, assuming that the ratio of L (piezometer intake length) to r (borehole radius) is greater than 8 to 1.

$$K = \frac{r^2 \ln (L/r)}{2LT_o} \qquad (2)$$

6.1 Measure the standing water level in the well before beginning the test. The water level should be measured from the top of the well casing and recorded as feet below casing level (e.g., 9.5 ft BCL).

6.2 Attach the air hose with nozzle to the nitrogen bottle (Only nitrogen should be used in the procedure because compressed air or oxygen will affect the chemistry of the well water). Insert both the air hose (calibrated in feet to indicate approximate depth) and the air line into the well.

6.3 Turn the nitrogen on to the air hose and air-lift the water out of the well bore. Turn the nitrogen off and quickly remove the air hose from the well. As soon as possible, measure the depth to water using the water-level indicator. Record this value as H_o in the field book and at the same time start the stopwatch. As quickly as possible, continue measuring the water level and the time at which the measurement is made until the well recovers to the initial water level. If recovery is slow, readings can be spaced at the appropriate time interval where significant pressure changes occur. During the testing, one person should be reading and orally relaying the data to another person who records it in a field notebook.

6.4 The data from the bail test are now entered into individual data files on the computer. The first line of the data file contains H and H_o, respectively. The following lines contain time versus the head value recorded during the bail test. The program used to calculate the bail-test data accepts free format data input.

6.5 The computer program BAIL is an interactive program which calculates the hydraulic conductivity of an unconfined aquifer from bail test data. The program will plot the log of the normalized drawdown versus time. Bad data points can easily be eliminated to obtain an accurate straight-line fit. Well completion information, along with the proper units, are then entered and the hydraulic conductivity calculated. All of the above information should be recorded in a project notebook.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-091 Page: 1 of 2 Revision: 0 Date: 10/01/90

FIELD DETERMINATION OF GRAVIMETRIC MOISTURE

1.0 PURPOSE

This procedure briefly describes the method of determining the amount of moisture in soil, sediment, and rock samples.

2.0 APPLICABILITY

This procedure applies to field determination of the gravimetric moisture content of dry or wet soil, sediments, or rock samples.

3.0 DISCUSISON

Gravimetric determination of the moisture content of soil or rock is based on field-weighing the sample, drying it in an oven, and then reweighing the sample to determine the percentage of water. To ensure accuracy, weigh the sample in the field as soon after collection as possible to prevent moisture loss. Place the sample in a preweighed, prelabeled sample container with an airtight lid immediately upon collection and weigh it as soon as possible using a top-loading balance. For samples with low moisture content, the accuracy of the balance can make considerable difference; therefore, use a balance with a range of 0 to 4000 g and a readability of 0.01 g.

4.0 EQUIPMENT AND MATERIALS

4.1 Top-loading electronic balance (preferably with a weighing range of 0 to 4000 g, readability of 0.01 g);

4.2 wide-mouth sample bottles with airtight lids;

4.3 drying oven with thermostatic control;

4.4 sample labels.

Approved by:

Mic Peeta 9/19/90 (Date)

Craig A Little 9/19/90
C.A. Little (Date)

5.0 PROCEDURE

5.1 Prepare, label, and weigh sample containers (including the air tight lid).

5.2 Collect the sample and immediately place it in a prepared container.

5.3 Weigh the sample-filled container as soon as possible with a top-loading balance.

5.4 Deliver the sample-filled containers to the laboratory for oven drying. The temperature of the oven should be set at 105° C. Oven temperatures should not exceed 110° C, since higher temperatures can drive off water in the mineral structure of the sediment or rock and distort the accuracy of the test.

5.5 After drying for a minimum of 24 hours, reweigh the samples. Take care to weigh not only the bottle and sample, but also the lid. Samples should be weighed as soon as possible after cooling to room temperature.

6.0 DOCUMENTATION

Prelabel bottles and lids with the appropriate sample number. A description of the sample should be included in the sample log book and retained as a permanent record (TE-071).

All data obtained from the gravimetric moisture determination procedure should be recorded in a field notebook and retained as a permanent record.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-092 Page: 1 of 4 Revision: 0 Date: 10/01/90

DETERMINING PERMEABILITY USING A PACKER TEST

1.0 DISCUSSION

A packer test determines the approximate values of permeability of individual strata penetrated by drill borings. The purpose of this procedure is to describe the equipment and the operation of the equipment involved in conducting a packer test.

2.0 APPLICABILITY

This procedure applies to all PAG employees involved with hydrologic investigations.

3.0 RESPONSIBILITY

The staff hydrologist trains and field checks any technician assigned the duty of performing the packer test. The project technical supervisor reviews the calculations and results of the packer test.

4.0 OTHER DOCUMENTS

4.1 REFERENCES

4.1.1 Seminar for Drillers and Exploration Managers, conducted by the University of Missouri at Rolla in Orlando Fla., February 25, 1981.

4.1.2 Earth Manual: A Water Resource Technical Publication, 2d ed. U.S. Dept. of the Interior, 1974.

4.2 APPENDICES

4.2.1 Pump-in Borehole Test Form

5.0 EQUIPMENT AND MATERIALS

5.1 pump;

Approved by:

Nic Kato 9/25/90 (Date)

Craig Little 9/26/90 C.A. Little (Date)

5.2 water meter;

5.3 pressure gauges;

5.4 conductor pipe;

5.5 dual packer system;

5.6 common valves and fittings;

5.7 short pressure hoses;

5.8 water level indicator.

6.0 CONDUCTER PIPE CALIBRATION

Calibrate the conductor pipe by assembling about 100 ft of pipe horizontally on the ground. Regulate flows by opening and/or closing valves at each end of the conductor pipe. Check at least three flow rates in the range of 0 gallons per minute (gpm) to the flow capacity of the conductor pipe and pump and develop a calibration curve of flow pressure loss versus flow rate.

7.0 WATER CHARACTERISTICS

The packer test described below is a pumping-in type of test; that is, it measures the amount of water accepted by the ground through the open bottom of a pipe or through an uncased section of the hole. Unless clear water is used, the test is invalid and test data may be grossly misleading. The presence of even small amounts of silt or clay in the added water will result in a plugging of the test section and give permeability results that are too low. Using a settling tank or a filter, make an effort to assure that only clear water is used. The temperature of the added water should be higher than the groundwater temperature to prevent creating air bubbles in the ground which may greatly reduce its acceptance of water.

8.0 PROCEDURE

8.1 Determine the test depth (and packer spacing if a dual packer is used).

8.2 Select the number of conductor pipe sections to give the correct depth of the setting.

8.3 Lower the packers into the open borehole and expand them against the side of the borehole. (NOTE: Usually an effective packer pressure of about 30

pounds per square inch (psi) above the maximum test water pressure is adequate to seal pneumatic packers).

8.4 Record header information on the data sheet.

8.5 Make a water level measurement in the conductor pipe to determine the formation pressure. Check the water level several times until a stable value is obtained. Record the initial water level on the data sheet.

8.6 With the valve to the borehole closed, start pumping water.

8.7 Record the initial gauge pressure on the data sheet.

8.8 Carefully and slowly open the valve that regulates water flow to the borehole.

8.9 Regulate the flow until the gauge pressure can be held relatively constant. The pressure may fluctuate as a result of the pump (especially common in piston-type pumps). Record the minimum and maximum pressure readings in the gauge pressure column on the data information sheet.

8.10 Check clock time and start recording the water meter readings at 1 min intervals (or as specified).

8.11 Compare the fluid flow rate at a specified time interval with the previous time interval. If the difference is less than 5%, then the test at that pressure level can be terminated. If the difference is greater than 5%, continue to pump at constant pressure until the difference becomes less than 5% (or as specified) or until 15 min of pumping time elapses (or the specified test duration is reached).

8.12 Perform the test two more times, once at a higher and once at a lower pumping pressure.

(From References 4.1.1 and 4.1.2).

9.0 DOCUMENTATION

Record all data from the packer test on a data information sheet (Appendix 1). This form should be filled out during the test and retained as a permanent record.

Appendix 1. Pump-in Borehole Test Data Sheet

PUMP-IN BOREHOLE TEST

PROJECT NAME_____ PROJECT NO._____

BOREHOLE NO._____ INCREMENT DRILLED _____

READING MADE BY_____ DATE _____

SWIVEL ELEVATION_____

TOP PACKER SET_____ BOTTOM PACKER SET_____

TYPE OF PACKER _____ TEST INCREMENT _____

GROUNDWATER LEVEL MEASUREMENTS _____

APPROVAL (TECHNICAL SUPERVISOR)_____

READING NO.	CLOCK	ELAPSED TIME	FLUID METER	FLOW RATE	GAUGE PRESSURE

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-093 Page: 1 of 7 Revision: 0 Date: 10/01/90

PUMPING TEST IN AN UNCONFINED AQUIFER

1.0 PURPOSE

The principle for an aquifer test is: water is pumped from a well for a certain time period at a certain rate. The effect of this pumping on the water table is measured at the pumping well and selected observation wells in the vicinity. Although pumping tests measure several pertinent hydraulic parameters from a variety of different aquifers, the following discussion will be limited to determining the transmissivity and storativity in an unconfined aquifer.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 F.G. Driscoll, Groundwater and Wells, Johnson Division, St. Paul, 1986.

2.1.2 N. Korte and P. Kearl, Procedure for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells, 2d ed., GJ/TMC-08 (85), U.S. DOE Technical Measurements Center, Grand Junction, Colo., 1985, pp. 15, 16-18, 29-30.

2.1.3 G.P. Kruseman and N.A. DeRitter, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, The Netherlands, 1979.

2.1.4 R.W. Stallman, "Aquifer Test Design, Observation and Data Analysis, Techniques of Water Resources Investigations of the U.S. Geological Survey, Chap. B1, Government Printing Office, Washingtin, D.C., 1971.

2.1.5 J.A. Cherry, "Migration of Contaminants in Groundwater at a Landfill: A Case Study," Journal of Hydrology, Vol. 63. No. 1/2 (special issue), 1983.

2.1.6 J.A. Cherry and P.E. Johnson, "A Multilevel Device for Monitoring in Fractured Rock," Groundwater Monitoring Review, Summer, 1982, pp. 41-44.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

3.0 PROCEDURE

The most common procedure for determining the hydraulic properties of an aquifer is to:

1. calculate the expected response in the aquifer by letting the hydraulic properties be variable and taking into account the hydraulic and physical boundaries;

2. compare the observed response with the computed response;

3. adapt those hydraulic properties that were assumed in the computed response and match the observed response.

3.1 RESPONSE PREDICTION

Identifying hydraulic and physical boundaries is part of the response prediction necessary to check the assumptions upon which the aquifer analysis is based. In addition to the boundary identification process (which is part of the aquifer characterization), the second component for response prediction includes estimating aquifer hydraulic parameters (i.e., transmissivity and storativity).

Since the type of aquifer for this study is unconfined, the first step of identifying the type of aquifer as confined or semi-confined can be disregarded. Specific information necessary for the correct analysis of the aquifer includes:

- depth to the water table;
- thickness;
- areal extent;
- stratification; and
- nearby aquifer discontinuities caused by changes in lithology, geologic structure, or by incised streams and lakes.

Estimating the aquifer's hydraulic properties is not only important to anticipating the response of an aquifer due to pumping, but is also useful when determining the appropriate pumping rate and observation well placement. Methods for estimating the transmissivity and storage include the following:

- review the literature for previous tests performed in the area;

- use published values based on the lithology of the aquifer; and

- perform single-well tests on existing wells to measure the hydraulic conductivity and estimate the specific yield.

3.2 TEST DESIGN

A successful pumping test includes properly designed pumping and observation wells, sufficient duration of pumping, and compensation for barometric fluctuations and other changes which could affect the water levels during the tests. A description of the well design and construction (i.e., gravel pack, screen slot size, grouting, etc.), is in TE-110 and TE-111, which were adapted from methods described in Reference 2.1.1 and Reference 2.1.2. Major items in this procedure include:

1. The pumping well must be equipped with reliable power, pump, and discharge-control equipment.

2. The well diameter should accommodate the pump with proper clearance for installation and efficient operation.

3. The water discharge must be carried away from the test area so it cannot return to the aquifer during the test.

4. The well head and discharge lines should be accessible for installing discharge, regulating, and monitoring equipment.

5. It should be possible to measure depth to water in the pumping well before, during, and after pumping.

One of the most important aspects of the pumping well design is the penetration depth and length of well screen. This criterion is not only critical to the pumping well design but has a direct influence on the spacing of the observation wells. Ideally, the pumping well should be fully penetrating and screen the entire length of the aquifer. This type of well design results in horizontal flow in the aquifer during pumping, which greatly simplifies the aquifer analysis.

Another important advantage to a fully penetrating pumping well is that drawdowns measured even at short distances can be used for the analysis. Close spacing of observation wells is especially important in lower permeable aquifers where steep cones of drawdown surrounding the pumping well will only propagate a short distance. Achieving a sufficient amount of drawdown in the observation well is an important consideration. Experience has shown that at least 2 ft of drawdown in the observation well obtains a drawdown

curve of sufficient accuracy for analytical purposes. Therefore, based on the expected response of the aquifer, an observation well should be located near enough to the pumping well to allow a sufficient amount of drawdown.

In many cases, conditions may not allow installing a well screen over the entire thickness of the aquifer. If the length of the well screen is considerably less than the saturated thickness of the aquifer, it induces a distorted drawdown pattern near the well due to vertical flow components. Drawdown readings from wells close to such a partially-penetrating well may lead to incorrect results, and rather complicated correction methods have to be applied before these readings can be used in the test data analysis. These difficulties can be avoided by placing the observation wells away from the pumping well where these abnormal effects do not appear. As a general rule, the nearest observation wells should be placed at a distance at least equal to the thickness of the aquifer (Reference 2.1.3), so that one can assume that flow is essentially horizontal.

Other design considerations for observation wells include:

1. Response of all observation wells to changing water levels should be tested by injecting a known volume of water and measuring the subsequent decline in water level. The initial rise of water should dissipate within a few minutes if the observation well is to satisfactorily reflect change of head in the aquifer during the test.

2. Total depth, diameter, and screened interval should be recorded.

3. A minimum of two observation wells are required for the test. Preferably, two of the observation wells should be placed along the same radial line from the pumping well. This arrangement allows for possible steady-state determinations of the aquifer's transmissivity (assuming an isotropic aquifer) if the duration of the pumping test is sufficient.

3.3 DURATION OF PUMPING

The length of a pumping test is controlled by the type of aquifer and the degree of accuracy required. In unconfined aquifers, the propagation of hydraulic head loss is rather slow because the release from storage water is mainly due to dewatering of the zone through which the water is moving and only partly due to the compressibility of water and aquifer material in the saturated zone. If steady-state conditions are required for the analysis, a common pumping duration of three days may be required.

For transient state analysis, a lesser pumping duration is required. The amount of time is dependent upon the hydraulic properties of the system, the

spacing of the observation wells, and the amount of drawdown necessary to obtain an accurate analysis. For this type of test, it is recommended that the on-site hydrologist continually plot the data on log-log graph paper and match the data to the appropriate type curve until enough data has been collected. Commonly, the plotted data will uniquely match a type curve and additional days of pumping will only yield data making up a minor portion of the drawdown versus time curve.

3.4 DATA COLLECTION

Discharge and water-level measurements are the key parameters to be collected during a pumping test. Discharge from a well may be constant or variable during the test. The most simple approach, in terms of data analysis, is to maintain a constant discharge rate. To do so, install a valve on the discharge line and partially close it before starting pumping.

As the water level in the pumped well declines, discharge tends to decrease. Discharge is maintained constant by progressively opening the valve, a procedure which keeps the total head against the pump constant.

Several methods are available to measure discharge from a pumping well. The most important factor controlling the measurement is the quantity: a simple bucket will suffice for small discharge volumes (less than 100 Lpm) while large volumes may require use of a weir similar to those used for surface-water flow measurement. The easiest and most direct method of measuring discharge is an in-line water meter. Various types of meters are available depending on the amount of discharge and the degree of accuracy required. Other methods for measuring the discharge of a pumping well include:

- container or calibrated bucket (i.e., an oil drum);
- orifice;
- orifice bucket (Reference 2.1.3);
- jet-stream method;
- flumes.

The frequency of measuring water levels decreases as the duration of the test increases. During the initial stage of the test, the water level in the pumping well changes rapidly. This fluctuation requires constant monitoring of the discharge until the rate of water level decline decreases. The interval between readings can gradually increase as the pumping continues. By plotting the

data on log-log paper, one can easily determine the required frequency of measurement.

Several methods are also available for water level measurements including:

- steel tape and chalk;
- water level indicator;
- Stephen Type F recorder; and
- pressure transducers.

Pressure transducers are by far the easiest and most accurate method to obtain water level measurements. Used in conjunction with a scanner/ recorder, transducers can take large numbers of measurements. This is especially important in the earlier stages of testing when water levels change rapidly. Unfortunately, pressure transducers are the most expensive of the water level measuring options.

Reference 2.1.4 outlines important information requiring documentation during a pumping test. The accuracy and tolerance of measurements generally considered acceptable for a pumping test are:

- pumping well discharge ($\pm$ 10%);
- water level measurement ($\pm$ 0.01 ft);
- distance from pumping well to each observation well ($\pm$ 0.5%);
- synchronous time ($\pm$ 1% of time since pumping initiated);
- description of measuring points;
- elevation of measuring points ($\pm$ 0.01 ft);
- vertical distance between measuring point and land surface ($\pm$ 0.1 ft);
- total depth of all wells ($\pm$ 1%);
- depth and length of screened intervals of all wells ($\pm$ 1%);
- diameter, casing type, screen type, and method of construction of all wells; and

- location of all wells in plan view relative to land survey.

Much of this information can be recorded in a field notebook, especially if a scanner-recorder is storing time and water level data during the test. Discharge records should also be documented in the field notebook.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-094 Page: 1 of 4 Revision: 1 Date: 02/03/92

WATER LEVEL MEASUREMENT

1.0 PURPOSE

This procedure describes the steps for taking water level measurements from boreholes, piezometers, or monitoring wells.

2.0 APPLICABILITY

This procedure applies to the water level measurements used to construct a single potentiometric surface map.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-073, Equipment Decontamination.

4.0 EQUIPMENT AND MATERIALS

4.1 Steel tape
4.2 Electric sounder
4.3 Reflection sounder
4.4 Transducer
4.5 Airline
4.6 Field logbook

5.0 FREQUENCY

5.1 Collect water level measurements at a given site within a 24-h period.

5.1.1 This practice is adequate if the change is small over that period of time.

5.2 Under the following conditions, take all measurements within a shorter time interval:

Approved by:

2/5/92 (Date)

Craig A. Little 2/5/92 (Date)
C.A. Little

5.2.1 Atmospheric pressure change;

5.2.2 Tidally influenced aquifers;

5.2.3 Aquifers affected by river stage, impoundments, and/or unlined ditches;

5.2.4 Aquifers stressed by intermittent pumping of production wells;

5.2.5 Aquifers being actively recharged due to precipitation.

6.0 PROCEDURE

6.1 Use a water level measuring device accurate to 0.01 ft.

6.1.2 Check the accuracy of the electric sounder tape against a steel tape before each use.

a. Unroll 20 ft of the electric sounder tape and a steel tape next to each other.

b. Secure both tapes at the 20 ft mark; pull tight on the other end of both tapes.

c. If the measuring point of the electric sounder tape does not fall within 0.01 ft of the 0.0 mark on the steel tape, replace the electric sounder tape.

6.2 Establish a reference measuring point.

6.2.1 Place a survey mark on the north side of the well-casing riser pipe.

a. Often the lip of the riser pipe is not flat.

6.2.2 Locate another measuring reference on the grout apron.

6.2.3 Document the measuring point in the field logbook and on the field form.

6.3 Prior to measurement, allow water levels in piezometers and monitoring wells to stabilize for a minimum of 24 hours after well construction and development.

6.3.1 In low yield situations, recovery may take longer.

6.4 Measure water level.

6.4.1 Remove locking well cap and note the location, time of day, and date in the field logbook or on the appropriate field form.

6.4.2 Remove the well casing cap.

6.4.3 If required by site-specific conditions, sniff the headspace of the well with a photoionization or flame ionization detector to determine the presence of volatile organic compounds and record the results in the field logbook.

6.4.4 Lower an electric water level measuring device or its equivalent, for example, permanently installed transducers or airline, into the well until the water surface is reached.

6.4.5 Measure the distance from the water surface to the reference measuring point on the well casing and record the reading in the field logbook.

a. Alternatively, note that water level measurement is from the top of the steel casing, from the ground's surface, or from some other position on the well head.

6.4.6 Measure the total depth of the well at least twice to confirm and record in the field logbook or on the log form.

6.4.7 Remove all downhole equipment, replace the well casing cap, and lock the steel caps.

6.4.8 Rinse all downhole equipment and store for transport to next well.

6.4.9 Clean up and restore the site if necessary.

a. Note any physical changes such as erosion or cracks in the protective concrete pad or variations in the total well depth in the field logbook.

6.5 Decontaminate equipment according to TE-073.

6.6 The field log should contain:

6.6.1. The log date: the day water levels are being measured;

6.6.2. Comments: any information that field personnel deem applicable;

6.6.3. Log time;

6.6.4. Depth to water: the water level measurement in feet;

6.6.5. Measuring point: marked measuring point on PVC riser pipe, protective steel casing, or concrete pad surrounding well casing from which all water level measurements for individual wells are measured, thus providing consistency in future water level measurements.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-100 Page: 1 of 9 Revision: 0 Date: 10/01/90

DRILLING LOG PREPARATION AND WELL CONSTRUCTION DOCUMENTATION

1.0 PURPOSE

This procedure outlines the information included on a standard form when logging core holes or boreholes used for completing groundwater monitoring wells. The intent of the procedure is to ensure uniform information on forms.

2.0 OTHER DOCUMENTS

2.1 APPENDICES

2.1.1 Appendix 1: Well summary information sheet

2.1.2 Appendix 2: Rock structural classification

2.1.3 Appendix 3: Fracture intensity

2.1.4 Appendix 4: Rock strength classification

2.2 EXHIBITS

2.2.1 Exhibit 1: Unified soil classification system

3.0 EQUIPMENT

- Munsell color chart (for soils);
- G.S.A. rock color chart;
- magnifying lens;
- ball-point pen (permanent ink);
- total depth indicator;
- water level indicator;

Approved by:

Mi Kuta 1/8/91 (Date)

Craig A Little 1/8/91
C.A. Little (Date)

- engineer scale or ruler;
- appropriate soil classification chart; and
- well summary information form (Appendix 1).

4.0 PROCEDURE

4.1 Record preliminary information on the well summary information form (Appendix 1): name, date, project, hole number, location, rig type, auger/bit-size, and sample type (split spoon, Shelby tube, core, etc.).

4.2 Depict textures and textural changes (including fractures, fracture zones, fossil zones, lithologies, etc.) either as sharp discontinuities or as gradational changes. Where uncertainty exists, draw the boundary line with dashed, wavy, or slanted lines.

4.3 Record sample interval or core runs, depth, and number of blows per sample interval (or, if applicable, per unit of length) or core-box number in the appropriate columns.

4.4 The description and comments column should contain textural, lithologic, and color descriptions of the core/auger cuttings and sample intervals. Descriptions of unconsolidated material should include the unified soil classification names and group symbols (Exhibit 1), plus any other significant geologic terminology, and comments on the water characteristics (i.e., where water first appears in the section, which soils are saturated, etc.). The water level indicator may be used as an aid in determining water levels.

4.5 Record both the grain size and the specific scale used to estimate grain size (either the Wentworth scale or the unified soil classification scale). Record the consistency or strength of clays and the relative densities of sands. Record any soil or rock core color and color changes using the Munsell color chart or the G.S.A. rock-color chart.

4.6 Rock core logs shall have a record of all pertinent geologic characteristics (i.e., rock name, color, grain size, etc.). In addition, the rock structural classification (Appendix 2), the fracture intensity (Appendix 3), and the rock strength classification (Appendix 4) must be documented on the well summary information form.

4.7 Note any modifications in groundwater monitoring well construction while completing the graphic log column. Planned depths do not always correspond with the actual depths obtained when using the depth indicator. When that situation occurs, the well summary information form must be neatly

redone as soon as possible after the hole is completed and both the original version and the new version submitted for data verification. After the field version has been redone (if applicable), both versions should be presented to the project manager or qualified staff geologist, who verifies that the data presented on the form are sufficient and correct and so signifies by signing and dating the appropriate space on the form.

Appendix 1. Well summary information sheet

ornl OAK RIDGE NATIONAL LABORATORY

Well Summary Information

Prepared By _____ Date _____ Page ___ of ___

Hole No. _____ Casing Elev. _____ Ground Elev. _____ Location _____

Total Depth _____ Number of Completions _____ Rig Type _____

Auger Size _____ Sample Type _____

Project _____ Date Verified By _____ Date _____

DEPTH (FEET)	BLOWS/6"	SAMPLE INTERVAL	WELL CONSTRUCTION	LITHOLOGY	DESCRIPTION

UCN17192 (9/90)

Appendix 2. Rock structural classification

Structural classification	Typical geologic classification	Common identification characteristics	Coring characteristics (%) NX[a] or larger		BX[b] or smaller	
			Recovery	Rock quality designation	Recovery	Rock quality designation
Class 1- hard sound rock slightly jointed Unweathered	Crystalline igneous or metamorphic rocks	Rings when struck with bar. Does not disintegrate upon exposure nor slake in water.	95 or More	85 or More	85 or More	75 or More
	highly siliceous sedimentary rocks	Joints or fractures generally unweathered, less than 1/8 in. wide, and no closer than 3 ft apart in exposure. Sharp, hard fracture surface when broken.				
Class 2- medium-hard rock Moderately sound Moderately jointed Slightly weathered	Same as class 1 Moderately siliceous sedimentary rocks Certain calcareous rocks	Characteristics same as class 1 except joints or fractures may be 1/4 in. wide and slightly weathered. Generally no closer than 2 ft apart in exposure. Piece can be broken off with hammer and the fracture surface iron-stained.	70	50 - 85	50	40

Appendix 2. Continued

Class 3- intermediate rock Moderately to highly jointed Moderately weathered	Same as class 2 Most sedimentary rock other than compaction shales Most calcareous rocks are not porous	Gives dull sound when struck with bar. Does not disintegrate upon exposure. Unweathered pieces do not slake in water. Joints or fractures may be up to 1 in. wide. Contains weathered material. Spaced as close as 8 ft in exposure. Piece can be broken off with hammer on weathered surface.	50	35 - 50	35	25
Class 4- soft rock Highly jointed Extensively weathered Porous	Weathered rocks of class 3 Compaction sedimentaries Calcareous rocks with soil filled cavities	May soften upon exposure. May slake in water. May include thoroughly weathered zones up to 3 in. wide with stiff soil weathered zones or soil-filled cavities exhibit standard penetration resistance exceeding 50 blows per foot.	Less than 50	Less than 35	Less than 35	Less than 25

[a] NX = Outside diameter 3 1/2 in., inside diameter 3 1/16 in.

[b] BX = Outside diameter 2 7/8 in., inside diameter 2 9/16 in.

Appendix 3. Fracture intensity

Fracture frequency (measured parallel to core length)	Classification
-5 micron to 0.05 ft (contains clay)	Crushed
0.05 to 0.1 ft (contains no clay)	Intensely fractured
0.1 to 0.5 ft	Closely fractured
0.5 to 1 ft	Moderately fractured
1 to 30 ft	Little fractured
4 ft and larger	Massive

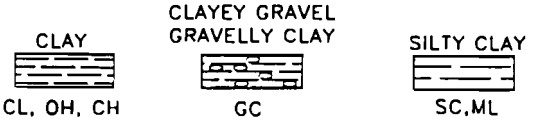
Appendix 4. Rock strength classification

Strength test	Classification
Easily deformed with finger pressure.	Plastic
Crumbles under finger pressure.	Friable
Unfractured rock; crumbles under light hammer blows.	Weak
Withstands a few firm hammer blows before breaking.	Moderately strong
Yields large fragments with difficulty and withstands several heavy, ringing hammer blows.	Strong
Yields only dust and small fragments; resists ringing hammer.	Very strong

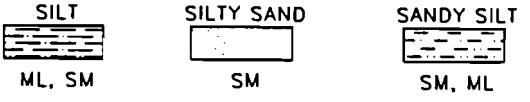
Exhibit 1. Unified soil classification system

UNIFIED SOIL CLASSIFICATION SYSTEM

HATCHING PATTERNS

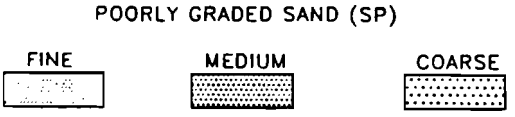


CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
OH ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.

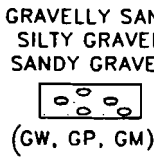


MH INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT.
OL ORGANIC SILT, SILT-CLAY OF LOW PLASTICITY.
ML INORGANIC SILT AND VERY FINE SAND, ROCK FLOUR, SILTY OR CLAYEY FINE SAND, CLAYEY SILT WITH SLIGHT PLASTICITY.

SC CLAYEY SAND, SAND-CLAY MIX.
SM SILTY SAND, SAND-SILT MIX.



SP POORLY GRADED SAND, GRAVELLY SAND.
SW WELL GRADED SAND, GRAVELLY SAND.



GC CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE.
GM SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE.
GP POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURE.
GW WELL GRADED GRAVEL, GRAVEL-SAND MIXTURE.

P:USCS

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-101 Page: 1 of 3 Revision: 0 Date: 10/01/90

SUBSURFACE SAMPLING USING A 5-FT CONTINUOUS SAMPLER AND A SPLIT-BARREL SAMPLER

1.0 PURPOSE

A standard method is used in continuous and split-barrel sampling to ensure a representative sample for quantitative analysis by the laboratory. This procedure provides instructions for using a continuous and split-barrel sampler for collection of subsurface soil samples.

2.0 APPLICABILITY

The continuous sampler is designed for continuous sampling from ground surface to the total depth or to bedrock. The sampler is connected to the drive rods in such a manner that it does not rotate with the auger. As the lead auger penetrates, the continuous sampler collects the undisturbed column of soil inside the hollow stem of the auger. Penetration with a continuous sampler will be hindered by the presence of large cobbles in the subsurface. In this case the sampler is removed and the borehole is augered past the obstruction. The sampler is then replaced and sampling can continue.

3.0 OTHER DOCUMENTS

3.1 ASSOCIATED PROCEDURES

3.1.1 TE-071 Sample Documentation;

3.1.2 TE-072 Soil sample Packaging and Preservation;

3.1.3 TE-073 Equipment Decontamination; and

3.1.4 TE-100 Drilling Log Preparation and Well Construction Documentation.

4.0 EQUIPMENT

- safety glasses;

Approved by:

Mic Doty 9/19/90
(Date)

Clair Little 9/19/90
C.A. Little (Date)

- split-barrel sampler;
- 5-ft continuous sampler;
- disposable latex gloves;
- felt-tip marker (permanent);
- stainless steel scoop or spoon;
- sample log book; and
- truck-mounted hollow stem auger rig (with hollow stem augers, center bit(s) and drive rod(s), and 140-lb hammer or equivalent hydraulic driver).

5.0 PROCEDURE

5.1 The sampler should be decontaminated before use according to TE-073.

5.2 (Applies only to the split-barrel sampler.) Auger the hole to the sampling depth, then lower the split barrel sampler to the top of the interval to be sampled. Drive the sampler using a 140-lb hammer with a 30-in. drop, or the equivalent, for the length of the sampler or until no further penetration can be accomplished after 50 hammer blows for each 6 in. of penetration. Record the number of blows for each 6 in. penetration on the well summary information form (TE-100, Appendix 1).

5.3 Once the full sample is acquired or no further penetration is possible, remove the sampler from the borehole, taking care not to lose any of the sample. Separate the sampler from the drive-rod assembly, lay the sampler on a flat, uncontaminated surface, and remove the sampler head and drive shoe. Carefully remove one-half of the split barrel, making certain that the other half is positioned to hold the sample. Discard the uppermost part of the sample (material sloughed into the hole).

5.4 Log the sample on the well summary information form.

5.5 Complete necessary documentation on the sample label (TE-071).

5.6 Remove and package the sample (TE-072).

NOTE: All soil sample replicates are collected, homogenized, and then split, except volatile organics. Volatiles are NOT mixed, but selected segments of soil are taken from the core length and placed in the appropriate glass jars.

Generally, replicates are taken at a 10% frequency and analyzed by the same lab.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-102 Page: 1 of 2 Revision: 0 Date: 10/01/90

SUBSURFACE SAMPLING USING A SHELBY THIN-WALL TUBE SAMPLER

1.0 PURPOSE

This procedure provides a standard method for Shelby thin-wall tube sampling which ensures acquiring an undisturbed subsurface sample.

2.0 OTHER DOCUMENTS

2.1 ASSOCIATED PROCEDURES

2.1.1 TE-071 Sample Documentation;

2.1.2 TE-072 Soil Sample Packaging and Preservation;

2.1.3 TE-073 Equipment Decontamination;

2.1.4 TE-100 Drilling Log Preparation and Well Construction Documentation.

3.0 EQUIPMENT

- wire or stiff-bristled brush;
- disposable wipes;
- felt-tip marker (permanent ink);
- ball-point pen (permanent ink);
- sample log book;
- Shelby thin-wall tube sampler (with head and thin-wall tubes 36 in. long by 3 in. outside diameter, equipped with end caps);
- paraffin or beeswax (if required);
- friction or plastic tape; and

Approved by:

Nic Kerto 9/19/90 (Date)

Craig Little 9/19/90 C.A. Little (Date)

- cases or core boxes.

4.0 PROCEDURE

4.1 Before using, inspect all downhole equipment, including the Shelby tube sampler and drive rods, for possible contamination and damage. Any tool found visibly contaminated must be thoroughly decontaminated and reinspected before being used downhole (TE-072).

4.2 Drill the hole to the specified sampling depth, then run the Shelby tube sampler to the bottom of the hollow stem auger.

4.3 Press the sampler into the undisturbed soil with a hydraulic feed core drill or its equivalent with one fast, smooth stroke.

4.4 Once a full 36-in. sample is acquired or no further penetration is possible, rotate the sampler to shear off the sample and retrieve the entire drill string from the borehole.

4.5 Separate the Shelby thin-wall tube from the head assembly. Remove 1 to 2 in. of material from the top and bottom ends of the sampler. If required, seal both ends of the sampler by pouring in hot, melted paraffin or beeswax to prevent moisture loss. Cover both ends of the tube with close-fitting caps; secure the caps with friction or plastic tape.

4.6 Label the tube by listing the hole number, sample interval, sample number, uphole direction (top), etc.

4.7 Place tube in a case or core box for protection.

4.8 Log the sample on the well summary information form (TE-100, Appendix 1) and complete sample label as described in TE-070.

4.9 Once sampling operations are completed, clean the Shelby sampler head with the wire brush, inspect for contamination and damage, decontaminate if necessary (TE-072), and reassemble with a new thin-wall tube. Store the sampler in an uncontaminated area.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-105 Page: 1 of 12 Revision: 0 Date: 05/01/91

U2CRT OPERATION

1.0 PURPOSE

This procedure describes the operation of the ORNL-developed truck-mounted auger rig, the U2CRT.

2.0 APPLICABILITY

This procedure applies to drilling and sampling using the U2CRT. See Procedures TE-101 and TE-110 for more details on sampling and monitoring well design.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-101, Subsurface Sampling Using a 5-ft. Continuous Sampler and a Split-barrel Sampler
3.1.2 Procedure TE-110, Monitoring Well Design

3.2 EXHIBITS

3.2.1 Exhibit 1: U2CRT with Mast Raised
3.2.2 Exhibit 2: U2CRT Operating Control Panel

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 U2CRT drill rig
4.1.2 "A" rods
4.1.3 Auger dog
4.1.4 Auger fork
4.1.5 California splitspoon sampler
4.1.6 Drive shoe
4.1.7 Flexible exhaust pipe
4.1.8 Hydraulic hammer

Approved by:

Mi Kato 8/5/91
(Date)

Craig Little 8/14/91
C.A. Little (Date)

4.1.9 Hydraulic jacks
4.1.10 Augers, 3-in. solid stem and 4- or 6-in. hollow stem
4.1.11 Screw jacks
4.1.12 Hydropunch sampler
4.1.13 Pulling shoe
4.1.14 Auger bits, soft sediment and hard rock
4.1.15 Tool box

5.0 RESPONSIBILITY

5.1 It is the driller's responsibility to operate all equipment in a safe and efficient manner. The driller should not leave the control panel when any part of the rig is moving or engaged.

5.2 It is the helper's responsibility to perform tasks such as making connections, moving equipment, and assisting the driller in all aspects of rig operations while drilling, soil sampling, and installing piezometers so that the driller can concentrate on the operation of the rig.

6.0 DEFINITIONS

6.1 **"A" rods:** 2-in. hollow coupled rods that are driven into the borehole, forming the connection rod between the splitspoon and the drive hammer.

6.2 **Auger:** a drilling device which continuously removes cuttings from the bottom of the hole during drilling without the use of fluids.

6.3 **Auger dog:** a device that attaches the winch hook to the auger; used when the augers are pulled from hole.

6.4 **Auger flights:** the winding metal cutting edges of the auger that carry cuttings to the surface during drilling; alternatively, a section of auger itself.

6.5 **Auger fork:** a U-shaped flat metal piece with a welded handle that is placed between auger flights at ground level to prevent the auger from falling into the borehole.

6.6 **Control panel:** the panel on the left rear of the drill rig containing controls for operating the drill rig.

6.7 **Drill stem:** all parts in the assembly used for drilling from the swivel to the bit, including the kelly, drill pipe/rods, augers, and bit.

6.8 **Drive shoe:** an adapter for driving split spoons that is threaded onto the hydraulic hammer on one end and to the "A" rod on the other.

6.9 **Hammer attachment:** tooling to attach the hydraulic hammer to the "A" rod and to the drive shoe.

6.10 **Hydraulic hammer:** a weight located on the middle of the mast used to drive splitspoon samplers into the ground.

6.11 **Kelly:** a hollow steel bar that is the top section of the drill stem which transmits power directly from the rotary motor to the auger flights.

6.12 **Kelly extension:** a 3-ft extension pipe which connects the kelly to the auger.

6.13 **Kill switch:** a safety switch used to turn off the drill rig in an emergency.

6.14 **Mast:** the portable derrick, capable of being erected as a unit, which is upright during drilling or sampling.

6.15 **P.T.O. (Power Take Off):** a mechanism that converts power from the truck engine to the hydraulic system, which powers all functions on the rig.

6.16 **Pulling shoe:** attachment that slips under the hydraulic hammer on the mast to relieve pressure on the hammer during removal of a split spoon from the subsurface.

6.17 **RPM:** revolutions per minute.

6.18 **Splitspoon sampler:** a sampler which may be attached to the bottom of the "A" rods in order to obtain and hold subsurface soil samples; the sampler can be split in half to remove sample after removing both ends.

6.19 **Table:** the flat, movable surface at the back of the drilling rig.

7.0 SAFETY

7.1 Inspect the first aid kit for proper bandages, eye wash, and burn dressings.

7.2 Check the fire extinguisher for NFPA ABC extinguishing agents and determine that it is fully charged.

7.3 Look for overhead and underground utilities within the site and review utility maps to determine safe locations for soil borings.

7.4 Ensure a safe distance between the mast and overhead electric power lines. Do not operate drilling equipment closer than 10 ft to electrical transmission lines. See site-specific health and safety plan for more details.

7.5 Confirm that no unnecessary personnel or support vehicles are within the zone having a minimum radius of the height of the drill mast, specifically behind the drill rig where drill stems could fall from the mast or directly in front of the drill rig where extension of the mast beyond the front of the truck could cause damage.

7.6 Check the drill rig for contamination, damaged cables, loose bolts, frayed wires, and leaks. Wrap hydraulic lines if necessary. Check drill stems for contamination.

7.7 As the drill mast is being raised, watch for pinch points, cables and hoses hanging up, loose equipment lying on the mast, and other hazards.

7.8 All personnel within a minimum radius of the height of the drill mast must wear hard hats, steel-toed boots, and safety glasses or goggles.

7.9 When performing any activities within the area having a minimum radius of the height of the drill mast, approach the drill rig only after confirming that the driller is aware of approach and that drill stems, augers or split spoons have been secured on the ground, on racks, or safely supported next to the drill mast.

7.10 Avoid touching the drill rig when augering in areas of potential electrical hazard. The driller should contact only the control knobs in these situations.

7.11 When drilling operations are performed in areas of suspected underground pipeline, vaults, or other buried objects, the driller will use extreme caution when noting unusual auger sounds, change in speed, change in depth rate, or directional deviations due to change of soil type.

7.12 A change in auger soil cuttings from normal lithology to backfill material (especially sand) will be cause to suspend augering operations until the cause of the lithology change can be determined and safe working conditions can be ensured.

7.13 KNOW THE LOCATION OF THE KILL SWITCH.

8.0 PROCEDURE

8.1 Set up the drill rig. See Exhibit 1.

8.1.1 Locate the rig across the fall line of the terrain, rather than nose up or nose down.

8.1.2 Place the transmission of the truck in neutral.

8.1.3 Set the emergency brake on the truck.

8.1.4 Using screw jacks mounted on each side of the rear of the truck, level the rig from side to side.

8.1.5 Attach flexible exhaust pipe to tailpipe of truck.

a. Position the end of this hose downwind from the rig and away from personnel and sampling equipment.

8.1.6 Engage the P.T.O. throttle by turning it clockwise.

a. The P.T.O. is located in the cab of the truck and provides power to the hydraulics of the drill rig.

b. Leave the engine at idle speed.

8.1.7 To engage the hydraulics for the mast, press down the button located in the upper left corner of the control panel marked ACCY HYD - MAST.

a. See Exhibit 2 for control panel description.

8.1.8 Using the lever located in the lower left corner of the control panel marked MAST-RAISE/LOWER, slowly engage the hydraulics by moving the lever to raise the mast.

CAUTION: WATCH ALL HYDRAULIC LINES SO THAT THEY DO NOT BECOME ENTANGLED IN TOOLS OR OBSTRUCTIONS IN THE TRUCK BED.

8.1.9 Using the throttle control inside of the truck on the P.T.O., set the engine RPMs to 1900.

A. Watch the tachometer located on the left side above the dashboard to find the RPM setting.

8.2 Begin drilling.

8.2.1 Prior to beginning any rotary work, be certain that both feeder controls located on the upper and lower console of the control panel are in the full forward position (away from the operator).

8.2.2 Push the HAMMER/ROTARY button, located in the upper right-hand corner of the control panel, to the OFF position.

8.2.3 Pull the ROTARY SPEED lever down slightly to lower the RPMs. This is located at the top center on the control panel.

8.2.4 Pull the TABLE SLIDE lever, inside the box next to the control panel, toward the rear of the truck to move the table away from the truck; release the lever when the table is fully extended.

8.2.5 Engage the HAMMER/ROTARY button located in the upper right-hand corner of the control panel to the ON position.

8.2.6 Push in the flow control button located on the mast.

8.2.7 Pull out the flow control button located in the upper left-hand corner of the control panel to ACCY HYD.

8.2.8 Connect an auger to the kelly by depressing the button on the side of the auger and sliding the auger up into the kelly until the snap button pops out.

8.2.9 Push the FEEDER lever located in the lower right-hand corner of the control panel forward. This will move the auger toward the ground.

a. Stop the movement when the auger has touched the ground by moving the lever to the neutral position.

8.2.10 Slowly pull the ROTARY SPEED lever out to begin rotating the auger.

8.2.11 Push the FEEDER lever forward to lower the auger while slowly pulling the ROTARY SPEED lever out.

a. These two controls are used together to regulate the amount of rotation and vertical movement of the auger.

8.2.12 Continue drilling until the hydraulic cylinders bottom out.

8.2.13 Push the FEEDER control to the neutral position and push the ROTARY SPEED lever to the OFF position. This will stop all downward and rotating movements.

8.2.14 Slide the auger fork in between the auger flights to hold the augers stationary.

8.2.15 Disconnect the auger near ground level from the kelly extension.

8.2.16 Pull the FEEDER lever to the "Raise" position and raise the kelly to the fully upright position or high enough so that an additional auger can be attached to the first auger.

8.2.17 Connect the second auger to the lead auger protruding from the ground using the snap button.

8.2.18 Rotate the kelly by hand counter-clockwise to line up the kelly with the new auger.

8.2.19 Using the FEEDER lever, slowly lower the kelly onto the auger connection while the driller's helper guides the kelly extension into place on the auger.

8.2.20 Repeat the above drilling steps until the desired depth has been reached.

8.3 Remove the augers from the hole after drilling.

8.3.1 Push the HAMMER/ROTARY button to the OFF position.

8.3.2 Pull the ROTARY SPEED lever down slightly.

8.3.3 Push the TABLE SLIDE lever forward to move the table toward the front of the truck. Release the lever when the table is in the full forward position.

8.3.4 Attach the auger dog to the top of the last auger.

8.3.5 Using the winch line switch located at the center right of the control panel, lower the winch line and attach the hook to the top of the auger dog.

8.3.6 Remove the auger fork.

8.3.7 Reel in the winch line, pulling three augers from the hole at one time, and place the auger fork onto the fourth auger to prevent the remaining auger string from falling downhole.

8.3.8 Disconnect the third auger flight from the fourth auger flight. Remove all loose mud and debris from the auger flights.

8.3.9 While the driller lets out the winch line, the helper pulls the augers out and away from the drill rig and lays them on the ground.

8.3.10 After disconnecting the winch line, reel it in and connect it to the end of a bungie cord on the mast.

8.3.11 Repeat the above steps until all augers are removed from hole.

8.4 Use the splitspoon sampler to collect soil samples.

8.4.1 See Procedure TE-101 for more details on split barrel (splitspoon) sampling.

8.4.2 Prior to beginning any splitspoon sampling work, be certain that the feeder controls located on both the upper and lower console of the control panel are in the full forward position.

8.4.3 Following 8.3.1 through 8.3.3, move the table halfway between the fully out and fully retracted positions.

8.4.4 Engage the HAMMER/ROTARY button located in the upper right-hand corner of the control panel.

8.4.5 Pull out the flow control button located on the mast.

8.4.6 Remove the kelly extension from the kelly.

8.4.7 Connect the hammer attachment to the drive shoe coming from the hydraulic hammer.

8.4.8 Place the hydraulic jacks with base plates under each side of the mast and lower the hammering jacks located on both sides of the mast onto the hydraulic jacks. Adjust the jacks to provide support for the drilling mast.

8.4.9 Remove the pulling shoe at the base of the hydraulic hammer by removing the bolt and sliding the shoe out.

8.4.10 Lower the drive hammer by using the FEEDER lever.

8.4.11 Slowly pull the HAMMER FLOW CONTROL feeder forward.

8.4.12 After driving the splitspoon to the desired depth, move the HAMMER FLOW CONTROL to the forward position and the FEEDER switch to the neutral position.

8.4.13 Replace the pulling shoe at the base of the hydraulic hammer.

CAUTION: FAILURE TO REPLACE THIS SHOE WILL RESULT IN SERIOUS DAMAGE TO THE HYDRAULIC HAMMER.

8.4.14 Using the FEEDER switch, remove the splitspoon by lifting it slowly.

a. The hydraulic hammer may be used in conjunction with lifting to more easily remove the splitspoon.

8.4.15 Disconnect splitspoon and "A" rod from drive shoe.

Exhibit 1. U2CRT with Mast Raised

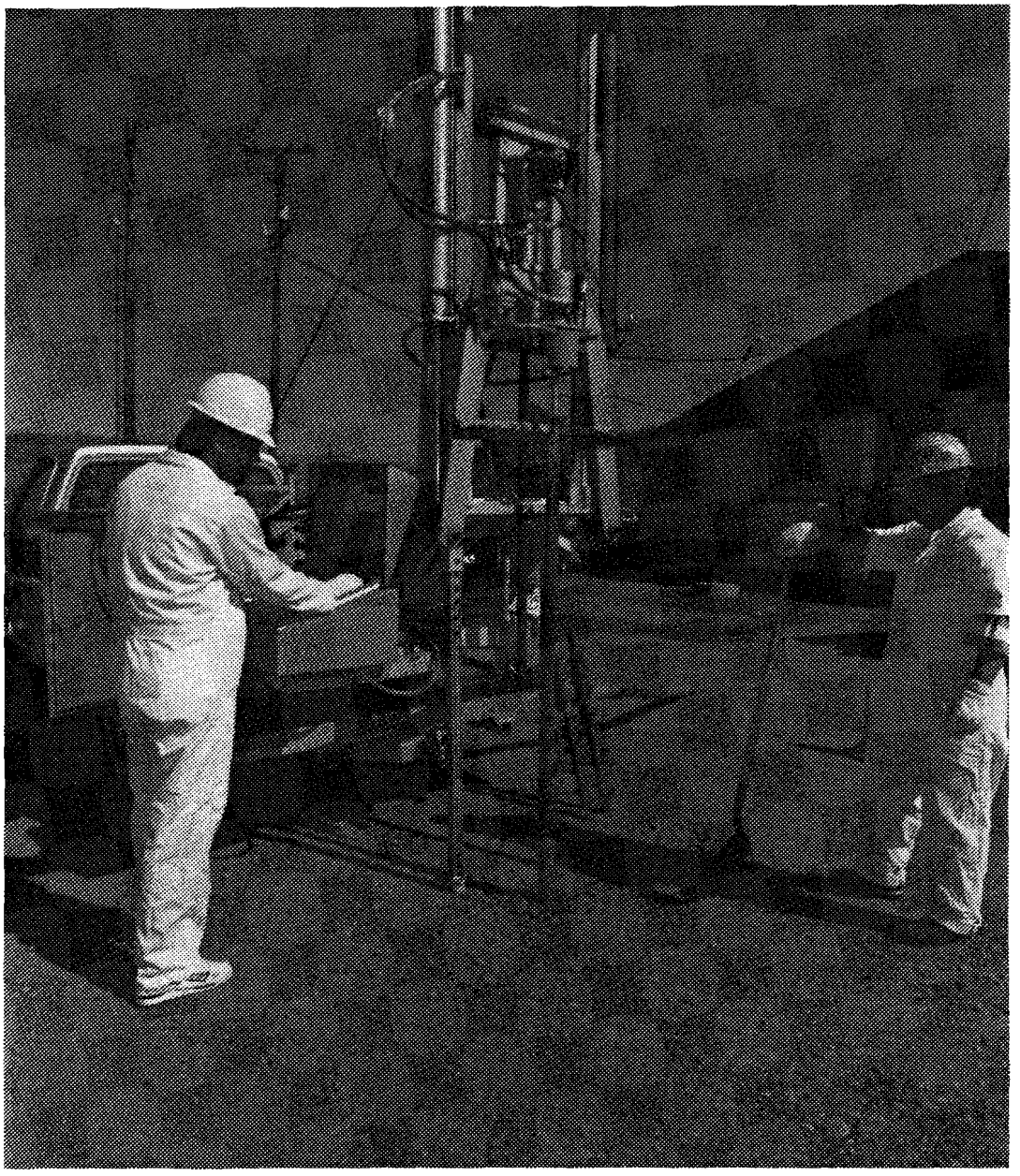


Exhibit 2. U2CRT Operating Control Panel

A. ACCY/HYD - MAST: hydraulic splitter control; when in the up position, the rotary hydraulic motor or the hydraulic hammer is activated; when in the down position, the hydraulics are diverted to the mast hydraulic ram.

B. TOGGLE SWITCH: emergency kill switch for the drill rig; when the switch is pushed away from the operator, power is on; when it is pulled toward the operator, power is off.

C. HYDRAULIC SYSTEM PRESSURE: pressure dial for the hydraulic system; the operator should not exceed 2000 psi when operating the system.

D. HAMMER FLOW CONTROL-ROTARY SPEED: controls hydraulic pressure to either the hydraulic hammer or the rotary motor, depending on which is selected by the hydraulic splitter on the mast. It also acts as a splitter between the hydraulic hammer or the rotary motor and the hydraulic rams which move the kelly up and down. The closer the operator moves the lever toward him, the less hydraulic pressure provided to the kelly.

E. HAMMER/ROTARY: hydraulic splitter button that turns on the hydraulic hammer or the rotary motor, depending on which has been selected using the hydraulic splitter button on the mast. When in the OFF position, the hydraulics are diverted to the Table Slide.

F. MAST: toggle lever that raises and lowers the mast when the hydraulic splitter button ACCY/HYD - MAST is engaged to MAST.

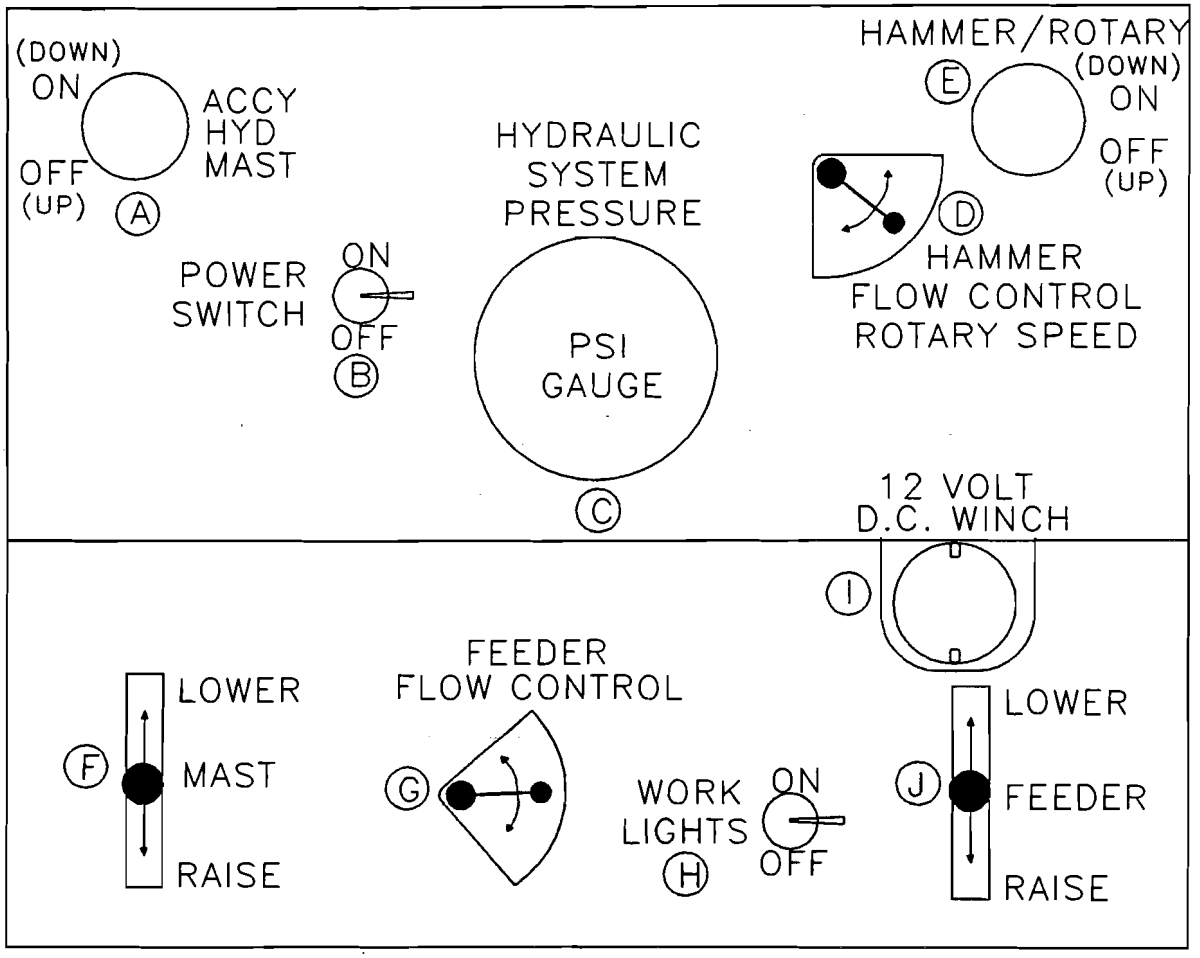
G. FEEDER FLOW CONTROL: a throttle that controls the downward movement of the auger during drilling operations.

H. WORK LIGHTS: toggle switch that operates the rig's overhead work lights; when the switch is pushed away from the operator, the lights will be activated; when switch is towards the operator, the lights they will be off.

I. WINCH: switch that operates the electric winch line located on top of the mast; twisting the switch clockwise reels the winch line in; counterclockwise lets the line out.

J. FEEDER: toggle lever that raises and lowers the hydraulic cylinders for both the hydraulic hammer and the rotary motor.

Exhibit 2. (continued)



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-110 Page: 1 of 12 Revision: 0 Date: 10/01/90

MONITORING WELL DESIGN

1.0 PURPOSE

This procedure gives guidelines for the design of groundwater monitoring wells, including multiple completion wells.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 N. Korte and P. Kearl, Procedure for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells, 2d ed., GJ/TMC-08 (85), U.S. DOE Technical Measurements Center, Grand Junction, Colo., 1985, pp. 15, 16-18, 29-30

2.1.2 F. G. Driscoll, Groundwater and Wells, Johnson Division, St. Paul, 1986.

2.1.3 J. A. Cherry, "Migration of Contaminants in Groundwater at a Landfill: A Case Study," Journal of Hydrology, Vol. 63. No. 1/2 (special issue), 1983.

2.1.4 J. A. Cherry and P. E. Johnson, "A Multilevel Device for Monitoring in Fractured Rock," Groundwater Monitoring Review, Summer, 1982,pp. 41-44.

2.1.5 J. F. Pickens et al., "A Multilevel Device for Groundwater Sampling," Groundwater Monitoring Review, Spring, 1981, pp. 48-51.

2.1.6 G. P. Kruseman and N. A. DeRidder, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, The Netherlands, 1979.

2.2 APPENDICES

2.2.1 Appendix 1: Well construction: material and procedures checklist

---

Approved by:

9/25/90 (Date)

C.A. Little 9/26/90 (Date)

2.3 EXHIBITS

2.3.1 Exhibit 1: Typical construction of a monitoring well in an unconsolidated unit

2.3.2 Exhibit 2: Typical multiple completion monitoring well

3.0 SCREEN DEPTH AND INTERVAL

Different densities and aqueous solubilities can cause contaminants to stratify into "floaters", "mixers", and "sinkers". Consequently, large screened intervals covering several geologic units can cause a more contaminated unit to be diluted with water from less contaminated units. Therefore, obtaining water samples from specific zones of interest within the aquifer is often desirable (multiple completion wells are discussed in Sect. 9.0). In general, Korte and Kearl (1985) have recommended the following guidelines:

- Individually screen permeable units within a stratified sedimentary sequence.
- In fractured media, screen individual fractures with short screen lengths.
- If the aquifer is contaminated with compounds denser than water, locate the screened interval at the top of the first impermeable unit underlying the permeable unit. For most applications, a 5-ft screened interval is recommended.

For monitoring wells that also serve as pumping wells for hydrologic testing, the screened interval should fully penetrate the aquifer. The general rule is to screen 70 to 80% of the aquifer's thickness (Kruseman and DeRidder 1979), thereby increasing the maximum yield of the aquifer to 90% or more.

Another advantage of this screen length is that the data obtained through pumping may be assumed to represent horizontal groundwater flow, an assumption that underlies most hydrologic tests. It should be noted, however, that this size of screened interval is impractical for large saturated zones because of the prohibitive well completion cost.

4.0 WELL SCREEN SLOT OPENINGS

4.1 DISCUSSION

Screen slot openings for the same formation can differ depending on whether the well is naturally developed or filter packed. Either design is satisfactory and the choice for a particular well depends primarily on the grain size of the aquifer materials. Coarse-grained heterogeneous materials can be developed

naturally, whereas fine-grained homogeneous materials are best developed using a filter pack. Well screen slot openings for either method are selected depending on the grain size of the water-bearing formation.

In rotary drilling, clay added to the drilling fluid can contaminate samples and lead to recommended slot sizes that are smaller than necessary. The well log should show the presence of natural clays which should be considered in the screen design. In some cases, fine material from formations overlying the aquifer may be kept in suspension in the drilling fluid while the aquifer is being drilled. These fine materials may then be included in the cuttings from the aquifer, although they originate in the overburden. The drilling method may also affect the the sample's accuracy. In air drilling, samples collected at the surface tend to be finer in texture than the materials in the formation. As the bit advances, formation water entering the borehole may pull in finer material differentially, resulting in a higher proportion of fine particles in samples taken at the surface.

Conversely, highly viscous drilling fluids made with clay additives may entrain fine aquifer materials and prevent them from settling out in the mud pit, making the sample coarser than the actual formation materials. Using a polymeric drilling fluid with little or no gel strength will minimize these sampling problems. Other problems associated with drilling fluids are discussed in Appendix A.

4.2 SCREEN SLOT SELECTION FOR NATURALLY DEVELOPED WELLS

In a naturally developed well, select the screen slot size so that most of the finer formation materials near the borehole are brought into the screen and pumped from the well during development. This practice creates a zone of graded formation materials extending 1 to 2 ft outward from the screen. The screen slot size should retain 60 to 70% of the formation materials opposite the screen before development.

Use a conservative slot opening in calcareous formations (shell fragments) which dissolve readily if the well is acid treated. Removing calcareous materials reduces the amount of bridging material and allows fine clastic material to enter the well.

A more conservative slot selection may be advisable when (1) there is some doubt about the reliability of the samples, (2) the aquifer is thin and overlain by fine-grained loose material, (3) development time is at a premium, and (4) the formation is well sorted. Under these conditions, slot sizes retaining 40 to 50% of the aquifer material are preferred.

On the other hand, when using Teflon screen in very deep formations, it may be necessary to select a slightly larger screen-slot size, since Teflon tends to compress and reduce the effective slot size.

When the formation consists of coarse sand and gravel, there is greater latitude in selecting the slot openings. An increase of a few thousandths of an inch in the slot size allows only a small amount of additional material to pass through the well screen during development. The slot size selected, therefore, may retain from 30 to 50% of the aquifer material. If the openings retain only 30%, more material is brought through the screen during development, which increases the time required to develop the well.

When designing screens for heterogeneous formations, choose slot openings for different sections of the well screen according to the gradation of materials in the different layers if the layers are at least 4 ft thick and their depths have been accurately determined. Two additional recommendations should be followed, however, when selecting slot openings for a multiple-slot screen. If fine material overlies coarse material:

1. Extend at least 3 ft of the screen designed for fine material into the coarse layer below;

2. The slot size for the screen section installed in the coarse layer 3 ft beneath the formation contact should not be more than double the slot size for the overlying finer material. Double the slot size over screen increments of 2 ft or more.

The guide for slot-size selection indicates that about 60% of the formation material near the screen will come through the screen during the development process. Removing this fraction results in some material settlement around the screen. Thus, the overlying finer layer moves downward slightly as settling occurs.

5.0 FILTER PACK DESIGN

Filter packing is the second primary method for completing wells. In filter packed wells, the zone immediately around the well screen is made more permeable by removing some formation material and replacing it with specially graded material. This relatively thin zone separates the screen from the formation material and increases the effective hydraulic diameter of the well. A filter pack retains most of the formation material; a well screen opening is then selected to retain about 90% of the filter pack after development. Filter pack materials should be well sorted to assure good porosity and hydraulic conductivity of the materials near the screen.

Filter packing is especially advantageous when the sediments are highly uniform and fine grained, when the sediments are highly laminated, or when all the materials to be used in the well construction must be on-site before drilling begins.

The grain size of the filter pack should be three to five times the average grain size of the formation materials. A filter pack selected in this manner ordinarily does not restrict the flow from the layers of coarsest material. The hydraulic conductivity of the pack is generally several times greater than that of the coarsest layers because the pack is cleaner and more uniform.

Filter pack material should consist of clean, well-rounded grains of a uniform size to increase its permeability and porosity. The chemical nature of the filter pack is as important as its physical characteristics; filter pack material must consist only of siliceous particles. If calcareous particles are present and the groundwater is slightly acidic, the pack may partially dissolve over time. Particles of shale, anhydrite, and gypsum in the filter-pack material also are undesirable.

5.1 THICKNESS OF FILTER PACK

The design theory of filter-pack gradation is based on the mechanical retention of formation particles; therefore, a pack thickness of only two or three grain diameters is actually needed to retain and control a formation. Laboratory tests made by the Johnson Division show that a properly sized pack with a thickness of less than 0.5 in. successfully retains the formation particles regardless of the velocity of water passing through the filter pack. It is impossible, however, to place a filter pack only 0.5 in. thick and expect the material to completely surround the well screen. To ensure a continuous layer of filter material surrounding the entire screen, the design should specify that the annulus around the screen be at least 3 in.

Filter-pack thickness does little to reduce the possibility of sediment pumping because the controlling factor is the grain size ratio of the pack material to the formation material. Also, a filter pack that is too thick can make final development of the well more difficult. Under most conditions, filter packs should not be more than 8 in. thick because the energy created by the development procedure must be able to penetrate the pack to repair damage done by drilling, break down any residual drilling fluid on the borehole wall, and remove fine particles near the borehole.

When calculating the required volume of filter pack, remember that the filter pack should extend at least 1 ft above the well screen to compensate for settlement during development and to ensure that no annular sealant can enter the well screen. It is good practice to have extra filter pack on the site.

6.0 ANNULAR SEALANT

The annular sealant must prevent contaminants from migrating to the sampling zone from surface or intermediate zones and so prevent cross contamination between strata. The permeability of the sealants should be one to two orders of magnitude less than the surrounding formation. An appropriate use of annular sealant material is using a minimum of 2 ft of certified sodium bentonite pellets immediately over the filter pack when in a saturated zone. The pellets are most appropriate in a saturated zone because they will penetrate the column of water to create an effective seal. Coarse grit sodium bentonite is likely to hydrate and bridge before reaching the filter pack. Use a cement and bentonite mixture, bentonite chips, or anti-shrink cement mixtures as the annular sealant in the unsaturated zone above the certified-bentonite pellet seal and below the frost line. Again, select a clay on the basis of the environment in which it is to be used. In most cases, sodium bentonite is appropriate.

6.1 GROUT

Place grout composed by weight of 6 parts cement to 1 part bentonite, with just enough water for a pumpable mix, in the monitoring well as follows:

6.1.1 Fill the annulus between the well casing and borehole wall with grout.

6.1.2 Place a grout pipe just over the top of a bentonite seal, which separates the wet sand or gravel pack from the grout.

6.1.3 Pump the grout through the grout pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface.

6.1.4 Install the protective casing.

7.0 PROTECTIVE CASING

Protective casing should be installed around all monitoring wells. At a minimum its design should incorporate the following elements.

7.1 Extend a 5-ft (minimum) length of steel casing approximately 3 ft above the ground surface and set in cement grout. Use a 6-in. diameter pipe for 4-in. wells, and 4-in. diameter pipe for 2-in. wells. For wells located on access roads, the casing can be flush with the ground surface. Otherwise, the top of the steel casing should not be more than 3 in. above the riser pipe to ensure that water level measurements can be taken accurately.

7.2 Secure a well covering, usually a hinged cover or a loose telescoping cap (Exhibit 1), with a padlock to the top of the protective casing to prevent

precipitation from entering (a single key should open all padlocks at a given site).

7.3 Pour a concrete apron with a minimum radius of 3 ft around the protective casing and slope it so water runs away from the steel casing (Exhibit 1).

7.4 Install three posts, 4 x 4 in. wood or 3-in. diameter steel, around the well. Set each post 4 ft from the well, extending 2 ft below and at least 4 ft above ground surface, and flag in areas of high vegetation. In grazing areas, install four posts with three-strand barbed wire strung around them to act as a livestock guard.

7.5 Drill a small hole at the base of the protective casing to allow trapped water to escape.

8.0 DOCUMENTATION

Completed monitoring wells should be documented on the well summary information sheet according to the procedure in TE-100. A typical completed monitoring well appears on Exhibit 2. In addition, the well construction material and procedural checklist form is filled out (Appendix 3).

A base map showing the approximate locations of all monitoring wells and abandoned drill holes should also be prepared. Following installation, survey the actual well locations and elevations according to the procedures TE-120, and update the map accordingly.

The log and checklist are prepared and maintained for each monitoring well installation, and should include the following information:

- the exact location of the well, including a brief description of the surrounding area;
- the start and completion dates for each boring;
- sequential soil and/or lithologic boundaries (when depths are estimated, note the degree of accuracy);
- the results of all water-table measurements (note also the method of determination);
- for drive (split-spoon), pushed (thin-wall or Shelby), and cored samples, the length and depth of the sampled interval and the length of sample recovered for that interval;

- for split-spoon samples obtained using a drive sampler, the number of blow counts, hammer weight, and length of fall (for thin-wall samples, indicate whether the sampler was hydraulically or manually pushed);

- when drilling fluid is used, the amount of fluid loss (quantitatively estimated) and the depth interval over which the loss occurred (the fluid loss should also be generally described using the following terminology: "no loss" means that no fluid was apparently lost other than through spillage while filling the hole; "partial fluid loss" means that the amount of return was significantly less than the amount used; and "complete water loss" means that no fluid returned to the surface during pumping);

- the type and amount of any drilling additive used for each boring, including lubricants, together with the reason for and start depth of additive use;

- a general description of drilling equipment, including bit type, rig manufacturer, and model; and

- all special problems or conditions, such as hole squeezing, recurring problems at a particular depth, grout in the well, excessive ground takes, drilling fluid losses, tools in the hole, and lost casings and screens.

9.0 MULTIPLE COMPLETION WELLS

When conducting a groundwater investigation in a stratified sedimentary regime or a fracture-flow system, obtaining representative samples from a number of specific depth intervals in order to accurately characterize the system is important. In such systems, certain flow paths may contain high contaminant concentrations while the remainder of the system may be relatively contaminant-free. Slotted wells completed over the length of the flow system tend to yield only an integrated sample, which may or may not be representative of the entire system. Instead, use a multilevel well completion in those cases where sampling at specific depth intervals is essential. Work at the University of Waterloo in Ontario, Canada, resulted in some excellent guidance relative to equipment and installation of multilevel sampling devices (Cherry 1983). A typical multiple completion monitoring well is illustrated in Exhibit 2. Piezometer nests are the easiest to install and provide the highest degree of integrity with respect to sampling of the desired intervals and preventing interlevel contamination. High cost is a major drawback of this method, however. Installation of a piezometer nest costs up to ten times that of a multilevel device with an equivalent number of sampling intakes.

Single borehole nests provide several sampling points within an individual borehole. This type of well completion is well-suited for most applications, especially where three completions per borehole are enough to characterize the system. The disadvantages of single borehole nests are the limited number of

piezometers that can be installed in each borehole, the difficulty of installing sand packs and seals at desired levels, and the large borehole that is required.

Multilevel sampling devices are becoming more popular as a result of improved efficiency, reliability, and lower cost. A device developed by Pickens and others (1981) and Cherry and Johnson (1982), consists of a bundle of tubes housed within a PVC pipe capped on the bottom. Each of the tubes is connected to a 90 elbow which protrudes through the casing. Each tube extends to a different depth in the casing so that water can be drawn from different intervals in the borehole. The depth interval sampled by each tube is isolated from above and below by expandable packers so that the annulus between the casing and the borehole wall is sealed over the specified intervals.

The packers are made from a solid but flexible sealant that expands with water. The sealant, which resembles a soft, light rubber, is formed into a cylindrical sleeve in a mold. The sleeve is placed around precut lengths of PVC pipe, the same type as that used for the casing. Packers can be conveniently joined into the casing using standard threadless couplings with a small amount of solvent joiner (solvent can be eliminated if threaded pipe and couplings are used for jointing the packers and for joining the PVC casing at other points in the assembly).

One disadvantage associated with the multilevel sampling device is its propensity for clogging at the sampling ports. In addition, the device makes it difficult to conduct hydrologic testing in an aquifer, to position the samplers at the desired depth intervals, and to efficiently isolate the sampling ports with properly placed packers.

Appendix 1. Well construction: material and procedures checklist

OAK RIDGE NATIONAL LABORATORY
CHEMICAL ASSESMENTS TEAM
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION, CO. 81502
(303) 248-6209
(FTS) 326-6209

WELL CONSTRUCTION MATERIAL AND PROCEDURAL CHECKLIST

Project _____ Site _____

Well # _____ Date _____

Location Sketch

WELL CONSTRUCTION

DRILLING	WELL COMPLETION
Method:	Borehole diameter:
Contractor:	Casing depth:
Rig type:	Total depth:
Driller:	Screened interval:
QA/QC:	Water level(Pre-level):
Equip. decon. prior to drlg?	Water level(post-level):
COMMENTS:	QA/QC:
	Casing decon. prior to setting?
	Grout mixed to specs?
	COMMENTS:

MATERIALS

	Size	Amount
Sand		
Portland Cement		
Powdered Bentonite		
Bentonite Pellets		
Casing		
Type		
Well cap		
Well points		
Screen: Length		
Size		
Type		

CAT/REP.

COMMENTS:

WELL DEVELOPMENT

Developed by: Date:

Method:

Volume of water purged:

Water quality | Temp: Cond: pH:

WELL TESTS

Bail test by: Date:

Pump test by: Date:

Other:

COMMENTS:

WELL SAMPLING

Temp.	pH	Cond.	WL	Date	By

COMMENTS:

Exhibit 1. Typical construction of a monitoring well in an unconsolidated unit

ORNL DWG-91-6012

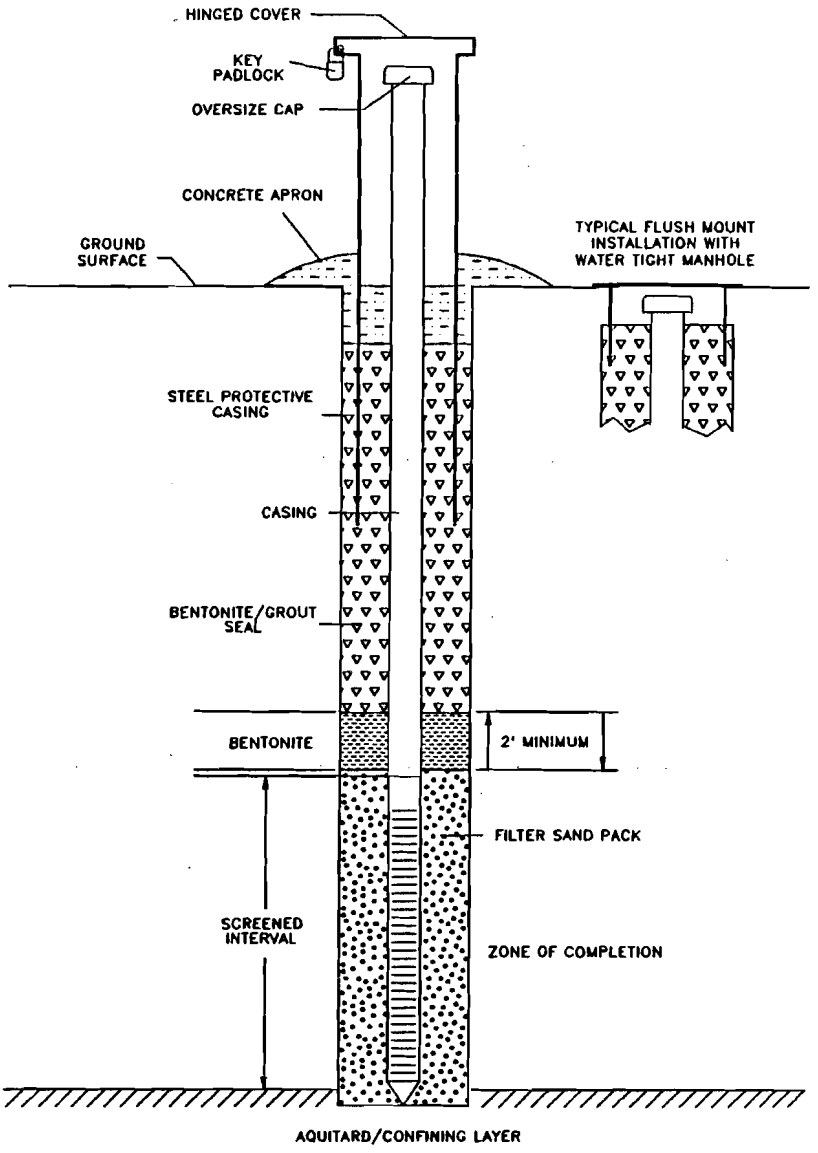
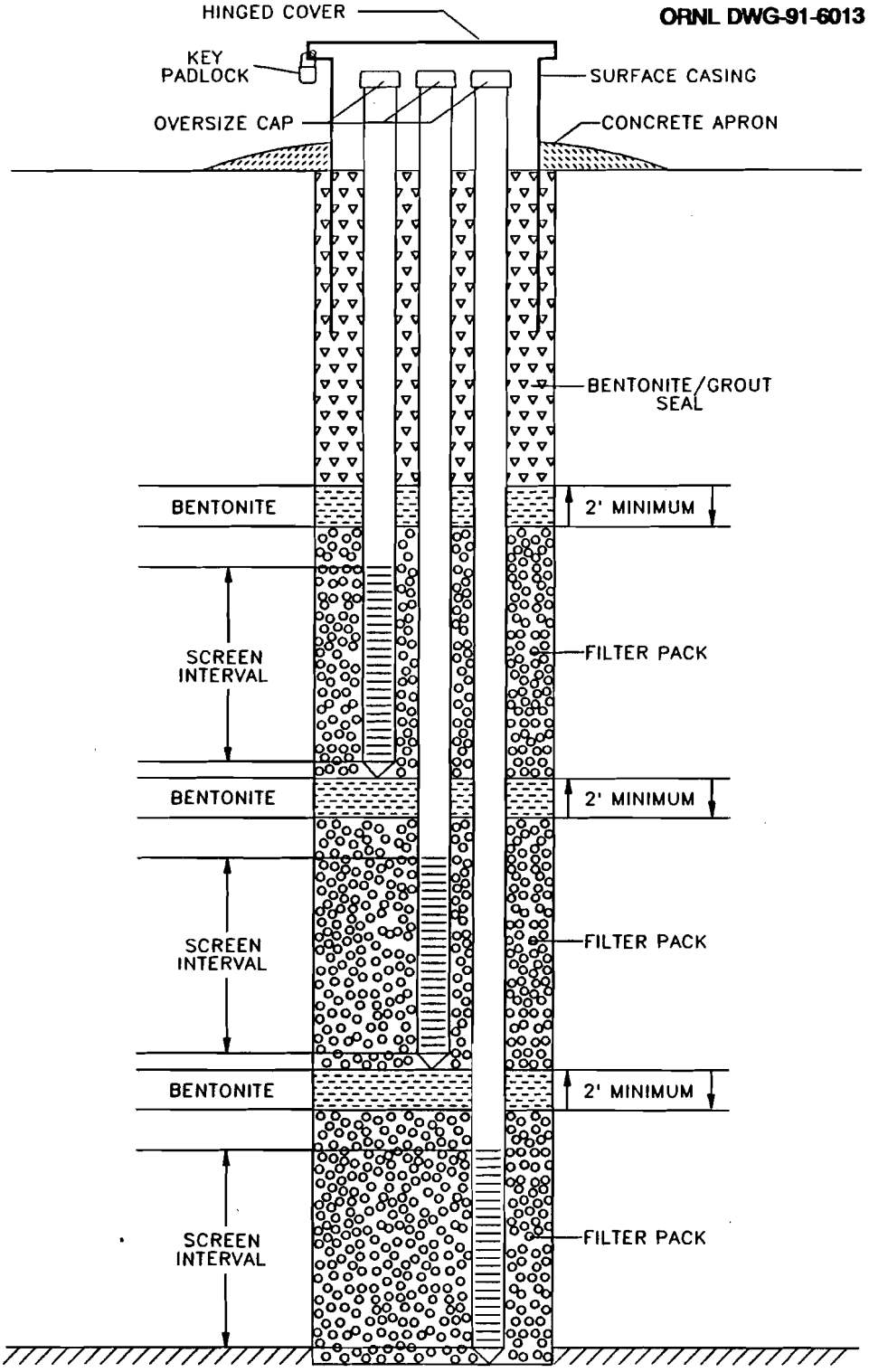


Exhibit 2. Typical multiple completion monitoring well



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-111 Page: 1 of 4 Revision: 0 Date: 10/01/90

WELL DEVELOPMENT

1.0 DISCUSSION

During the drilling, fine-grained materials smear on the sides of the borehole and form a mud "cake" that reduces the hydraulic efficiency of the well. To facilitate water entry into the monitoring well (a particularly important factor for low-yielding geologic materials), this mud cake must be broken down and the fine-grained materials removed from the well or well bore by well development. Development also removes fluids, primarily water, which are introduced to the water-bearing formations during the drilling process.

Additionally, develop monitoring wells to provide water samples free of suspended solids. When sampling for metal ions and other inorganic constituents, filter water samples and preserve at the well site at the time of collection. Improperly developed monitoring wells will produce samples containing suspended sediments that will bias the chemical analysis of the collected samples and frequently cause clogging of the field-filtering mechanisms.

The time and money spent for this important procedure will expedite sample filtration and result in samples more representative of water in the monitored formation.

Successful development methods include bailing, surging, and flushing with air or water. The basic principle behind each method is to create flow reversals in and out of the well (and/or borehole) to break down the mud cake and draw the finer materials into the hole for removal. This process also helps remove the finer materials close to the borehole, leaving behind a "natural" pack of coarser-grained materials.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 M. J. Barcelona et al., Practical Guide for Groundwater Sampling, Illinois State Water Survey, November 1985. pp. 40-41.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

2.1.2 National Water Well Association, Manual of Water Well Construction Practices, U.S. Environmental Protection Agency, 1975.

3.0 EQUIPMENT

- development pump, an appropriate amount of hose, controller;
- oil-less compressor and generator, or compressed nitrogen ("A" size cylinder), regulator and fittings;
- tripod and reel;
- 5-gal bucket;
- purge record form;
- containers for purge water (if required);
- Solvex or surgical gloves;
- jetting tool, air hose, compressed nitrogen ("A" size cylinder);
- large peristaltic pump (if needed), Tygon tubing, and extra silicone pump head tubing;
- water level indicator;
- stopwatch or wristwatch;
- distilled water;
- tap water;
- laboratory grade detergent;
- paper towels;
- keys to well casing padlocks;
- knife or file to mark north side of stick-up;
- crescent wrenches (2);
- Teflon tape for threads; and

- 50-ft extension cord gauge appropriate to amperage of generator.

4.0 PROCEDURE FOR ROUTINE WELL DEVELOPMENT

4.1 Develop the well as soon as practical after installation, but no sooner than 48 hr after completing the grouting. The objective is to remove as much sediment from the well as practical.

4.2 Use a combination of jetting with nitrogen gas and pumping to maintain a flow of fines from the mudcake and gravel pack to the inside of the well. The nitrogen can be used to remove the water from the well only if containerization of development water is not required. Adjust the flow of nitrogen so that an adequate turbulence is maintained but the water column is not ejected from the well. Raise and lower the jetting tool along the screened interval, then remove it from the well and begin pumping. The Well Wizard model HR4105D well development pump can be equipped with a wiper which enhances the surging action. Raise and lower the pump a few times to stir the sediment in the well, then start the pump.

4.3 The following guidelines have been developed as minimal requirements for well development:

4.3.1 For wells where the borehole was drilled without using fluid (mud or water), remove five times the volume of standing water in the well (well screen and casing plus saturated annulus).

4.3.2 For those where the borehole was drilled or enlarged using fluid (mud or water), remove five times the measured or estimated amount of total fluids lost drilling plus five times the volume of standing water in the well. This procedure also applies in cases of slow recharge, or discolored or particulate-laden water.

4.3.3 Remove the standing water from points near the bottom of the well screen, as well as from points near the top of the water column.

4.3.4 If possible, add no water to the well during development. In addition, use no dispersing agents, acids, or disinfectants.

5.0 WELL DEVELOPMENT IN A LOW HYDRAULIC CONDUCTIVITY FORMATION

The following discussion and well-development technique is taken from Barcelona et al., "Practical Guide For Groundwater Sampling," 1985.

Development techniques for monitoring wells in relatively unproductive geologic materials are somewhat limited. The low hydraulic conductivity of the materials

makes surging water in and out of the well casing difficult. When the well is pumped the entrance velocity of water may be too low to effectively remove fines from the well bore and the gravel pack material outside the well screen.

Clean water can be circulated down the well casing, out through the screen and gravel pack, and up the open borehole prior to placement of the grout or seal in the annulus. Maintain relatively high water velocities so that the mud cake from the borehole wall will be broken down effectively and removed. Control flow rates to prevent floating the gravel pack out of the borehole. Because of the relatively low hydraulic conductivity, a small amount of water will penetrate the formation being monitored. Immediately following this procedure, instal the well sealant and pump the well to remove as much of the water used in the development process as possible.

6.0 ADDITIONAL PROCEDURES

Additional well-development procedures are described in the Manual of Water Well Construction Practices, prepared by the National Water Well Association (U.S. Environmental Protection Agency, 1975).

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-112 Page: 1 of 4 Revision: 0 Date: 10/01/90

WELL INSPECTION AND MAINTENANCE

1.0 PURPOSE

This procedure is designed to provide guidelines for inspection and maintenance of small diameter, shallow monitoring wells.

2.0 APPLICABILITY

Site-specific conditions determine the frequency of well development. However, the wells should be inspected at least annually, depending on the frequency of sampling.

3.0 OTHER DOCUMENTS

3.1 ASSOCIATED PROCEDURES

3.1.1 TE-073 Equipment Decontamination;

3.1.2 TE-094 Water Level Measurement;

3.1.3 TE-111 Well Development.

4.0 EQUIPMENT

4.1 water level indicator;

4.2 oil-free compressed nitrogen;

4.3 surge block;

4.4 fluorescent spray paint;

4.5 pumps (choice dependent on depth and volume requirements);

4.6 tank for containing purge water (if necessary);

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

4.7 steel stamp for numbering wells.

5.0 PROCEDURE

5.1 INSPECTION

Check the surface exterior of the well for damage, including the following conditions. Note any damage and actions taken to correct it in the personal logbook.

5.1.1 Lock working;

5.1.2 Cap on surface easing intact;

5.1.3 Surface casing intact;

5.1.4 Surface grouting intact;

5.1.5 Riser cap present;

5.1.6 Perimeter guard posts present;

5.1.7 Guard posts adequately painted for high visibility; and

5.1.8 Well clearly and correctly numbered.

5.2 SUBSURFACE DAMAGE IDENTIFICATION

5.2.1 Measure the static water level and record. A dramatic change in water level since the last measurement could indicate damage to the casing.

5.2.2 Inspect the interior of the casing for dirt or microbial growth. Bail a sample from the surface of the water table and inspect it for microbial films. Redevelop if microbial growth is evident.

5.2.3 Measure the total depth of the well and record the results. If sediment has reached the bottom of the screen or higher, redevelop.

5.3 WELL REDEVELOPMENT PROCEDURE

Inspect wells annually to determine whether redevelopment is necessary. Any excessive sedimentation would require that the well be redeveloped. Use compressed nitrogen as a surge block for jetting the casing and the screen. Frequently, this should be followed by slow overpumping until the well is

clear. Jetting and surging should be done cautiously to prevent damage to the screen, casing, or bentonite seal.

Local regulations should be checked to determine the proper disposition for purge water.

5.4 AIR DEVELOPMENT

5.4.1 Before each use, clean all equipment to be placed in the well according to TE-073.

5.4.2 Place the jetting tool (connected to a compressed nitrogen gas source) at the bottom of the screened interval. Release the nitrogen at a low flow rate to begin "air lift" pumping of bore water and to reduce the head in the well before surging.

5.4.3 Jet the bottom of the screen to surge water out of the screen and filter pack.

5.4.4 Airlift repeatedly until the sediment removal is complete. For many wells, this technique will not sufficiently remove sediment; They require a surge block and slow overpumping with a peristaltic or other suitable pump.

5.4.5 Raise the jetting tool and repeat the above two steps. Continue until the entire length of screen and filter pack have been developed.

5.4.6 Lower the jetting tool or a pump to the bottom of the well and pump until the water is sediment free.

5.5 SURGE BLOCKING

5.5.1 Before each use, clean all equipment to be placed in the well with tap water containing laboratory-grade detergent (1% solution), followed by a tap water rinse, then a deionized water rinse.

5.5.2 Lower the surge block into the well below the water level but several feet above the screen (if possible). Using a gentle action at first to prevent damaging the well installation, begin surging action to move fine-grained sediments through the screen.

5.5.3 When flow through the well screen begins to improve, lower the surge block several feet and operate over successively deeper intervals of the screen (be careful that the surge block is the proper size and does not

damage the screen--particularly in wells completed with Johnson continuous slot screen, which has vertical ribs on the inside).

5.5.4 Remove the surge block periodically to pump or jet loosened sediment from the bottom.

5.5.5 After surging the entire screened interval, pump the well from the bottom until the water is sediment-free.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-120 Page: 1 of 6 Revision: 0 Date: 10/01/90

PHYSICAL SURVEY

1.0 PURPOSE

This section describes the equipment and methods used in the physical survey of a site. The objectives are to document and map the property boundaries, visible utilities, physical parameters, structural features, monitoring and sampling locations, and to provide required staking and computations.

2.0 EQUIPMENT

2.1 tripods;

2.2 brunton compass;

2.3 optical reading compass;

2.4 bound field book;

2.5 Philadelphia level rod;

2.6 stadia rod;

2.7 range pole;

2.8 Fargo level rod;

2.9 automatic level;

2.10 chaining pins;

2.11 Locke or abney hand level;

2.12 steel tapes (calibrated);

2.13 fiberglass measuring tapes;

Approved by:

K.M. Wynveen 24 Sept 90 (Date)

C.A. Little Craig Little 9/24/90 (Date)

2.14 theodolite (total station);

2.15 survey stakes;

2.16 other survey markers.

3.0 CARE OF EQUIPMENT

Surveying instruments must be maintained in a good operating condition and handled in the following manner:

3.1 Transport equipment to the field in the proper instrument cases.

3.2 Set up the tripod, tighten the wing nuts, and remove any dust or sand from the tripod head.

3.3 Carefully remove the instrument from its case and securely attach it to the tripod.

3.4 When using pivoting-scope instruments, after the instrument has been leveled so that the line of sight is horizontal, lock it into the position selected. Remove the lens cap and attach the sunshield.

3.5 Inspect instruments, clean them, and return them to their respective cases when field work is complete.

3.6 Wipe steel tapes dry with a clean cloth and oil them lightly after use.

3.7 Store all survey equipment in a dry location to avoid damage or warping.

4.0 EQUIPMENT CALIBRATION PROCEDURE

In order to maintain an acceptable level of accuracy in the physical survey, inspect the instruments and adjust as necessary before each use. If calibration is required, only factory-trained personnel are to perform the adjustments. The following paragraphs describe the conditions required for each instrument to be in proper adjustment.

4.1 The automatic level is considered to be in adjustment if, when the instrument is leveled, the horizontal crosshair is truly horizontal, the bubble is centered, and the line of sight is parallel to the axis of the telescope tube.

4.2 Although the theodolite does not generally need to be calibrated, it is possible that the tubular level, the circular level, or the line of sight may require adjustment. The theodolite is in adjustment if the tubular plate level

will center on the midpoint, irrespective of the direction in which the instrument is rotated. The circular-level bubble should be centered through two right angle turns of the theodolite. The line of site is in adjustment if readings of a bearing on both faces differ by exactly 180'

4.3 The electronic distance measurement (EDM) portion of the theodolite is in adjustment when no deviation in measurement exists between a known standard distance and the distance as measured by the instrument. A deviation of several tenths of a foot or less does not require adjustment, but a correction factor should be noted and applied in those cases where extreme accuracy is required. When instrument readings become very erratic, the instrument must be serviced.

5.0 PHYSICAL SURVEY PROCEDURE

5.1 OVERVIEW OF PROCEDURES

5.1.1 The team leader or designated alternate acquires all land information pertaining to the selected site.

5.1.2 Determine and identify apparent property corners for the survey starting point based on the legal description of the site or property.

5.1.3 Locate and plot all topographic features and relative ground elevations. When possible, correct elevations to the nearest USGS bench mark (BM).

5.1.4 Assign each drawing a number using an established drawing identification numbering system.

5.1.5 Complete the surveyor's final drawing with the addition of dimensions, north arrow, box scale, and any other relevant information. Format for CAD drawings is discussed in Section 8. When the surveyor's final drawing is completed, it is checked for accuracy by:

- the team leader or chief surveyor or designated alternate;
- the land survey support department coordinator or a designated and approved survey person; and
- the rodman or draftsman.

5.2 FIELD MEASUREMENT TECHNIQUES

5.2.1 Horizontal distance

Measure horizontal distances using one or more of the following methods.

a. Chain or tape distances using a calibrated steel or fiberglass tape. Maintain the tape on the line being measured, with a uniform tension applied for each measurement. A series of short measurements may be required to keep the tape horizontal on sloping terrain.

b. Use the Leitz Set 3 Total Station electronic distance-measuring instrument to obtain very accurate and quick measurements up to a maximum of 9600 ft (2925 m).

c. Use a stadia rod, read with a transit or automatic level, for quick measurements which do not require the accuracy of chaining.

5.2.2 Differential leveling

Differential leveling determines elevation differences between two or more points. The circuit starts and ends at a benchmark or other point of known elevation. The procedure is as follows.

a. Set the level at a convenient point between the starting benchmark and the next benchmark or turning point.

b. The instrument operator enters the following preliminary information into the survey logbook: survey location, project name, weather conditions, temperature, names of surveyors, date, description of starting and/or ending benchmark, and column headings.

c. The instrument operator observes and records the level rod readings (using the triple wire method) at the backsight benchmark, and records the total as the height of the instrument.

d. Any number of foresights may be sighted from the control station.

e. If the survey requires a series of stations in a traverse, close by sighting a known, established control station as the last foresight and computing the error of closure of the traverse.

f. If locating the present position becomes necessary, triangulate by sighting several other known stations. Calculate the present position using the various trigonometric functions that relate the leg distances and the interior angles of a triangle.

5.2.3 Topographic surveys

Topographic surveys are conducted to obtain ground-relief data and to determine the location of physical features. The primary instrument used is the Leitz Set 3 Total Station, accurately mounted and leveled on a tripod positioned over a benchmark, section corner, or other control station. The surveys are performed in the following manner:

a. Locate and sight a backsight point, whose bearing and measured distance from the control station are known through qualified research (recorded survey plats and previously located survey points), with the instrument. Set the horizontal vernier to zero while sighting the backsight point.

b. Rotate the instrument to sight and foresight, or the object whose location is desired, and read the horizontal angle with the vertical crosshair set on the target. Obtain the vertical angle with the horizontal crosshair centered on the target.

c. Determine the slope or horizontal distance between the two stations using the EDM while sighting the reflecting prism (with attached target) located on the foresight.

d. Any number of foresights may be sighted from the control station.

e. If the survey requires a series of stations in a traverse, close by sighting a known, established control station as the last foresight and computing the error of closure of the traverse.

f. If locating the present position becomes necessary, triangulate by sighting several other known stations. Calculate the present position using the various trigonometric functions that relate the leg distances and the interior angles of a triangle.

5.2.4 Field mapping

Field mapping is accomplished using an alidade, plane table, and stadia rod to plot topographic, natural, and man-made features directly as the physical survey proceeds.

a. Set up the alidade and plane table, determine the declination of magnetic north to grid north, and draw a line representing magnetic north on the paper. The table is rotated and locked in place at the point where the magnetic compass lines coincide.

b. The instrument position will be determined by sighting a known point, reading the stadia distance, and scaling the distance on the map using the alidade straightedge which parallels the line of sight.

c. Any other point may then be plotted by placing the straightedge through the mapped instrument position, reading the stadia distance, and scaling the distance on the map using the alidade straightedge which parallels the line of sight.

d. If the plane table must be moved, a previously located point will be used as the backsight to determine the instruments new position.

5.2.5 Analysis of surveying errors

Errors in surveying work are classified as instrumental, natural, or personal. The surveyor determines the acceptable margin of error based on professional judgement and the accuracy required for the work to be performed. Instrument errors may be reduced to a negligible quantity by properly adjusting the instrument and repeating the measurement. Natural errors are generally of such small magnitude that they are of concern only when very high precision is required. This type of error may be caused by settlement of the tripod, unequal atmospheric refraction, and unequal expansion due to temperature changes. Personal errors arise from the human limitations of the survey crew; as such, they are accidental and cannot be entirely eliminated.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-130 Page: 1 of 2 Revision: 0 Date: 10/01/90

PERISTALTIC PUMP OPERATION

1.0 PURPOSE

This procedure describes the general use of a peristaltic pump. For more detailed information, refer to the specific manufacturer's manual for the pump used.

2.0 DEFINITIONS

2.1 BGL: below ground level

3.0 DISCUSSION

Peristaltic pumps create suction by means of rollers turning about a central shaft on the pumphead. The rollers squeeze a length of silicone tubing flat, creating suction behind them. The silicone tubing is connected to the sample tubing, which is lowered into the well. Peristaltic pumps never need to be primed, and they can pump shallow, slow recharge wells to dryness. However, suction lift is limited to ~20 ft BGL, and the pumping rate is relatively slow. Also, suction degases the water as it is pulled through the tubing, making this type of pump unsuitable for collecting volatile organic samples.

4.0 PROCEDURE

4.1 Connect Tygon tubing to silicone tubing at the pumphead. For purging, use larger diameter, thicker-walled tubing. Sampling requires smaller diameter tubing and slower flow rates.

4.2 Lower the intake end of the tubing to the appropriate depth in the well. Eliminate the tendency of plastic tubing to curl by attaching a stainless steel tubing weight to the end.

4.3 Connect the outlet end of the tubing to the in-line filter or flow-through cell as needed. The flow rate needs to be decreased at this point to avoid leaks at the various connection points. For filtered samples, if fine sediment is present in the well water it may be necessary to install a glass fiber prefilter upstream from the 0.45µm filter to minimize clogging.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

4.4 After use, decontaminate the tubing and filter holders by washing them with detergent tap water, followed by a tap water rinse and a deionized water rinse. Sample tubing should be dedicated to each well. Decontaminate the exterior surface of non-dedicated tubing according to TE-073.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-131 Page: 1 of 2 Revision: 0 Date: 10/01/90

BLADDER PUMP OPERATION

1.0 PURPOSE

This procedure describes the use of the ISCO Series 3600 bladder pump. For more information, refer to the manufacturer's manual.

2.0 DEFINITIONS

2.1 psig: pounds per square inch gauge

3.0 DISCUSSION

The bladder pump operates by alternately inflating and deflating a Teflon covered elastomeric silicone bladder, which pushes against the pump body and, displaces water upward through a ball check valve and into the sample line. Since the sample water contacts only Teflon and stainless steel, and is pushed through the tubing rather than pulled, this type of pump is suitable for collecting volatile organics (provided Teflon tubing is used for the sample line). The bladder pump operates at a maximum depth of ~150 ft; maximum flow rate varies from 1.7 to 3.7 L/min, depending on depth.

Disadvantages to this type of pump are that the well water must be free of sediment, especially of angular particulates which tear the Teflon outer bladder, and the pump must be fully submerged in order for the bladder to effectively push water upward. Also, the ISCO 3600 pump cannot be used for well purging or development, as extended bladder cycling tears the Teflon.

4.0 PROCEDURES (ISCO SERIES 3600 WELL SAMPLING SYSTEM)

4.1 Connect the Teflon air line and the Teflon sample line to the controller and pump. Connect the stainless steel cable to the pump. The operator's manual should be consulted for tubing requirements. While lowering the pump into the well, make certain that the Teflon lines are lowered at the same rate as the cable to prevent the lines from becoming kinked at the top of the pump.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

4.2 Air can be supplied by either a portable compressor or a tank of compressed air or nitrogen. However, take care to regulate all gas supplies to a pressure no greater than 115 pounds per square inch gauge (psig). For limited sampling, scuba tanks of compressed air provide a lightweight gas supply.

4.3 Control the flow rate by adjusting both the air inlet pressure and the sample volume switch on the controller. Longer, smoother pulses can be obtained by rotating the Off/On/Sample Volume switch clockwise (to increase). Achieve short, rapid surges and maximum pumping rate by turning the switch counterclockwise (to decrease). The Isco operator's manual states that the pump will operate from ~20 to 115 psig. However, to prolong the life of the Teflon outer bladder, keep the gas supply pressure at a minimum. Isco offers the following guidelines for determining gas supply pressure:

4.3.1 for pumping from depths <50 ft, use 50 psig; and

4.3.2 for pumping from depths >50 ft, use the formula $P = 0.6H + 20$, where: P = the gas supply pressure, in psig; and H = the lift head, from the pump inlet to the ground surface, in feet. For example, the minimum required gas pressure for a pump lift head of 80 ft is $0.6 \times 80 + 20 = 68$ psig.

4.4 To minimize turbulence and aeration of the pumped water, decrease the gas pressure until a satisfactory flow rate is obtained. It may be necessary to increase the Off/On/Sample Volume switch to maintain sample volume. Extremely low turbulence can be achieved by rotating the Off/On/Sample Volume switch to off, then pressing the Manual Sample button while slowly increasing the gas pressure as a trickle of water comes out of the sample tube. When the sample is obtained, release the Manual Sample button. If more sample is needed, repeat the above procedure by first returning the pressure to zero.

4.5 When retrieving the pump from the well, again make certain that the Teflon tubes are withdrawn at the same rate as the cable.

4.6 Disassemble the pump and decontaminate according to TE-073.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-132 Page: 1 of 3 Revision: 0 Date: 10/01/90

WELL DEVELOPMENT PUMP OPERATION

1.0 PURPOSE

This procedure describes the use of the Well Wizard Model HR4105D well development pump with Model 350 controller. For more information, refer to the manufacturer's manual.

2.0 OTHER DOCUMENTS

2.1 ASSOCIATED PROCEDURES

2.1.1 TE-073 Equipment Decontamination;

2.1.2 TE-111 Well Development.

3.0 DISCUSSION

The well development pump is similar in principle to the bladder pump, except that gas is used to displace the water in the pump body. The pump controller alternately pressurizes, then vents the air supply line into the pump. Because the pump and tubing are not made from inert materials and turbulence is created by the air surges, this pump is unsuitable for sampling. Maximum pumping depth is 150 ft at a maximum rate of ~0.6 gal/min. At shallower depths it is possible to pump up to ~5 gal/min.

4.0 PROCEDURE

4.1 WELL PURGING AND DEVELOPING

4.1.1 Using the female end of the coupling supplied, attach the red compressed gas source hose to the long quick-connect nipple labeled "Pump Pressure Inlet" on the face of the controller, located in the upper right hand corner of the controller panel. Install the other end of this hose (a male 1/4 in. pipe thread fitting) in the air-cylinder regulator or air compressor.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

4.1.2 Connect either end of the red controller air hose to the short brass quick-connect nipple labeled "Pump Supply," located on the lower right hand side of the controller panel. Connect the other end of the controller air hose to the same type of quick-connect nipple located on the hose reel or the pump air hose.

4.1.3 To begin operating the pump, turn on the supply of compressed gas connected to the controller. Set pressure to 80 to 100 psig. If, after 10 to 15 s, the controller has not begun cycling, briefly push down the battery test button located in the middle of the controller panel. After 5 to 15 pumping cycles, full water flow from the sample supply tube should begin.

4.1.4 The refill and discharge control knobs, which control cycle times, are located on the controller panel just to the left of the pump supply quick-connect. They should be set in a 12 o'clock position for average well depths and average pump submergence (depths of 50 to 75 ft, submergence of 20 to 30 ft). To optimize pumping efficiency for a specific well depth, use the following three-step procedure:

a. Adjust the refill and discharge cycles to 10 to 15 s each. Measure the water volume discharged in a single discharge cycle.

b. Shorten the discharge cycle period (by adjusting the knob counterclockwise) until the end of the discharge cycle just begins to coincide with the end of water flow from the pump outlet.

c. Shorten the refill cycle period until the water volume per discharge cycle decreases 10 to 25% from the maximum value measured in step a.

4.1.5 To reduce water flow rate, decrease the pump supply pressure by turning the yellow knob labeled "Flow Throttle" counterclockwise. This knob is located at the lower left of the controller panel. When the pump supply pressure is decreased, increase the discharge cycle time to allow the full pump volume to exit the discharge tube.

4.2 OPERATING GUIDELINES

4.2.1 Deeper wells require both the refill and discharge cycles to be lengthened by turning the control knobs clockwise.

4.2.2 During the <u>discharge cycle</u>, apply the compressed gas source to the sample pump to discharge water. During the <u>refill cycle</u> vent the pump to atmosphere at the controller and allow the pump to refill.

4.2.3 When the water discharge flow rate decreases with the flow throttle, it is often necessary to increase the discharge cycle time to deliver a full pump volume.

4.2.4 The volume of water pumped per cycle should be approximately 250 to 350 mL. If the volume is below this level, recheck the cycle lengths according to the 3-step procedure outlined in step 5 above. If the volume is still unsatisfactory, check all air and water fittings for leaks.

4.2.5 When pumping deeper wells (>100 ft), the weight of the water line with water can cause the hose to separate at its connections. Reinforce the connections in order to avoid losing the pump in the hole.

4.3 FLOW THROTTLE GUIDELINES

4.3.1 Turning the yellow throttle-control knob clockwise increases both the pressure supplied to the pump and the flow rate.

4.3.2 Turning the yellow throttle-control knob counter-clockwise decreases both the pressure supplied to the pump and the flow rate.

4.3.3 The yellow throttle-control knob locks into place when pushed down; in this position it cannot be rotated. To rotate the knob, pull it up.

4.3.4 The pressure gauge on the controller shows the pressure applied to the sample pump. During the discharge cycle the gauge will indicate that pressure is being applied to the pump; during the refill cycle the gauge will fall to zero as the pressure is vented through the controller.

4.4 BATTERY GUIDELINES

4.4.1 Alkaline batteries are recommended.

4.4.2 As controller operating temperatures drop below 40 to 50° F, battery life decreases.

4.4.3 A continuous green battery life indicator light signal while the battery test button is depressed indicates fresh batteries.

4.4.4 A split-second flash of green on the battery life indicator light or a dead light while the battery test button is depressed indicates batteries need replacement.

4.4.5 The battery test button is also used to "start the controller" when a sampling session is just beginning. See controller operation section.

INTERNAL DISTRIBUTION (GRAND JUNCTION)

1. S. M. Berkoff
2-8. N. G. Conklin
9. T. A. Cronk
10. P. V. Egidi
11. D. B. Ertel
12. M. L. Espegren
13. F. G. Gardner
14. D. K. Halford
15. R. R. Knott
16. N. E. Korte
17. B. J. Krall
18. C. A. Little
19. D. A. Locke
20. D. C. Marty
21. C. A. Muhr
22. D. A. Pickering
23. J. A. Rice
24. S. M. Smuin
25. G. H. Stevens
26. J. E. Thate
27. M. J. Wilson
28. Brown van
29. Red van
30. OCS van
31. Dark-blue extended van
32. Baby-blue extended van
33. U2CRT
34. Blue Cherokee
35. Blue Pickup
36. Big red truck
37. Library Archive Library
38-42. PAG
43. PAG Soils Laboratory

INTERNAL DISTRIBUTION (OAK RIDGE)

44. B. A. Berven
45. L. S. Corrill
45. S. V. Kaye
46. D. C. Landguth
47. P. S. Rohwer
48. R. L. Siegrist
49. R. E. Swaja
50. P. F. Tiner
51. Central Research Library
52-53. Laboratory Records Department
54. Laboratory Records, ORNL-RC
55. ORNL Patent Section

EXTERNAL DISTRIBUTION

56. Office of Assistant Manager for Energy Research and Development, Oak Ridge Field Office, P.O. Box 2001, U.S. Department of Energy, Oak Ridge, TN 37831-8600
57. W. L. Beck, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, TN 37831-0117
58. D. E. Brown, Senior Environmental Protection Specialist, Allied-Signal, Inc., 200 E. 95th St., Kansas City, MO 64131
59. T. J. Harvey, Office of Technical Services, H & R Technical Associates, 12800 Middlebrook Rd., Suite 207, Germantown, MD 20874
60. P. Keary, U. S. Department of Energy, Kansas City Area Office, 2000 E. 95th St., Kansas City, MO 64131
61. D. N. Mackenzie, Office of Technical Services, H & R Technical Associates, 12800 Middlebrook Rd., Suite 207, Germantown, MD 20874
62. D. Robertson, HAZWRAP, P.O. Box 2003, Oak Ridge, TN 37831-7606
63. B. Stanley, HAZWRAP, P.O. Box 2003, Oak Ridge, TN 37831-7606
64. M. Wade, HAZWRAP, P.O. Box 2003, Oak Ridge, TN 37831-7606
65–66. Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831