DOE/OR/22160--T15

HEALTH AND SAFETY PLAN
(Revision 2)

**DEMONSTRATION TESTING AND EVALUATION
OF IN SITU SOIL HEATING**

Contract Number DE-AC05-93OR22160
IITRI Project C06787

DISCLAIMER

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.

For

Department of Energy
Oak Ridge Operations
P. O. Box 2001
Oak Ridge, Tennessee 37831

ATTN: Mr. Johnny Moore

By

Harsh Dev
IIT Research Institute
10 West 35th Street
Chicago, Illinois 60616
December 28, 1994

COMMITMENT TO EXCELLENCE

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DT

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

HEALTH AND SAFETY PLAN, REVISION 2

for

Demonstration, Testing, and Evaluation of

In-Situ EM Heating Technology, at

K-1070 C/D Classified Burial Ground

K-25 Site, Oak Ridge, Tennessee

Raymond McCauley,
IITRI Environmental Health and Safety Officer

12/28/94
Date

David Jones, Site Health and Safety Officer (SHSO)

12/28/94
Date

Guggilam Sresty, Project Manager

12/28/94
Date

Harsh Dev

12/28/94
Date

FOREWORD

This document is the Revised Health and Safety Plan, Revision 2, for US DOE contract entitled, "Demonstration Testing and Evaluation of In Situ Soil Heating," Contract Number DE-AC05-93OR22160, IITRI Project Number C06787. Other related documents which have been submitted are: Treatability Study Work Plan (Revision 1) and Demonstration System Design (Draft). Appendix D of this document contains responses to questions and clarifications raised by U.S. Department of Energy (DoE) Safety review of the Draft HASP. Appendix E of this document contains responses to questions and clarifications raised by the U. S. DoE Safety review of Revision 1 of this HASP.

In this project IIT Research Institute (IITRI) will demonstrate its in situ soil heating and decontamination technology which uses 60 Hz AC power to heat soil to a temperature of about 85° to 95°C. This technology is aimed at the decontamination of soil by the removal of organic hazardous constituents by the action of heat and a vacuum gas collection system.

Respectfully Submitted
IIT Research Institute

Harsh Dev
Science Advisor
Energy and Environmental Sciences

Approved:

G. C. Sresty
Manager
Energy and Environmental Sciences

TABLE OF CONTENTS

Section	Title	Page
1	INTRODUCTION	1
1.1	Description of the Technology	1
2	SITE DESCRIPTION	4
2.1	Site History	4
2.2	Soil Sample Analysis Results	6
2.3	Contaminants of Concern	12
2.4	Estimate of Contaminant Weight and Emissions	12
2.5	Site Location and Conceptual Layout	12
3	PROJECT ORGANIZATION AND RESPONSIBILITIES	16
3.1	Project Manager	16
3.2	Site Operations Manager	16
3.3	SHSO	18
3.4	Field Project Personnel	19
4	SITE OPERATING PROCEDURES	21
5	CONTINGENCY PLAN	25
5.1	Shift Superintendent	25
5.2	Emergency Preparedness	25
5.2.1	Reporting an Emergency	26
5.2.2	Alarm Signals	27
5.2.3	Site Evacuation Procedures	27
5.2.4	Important Reminders	28
5.3	On Site Sheltering in Place	28
5.4	On-Site Relocation	29
5.5	On-Site Facility Evacuation	29
6	HEALTH AND SAFETY HAZARD ANALYSIS AND CONTROLS	31
6.1	Suspected Contaminants	31
6.2	Task-Specific Hazard Evaluation	31
6.2.1	Precautions and Procedures for Mitigating Electrical Shock Hazards	43
6.2.2	Electrode Array, Gas Collection Well, and Thermowell Installation	52
6.2.3	Decontamination	53
6.2.4	Subsurface Soil Sampling	53
6.3	Special Hazards	54
6.3.1	Heat Stress	54
6.3.2	Animal Hazards	54
6.3.3	Ergonomics	55

TABLE OF CONTENTS (Continued)

Section	Title	Page
7	SITE CONTROL MEASURES	56
7.1	Zone 1: Exclusion Zone	55
7.2	Zone 2: Contamination Reduction Zone	61
7.3	Zone 3: Support Zone	61
8	TRAINING REQUIREMENTS	62
9	PERSONAL PROTECTIVE EQUIPMENT	64
9.1	Protective Clothing Donning Procedure	66
9.2	During the Work Task	67
9.3	Protective Clothing Doffing Procedure	67
9.4	Respiratory Protection	68
10	MONITORING AND SAMPLING	71
11	DECONTAMINATION PROCEDURES	74
11.1	Personnel Decontamination Procedures	74
11.1.1	Level D Protection Decontamination	74
11.1.2	Level D+ Protection Decontamination	77
11.1.3	Level C Protection Decontamination	77
11.2	Equipment Decontamination	79
12	REFERENCES	80
APPENDIX A	EXCERPTS FROM: K-25 FACILITY EMERGENCY PROCEDURE	A-1
APPENDIX B	IITRI'S LOCKOUT/TAGOUT PROGRAM	B-1
APPENDIX C	IITRI'S RESPIRATORY PROTECTION PROGRAM AIR PURIFYING RESPIRATORS AND THEIR USE RELATED TO SPECIFIC HAZARDS... WRITTEN STANDARD PRACTICE	C-1
APPENDIX D	ANSWERS TO THE DRAFT HEALTH AND SAFETY PLAN REVIEW QUESTIONS FROM DOE	D-1
APPENDIX E	ANSWERS TO THE REVISION 1 HEALTH AND SAFETY PLAN REVIEW QUESTIONS FROM DOE	E-1

LIST OF FIGURES

Number	Title	Page
1	Artist's Illustration of the EM Process	3
2	Map of the K-1070 C/D Classified Burial Ground Showing Burial Areas and Sampling Locations	5
3	Map Showing the Location of the Demonstration Site	8
4	Conceptual Site Layout	15
5	Project Organization Chart	17
6	K-25 Site Assembly Station Directory	30
7	Site Work Zones	57
8	Conceptual Site Layout Showing Electrical Exclusion Zone	58
9	Contour Plot of Step-Potential at 100 kW, Initial Condition	59
10	Contour Plot of Step-Potential at 100 kW "Dried Out" Condition	60
11	Minimum Decontamination Requirements for Level D+ Protection	75
12	Minimum Decontamination Requirements for Level C Protection	76

LIST OF TABLES

Number	Title	Page
1	Concentration of Volatile Organics, ppb	7
2	Volatile Hydrocarbons Found in Bore Holes 71, 75, 76, 80	9
3	Semivolatiles Found in Bore Holes 71, 75, 76, 80	10
4	Measurement of Radioactivity in Soil Samples, pCi/gm	11
5	Estimate of Volatile Contaminant Mass Loading in the Demonstration Volume	13
6	Emergency Phone Numbers	25
7	Contaminant Characteristics	32
8	Major Tasks and Associated Sub-Tasks	35
9	Hazards Analysis for In Situ EM Technology Demonstration	37
10	Safe Working Distances From Electrical Transmission Lines for Equipment	45
11	Training Requirements for Workers and Visitors at the EM Demonstration Site	63
12	Site Monitoring Action Limits	72
13	Summary of Contamination Values	73

ACRONYMS

APR	air purifying respirator
CNS	central nervous system
CVS	central vascular system
DAC	derived air concentration
DOE	U. S. Department of Energy
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	U. S. Environmental Protection Agency
FEV	forced expiratory volume
FOM	Field Operations Manager
FP	flashpoint
FVC	forced vital capacity
GET	General Employee Training
GFI	ground fault interrupting
GI	gastrointestinal tract
HASP	Health and Safety Plan
HP	health physics
HSD	Health and Safety Division
IDLH	immediately dangerous to life and health
IH	industrial hygiene
IITRI	IIT Research Institute
IP	ionization potential
IS	industrial safety
LEL	lower explosive limit
LFL	lower flammability limit
MSDSs	Material Safety Data Sheets
NA	not available
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PEL	permissible exposure limit
PPE	Personal Protective Equipment
PVC	polyvinyl chloride
QAPjP	Quality Assurance Project Plan
QA	quality assurance
SA	Safety Assessment
SCBA	self-contained breathing apparatus
SED	site emergency director
SHSO	Site Health and Safety Officer
SOL	solubility
SR	Safety Reviews
STEL	short-term exposure limit
TLV	threshold limit value
TWA	time-weighted average
UEL	upper explosive limit
UFL	upper flammability limit
VP	vapor point
WBG	wet bulb globe temperature
WSP	written standard practice

1. INTRODUCTION

This document is the Health and Safety Plan (HASP) for the demonstration of IITRI's EM Treatment Technology. In this process, soil is heated in situ by means of electrical energy for the removal of hazardous organic contaminants. This process will be demonstrated on a small plot of contaminated soil located in the Pit Area of Classified Burial Ground K-1070-D, K-25 Site, Oak Ridge, TN. The purpose of the demonstration is to remove organic contaminants present in the soil by heating to a temperature range of 85° to 95° C. The soil will be heated in situ by applying 60-Hz AC power to an array of electrodes placed in boreholes drilled through the soil. The design of the demonstration system is described in Reference 1.

In this section a brief description of the process is given along with a description of the site and a listing of the contaminants found in the area.

1.1 DESCRIPTION OF THE TECHNOLOGY

Over the last nine years IITRI has been developing and testing the in situ heating and soil decontamination process for the remediation of soils containing hazardous organic contaminants. In this process the soil is heated in situ using electrical energy. The contaminants are removed from the soil due to enhanced vaporization, steam distillation and stripping. The vaporized contaminants, water vapor and air are recovered from the heated zone by means of a vacuum manifold system which collects gases from below surface as well as from the soil surface. A vapor barrier is used to prevent fugitive emissions of the contaminants and to control air infiltration to minimize dilution of the contaminant gases and vapors. The recovered gases and vapors are conveyed to an on site vapor treatment system for the clean up of the vent gases.

Electrical energy is applied to the soil by forming an array of electrodes in the soil which are electrically interconnected and supplied with power. The electrodes are placed in drilled bore holes which are made through the contaminated zone. There are two versions of the in situ heating and soil treatment process: the first version is called the In Situ Radio Frequency (RF) Soil Decontamination Process and the second version is called the In Situ Electromagnetic (EM) Soil Decontamination Process. The first version, the RF Process is capable of heating the soil in a temperature range of 100° to 400°C. The soil temperature in the second version, the EM Process, is limited to the boiling point of water under native conditions. Thus the soil will be heated to a temperature of about 85° to 100°C, depending upon native conditions.

In this project IITRI will demonstrate the EM Process for in situ soil decontamination at Site K-25 due to the fact that most of the contaminants of concern are volatile organics which can be removed by heating the soil to a temperature range of 85° to 95°C.

The efficiency of the in situ treatment will be determined by comparing the concentration of contaminants in soil samples. Samples will be obtained before and after the demonstration for a measurement of the concentration of contaminants of concern.

Figure 1 is an artist's sketch illustrating the electrode array and the vapor barrier used for the implementation of the EM soil decontamination process. The electrode array is formed by drilling multiple rows of electrodes in the soil volume which is to be heated. The tubular electrodes are made from pipe or tubing fabricated from copper, steel or aluminum. The electrodes are dropped into bore holes and electrically connected at the surface to the power source. A vapor barrier is placed on the surface to prevent fugitive emissions of gases and vapors formed upon heating of the soil. The vapors and gases formed upon heating of the soil are recovered by means of a vacuum manifold system which collects gases and vapors from the surface of the heated zone as well as from gas collection wells which have perforations to assist in the collection of the gases and vapor formed in the heated soil volume.

The collected gases are treated on site by means of conventional gas treatment unit operations which depend upon the amount, concentration, and type of contaminants. In this project, because of the low concentrations and total weight of contaminants, it is proposed to release the collected gases without treatment.

In Situ Electromagnetic (EM) Heating Process for Soil Decontamination

IN SITU Radio Frequency Soil Decontamination Process

Figure 1. Artist's Illustration of the EM Process.

2 SITE DESCRIPTION

2.1 SITE HISTORY*

The K-1070-C/D Classified Burial Ground is a 22-acre tract on the east side of the K-25 Site, inside the security perimeter fence. A security-cleared escort is required for entry by uncleared personnel. The K-1070 C/D Classified Burial Ground is composed of two distinctly bounded disposal areas: the K-1070-C maintenance equipment storage area and the K-1070-D disposal area. Prior to the establishment of K-1070-C as a maintenance equipment storage site (circa early 1975), the area was used as a burial ground for classified material. The K-1070-C area is currently serving as a maintenance equipment storage area. A shed and several piles of landscaping materials are located in this area. In general, the storage area is covered with gravel and serves as a parking lot. A natural drainage gully is located behind the shed; it channels surface water runoff from the K-1070-D hill. This ditch area and the boundary of the storage area are covered with vegetation.

The K-1070-D area is mostly covered with scrub grass and small trees. Several large trees are located along the northeast and southern boundaries. The southern portion of the site, which slopes downhill, has been eroded by heavy rainfall events, and several deep gullies are present in this area. Surface water runoff in the southern portion of the burial ground is funneled down these gullies to the drainage ditch located in the K-1070-C area. The K-1070-D disposal area is composed of multiple disposal sites, including 3 large trench burial areas, 3 earthen dike storage areas, 13 small pits, 3 glass pits, 2 land farms, and a concrete pad.

The proposed demonstration will be done in the pits area as shown on Figure 2. A brief description of the pit area is given below. Reference 2 contains description of the other past disposal activities in K-1070-D.

Pits

Ten pits (A-1, A-2, B-1, B-2, D-1, D-2, E-1, E-2, G-1, and G-2) are located on the west side of the K-1070-C/D Classified Burial Ground tract, and each measures ~20 x 20 x 20 ft. These pits were used from 1977 to 1979 for the disposal of various hazardous wastes, including laboratory quantities of corrosives, oxidizers, reducing agents, and chemical and pesticide containers. One of the "G" pits was used for the disposal of drum quantities of various

* Taken from Reference 2.

Figure 2. Map of the K-1070 C/D Classified Burial Ground Showing Burial Areas and Sampling Locations (Taken From Reference 2).

solvents and organics including methylene chloride, freon, and trichloroethene. Liquid wastes were poured onto sand back filled into the bottom of the pits.

Glass Pits

In addition to the pits described above, three more pits (glass pits H, I, and J) on the site were used for the disposal of plastic materials and waste glass. These three pits are located immediately adjacent to the pits listed above. All 13 pits were used from 1977 to 1979 for the disposal of hazardous wastes and are believed to be a significant source of contamination.

Perennial Spring

A perennial spring is located about 200 ft west of K-1070-C/D Classified Burial Ground. This spring is the result of efforts to route seepage in this area to a local storm drain. In the mid-1970s, a polyvinyl chloride pipe was inserted into the K-1070 C/D Classified Burial Ground hillside. The pipe now serves as a conduit for the perennial spring.

2.2 SOIL SAMPLE ANALYSIS RESULTS

Table 1 is a summary of soil sample analyses³ for volatile hydrocarbons. The soil samples were obtained from Bore Holes 71, 75, 76 and 80 marked on Figure 3. As the data show the highest concentration of total volatile hydrocarbons occurs in hole 71. This hole also has the highest concentration of volatile chlorinated hydrocarbons. Due to these results the demonstration should be located as close as possible to Bore Hole 71 while satisfying other constraints. Table 2 is a list of volatile hydrocarbons which were analyzed and found in the soil samples obtained from the four bore holes. The soil obtained from these four bore holes was also analyzed for semi-volatiles, pesticides and PCBs. Table 3 summarizes the results of these analyses. It should be noted that the concentration of the semivolatiles is low, ranging from less than 1 ppm to 7 ppm. The maximum concentration of PCB was found in Bore Hole 71 which had 6.5 ppm of Aroclor 1248 and 4.1 ppm of Aroclor 1254.

Measurements of radioactivity from the soil samples at various depths was done. Table 4 summarizes the radiation level for soil samples as a function of depth and bore holes. As the data indicate, the specific activity of various radio-isotopes in the soil is quite low.

It should be noted that the information presented in this section and in Tables 2 to 4 is based on preliminary results.

Table 1. Concentration of Volatile Organics, ppb

	Hole Number 71			Hole Number 75		Hole Number 76		Hole Number 80		
	5-10 ft	10-15 ft	15-20 ft	5-10 ft	10-15 ft	5-10 ft	15-18 ft	0-5 ft	10-15 ft	15-18 ft
Total Volatiles, ppb	5300	29500	54900	6900	6600	20	390	30	5900	4200
Total Chlorinated Volatile HCs, ppb	20	1100	4200	75	700	0	210	10	120	540

(Based on Preliminary Data, Reference 3)

LEGEND:

- EXISTING BUILDING
- EXISTING FENCELINE
- EXISTING CONTOUR
- EXISTING TREELINE
- EXISTING TREE
- AREA OF CONTAMINATION (AOC)
- TANK PIT
- EXIST. MANHOLE
- EXIST. CATCH BASIN
- EXIST. FIRE HYDRANT
- EXIST. POWER POLE
- EXIST. LIGHT POLE
- BRW-11..... BEDROCK WELL
- UNW-110..... UNCONSOLIDATED WELL
- TMW-1..... MONITORING WELL
- 16-A..... PHASE 1 SOIL BORING
- SB-025..... PHASE 2 SOIL BORING
- TMW-2..... K-1414 SOIL BORING
- SW-28..... PHASE 1 STORM WATER SAMPLE
- SW-022..... PHASE 2 STORM WATER SAMPLE
- SD-001..... PHASE 2 SEDIMENT SAMPLE
- SURVEYED BUT NOT SAMPLED

SAIC

Science Applications
International Corporation

**K-1070 C/D CLASSIFIED
BURIAL GROUNDS
OAK RIDGE, TENNESSEE**

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	R. BEELER	D. KEEFER	02-20-94

XREFERENCES	PLOT FILES
/93043/XREF/5835513	/93043/PL01/31311X17
/93043/XREF/5835514	
/93043/XREF/5835518	
/93043/XREF/5835519	

SHT. 1 OF 1	/94043/DWGS/31311X17	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

Table 2. Volatile Hydrocarbons Found* in Bore Holes
71, 75, 76, 80

Contaminants	Concentration Range, ppb
<u>Hydrocarbons:</u>	
Acetone	15-26,000
2-Butanone	10-16,000
Ethyl Benzene	15-180
Toluene	140-2200
2-methyl-2-pentanone	15-25
Benzene	up to 6
Carbon disulfide	up to 7
<u>Chlorinated Hydrocarbons:</u>	
Methylene Chloride	5-40
Tetrachloroethene	25-130
1,1,1-Trichloroethane	5-25
1,1,2-Trichloroethane	10-90
Trichloroethene	20-400
1,1-dichloroethane	15-60
1,2-dichloroethane	5-30
1,1,2,2-trichloroethane	up to 15

* Only those found at or above detection limit.
Based on preliminary data, Reference 3.

**Table 3. Semivolatiles Found* in Bore Holes
71, 75, 76, 80**

Contaminant ¹	Concentration Range, ppb
bis(2-ethyl hexyl) phthalate	62 - 6600
Chrysene ²	250 - 1300
Di-n-butyl phthalate ²	400 - 650
Dimethyl phthalate	49
2,4-Dimethylphenol ²	42 - 77
Fluorene	58 - 160
Isophorone ³	140
2-methylnaphthalene	320 - 770
Naphthalene	63 - 360
2-nitrophenol	73 - 84
Naphthalene	63 - 360
2-nitrophenol	73 - 84
N-nitrosodlphanylamine ³	40
Pentachlorophenol ³	38 - 130
Phenanthrene	95 - 130
Pyrene ⁴	45
PCBs and Pesticides	
Aldrin ³	1.2
Aroclor ³ 1242	1200
Aroclor 1248	200 - 6500
Aroclor ² 1254	350 - 4100

* Based on preliminary data from Reference 3.

¹ Only those found at or above detection limit.

² Found in Blanks also.

³ In Bore hole 80 only.

⁴ In Bore hole 76 only.

Table 4. Measurement of Radioactivity in Soil Samples, pCi/gm

Radio-Isotope	Units	Hole Number 71			Hole Number 75		Hole Number 76		Hole Number 80		
		5-10ft	10-15ft	15-20ft	5-10ft	10-15ft	5-10ft	15-18ft	0-5ft	10-15ft	15-18FT
Co-60	pCi/g	0.31	0.35	0.3	0.32	0.27	0.28	0.22	0.23	0.27	0.28
Cs-137	pCi/g	0.22	0.06	0.15	0.3	0.26	0.17	0.27	0.3	0.31	0.28
Gross Alpha	pCi/g	28±10	35±9.5	26±8.5	20±7.3	31±9.3	21±9.7	19±7.8	27±5	25±5	48±5.9
Gross Beta	pCi/g	28±5	35±5.7	35±5.3	20±4.7N	42±5.7	35±5.6	26±5	0.09±0.93	0.51±1.4	-1.20±1.3
Sr-90	pCi/g	0.53±0.73	1.50±0.54	0.49±0.86	-0.98±1.2	-1.80±4.5	3±2.6	-0.23±0.5	1.30±1.2	0.86±1.2	0.99±0.28
Tc-99	pCi/g	0.06±1.2	0.06±1.2	0.72±1.2	0.70±1.2	1.70±1.2	0.50±1.2	1±1.2	1.70±0.4	1.30±0.35	0.80±0.28
U-234	pCi/g	1.30±0.32	1.30±0.32	0.90±0.27	0.68±0.24	0.78±0.26	1.30±0.35	0.03±0.32	0.15±0.12	0.08±0.09	0.10±0.1
U-235	pCi/g	0.07±0.08	0.07±0.08	-0.01±0.01	0.05±0.07	0.01±0.05	0.11±0.1	0.11±0.1	1.80±0.41	1.20±0.35	0.64±0.25
U-236	pCi/g	1.2±0.3	1.20±0.3	0.83±0.27	0.77±0.25	0.86±0.26	1.10±0.32	0.87±0.3			

Based on Preliminary Data, Reference 3

2.3 CONTAMINANTS OF CONCERN

The main contaminants of concern are the volatile hydrocarbons and chlorinated hydrocarbons present at the site. Based on the concentration ranges given in Table 2 the main contaminants of concern for this demonstration are:

- Benzene, toluene, ethyl benzene, xylene (BTEX family)
- 2-Butanone
- Various chlorinated hydrocarbons derived from methane, ethane, ethylene

2.4 ESTIMATE OF CONTAMINANT WEIGHT AND EMISSIONS

Using the data presented in Table 1, an estimate of the weight of contaminants in the heated volume of soil was made. Table 1 presents the concentration of total volatile hydrocarbons (including chlorinated volatile hydrocarbons) as well as a separate estimate of only chlorinated volatile hydrocarbons. These data are summarized in Table 5 along with an estimate of maximum and average weight of the contaminants in the heated zone. The demonstration will be done outside the Q fence near Bore Hole 71. This distance is estimated to be approximately 40 to 65 ft from Bore Hole 71. Other nearby Bore Holes are 75 (concentration data in Table 10) and 74. It is estimated that Bore Hole 75 will be within 25 to 40 ft of the heated volume. As the data of Table 5 show, the concentration of contaminants in soil obtained from Bore Hole 75 is less than that of Bore Hole 71 by a factor of 4 to 8. Concentration data for Bore Hole 74 was not available.

The estimated weight of total volatile hydrocarbons is in the range of 5 to 45 lbs. And the estimated weight of chlorinated hydrocarbons is in the range of 0.3 to 3 lbs. In Reference 1, it was estimated that the soil heating will take 18 to 25 days. Thus the average rate of total volatile hydrocarbon removal from the heated zone will be in the range of 0.2 to 2.5 lb/day, and 0.01 to 0.2 lb/day for the volatile chlorinated hydrocarbons. This assumes 100 percent recovery of the hydrocarbons and uniform rate of recovery over time.

The above calculations show that the total weight of contaminants as well as their average rate of recovery will be quite small. In fact, these rates may be small enough to justify open release to the atmosphere without treatment, as long as there is no steam condensation at the outlet of the vent stack.

2.5 SITE LOCATION AND CONCEPTUAL LAYOUT

It is planned to conduct the demonstration outside the Q fence on the shoulder of the road between Bore Holes 74 and 75 which are

Table 5. Estimate of Volatile Contaminant Mass Loading
in the Demonstration Volume
(All Concentrations are in ppm,
all masses are in lb.)
(Assumes: 8000 cu. ft. heated,
equivalent to 400 tons)

	BORE HOLE NUMBER			
	71	75	76	80
Max. Volatile Concentration Encountered in any depth interval	55	6.9	0.39	5.9
Average Volatile Concentration encountered averaged over all depth intervals	30	6.8	0.2	3.4
Mass of Volatile Contaminants				
based on max. conc.	44	5.5	0.31	4.8
based on average conc.	24	5.4	0.16	2.7
Max. Chlorinated Volatile Concentration in any depth interval	4	0.71	0.21	0.54
Average Chlorinated Volatile Concentration averaged over all depth intervals	1.8	0.37	0.1	0.22
Mass of Chlorinated Volatile Contaminants				
based on max. conc.	3.2	0.57	0.17	0.43
based on average conc.	1.4	0.3	0.09	0.2
Shortest Distance to the nearest fence, ft	40	55	105	10
Type of Fence	Q	L	L	L

marked on Figure 3. Figure 4 shows a conceptual site lay out. The shaded area shows the approximate location of the heated zone. This area was picked so as to keep the long dimension of the electrode array parallel to the Q fence and also to maximize the distance between the array and the overhead power line. In addition, previous sampling has indicated that the high concentration plume lies between the two Bore Holes 74 and 75. Figure 4 does not show the location of new transformer poles, a power distribution panel, light poles, etc. These details can be decided upon once the design of the power supply line for the site has been finalized, including the issue of drilling in the close proximity of the overhead line. It is IITRI's understanding that the overhead line in the vicinity of the test site will be de-energized during site preparation and process demonstration so that drilling activities can take place in close proximity to the line.

Figure 4. Conceptual Site Layout

3. PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization chart is shown in Figure 5. IITRI's project manager is Mr. Guggilam Sresty. He will be assisted by the project team comprising of engineers, chemists, and technicians in ensuring that the demonstration project health and safety plan is implemented and that all project activities are conducted in a safe manner. It is the personal responsibility of all project personnel to ensure that they as well as their co-workers follow the health and safety rules and guidance provided in this document. The responsibilities of the various project team members with respect to the administration of the HASP are described below.

3.1 PROJECT MANAGER

The Project Manager is responsible for overall project execution. The responsibilities of the Project Manager include:

- coordinating with DoE personnel, including, project manager and field coordinator manager;
- ensuring implementation of the HASP;
- ensuring that a qualified SHSO is designated; and
- maintaining a current copy of the HASP.

3.2 SITE OPERATIONS MANAGER

The site operations manager will oversee the installation of the EM technology demonstration system, soil sample collection and related QA/QC activities, and the implementation of HASP. He will delegate further responsibilities to other members of the sampling team. He/she is ultimately responsible for implementation of this HASP. Specific responsibilities of the site operations manager are listed below:

- ensuring that all personnel on site follow the requirements of the HASP;
- coordinating on-site operations, including logistics;
- interfacing with plant and project personnel;
- assisting the SHSO when necessary;
- participating in on-site system installation activities;
- maintaining project activities and data logs; and

Figure 5. Project Organization Chart

- maintaining a current copy of the HASP.

3.3 SHSO

The SHSO is responsible for making health and safety decisions and for specific health and safety activities. When the SHSO determines that serious health and safety problems have occurred or are eminent, the plant shift superintendent will be notified. All site personnel including the SHSO have stop work authority. The SHSO has primary responsibility for the following:

- Ensuring that personnel receive this plan and are aware of its provisions, are instructed in safe work practices, and are familiar with potential hazards and planned emergency procedures prior to initiation of site activities.
- Maintaining on-site copies of Material Safety Data Sheets (MSDSs) for applicable materials utilized at the site.
- Confirming that all on-site personnel have received the training listed in the Training Requirements section of this HASP.
- Reporting to the Site Operations Manager any deviations from anticipated conditions, and stopping work if serious health and safety problems are encountered. The SHSO must also authorize resumption of work following correction of the adverse condition(s).
- Maintaining on-site copies of current training records for all on-site personnel, in accordance with 29 CFR 1910.120.
- Issuing respirators, as necessary, and ensuring that respirator users have been properly trained and fitted for respiratory protection. Note that this requires training to comply with 29 CFR 1910.134.
- Establish site work zones and the level of protection required. In addition, establishing personal decontamination stations and instructing personnel in their use.
- Establishing and making available at the site an emergency action plan, with telephone numbers and appropriate radio communication information.

- Field checking the calibration and battery condition of all monitoring equipment that will be used daily, and recording the results in the field logbook.
- Ensuring that all monitoring equipment is operating according to the manufacturer's specifications and instructions and providing minor maintenance if warranted.
- Verifying that all permits such as the penetration/excavation, hot work, safety work, etc. have been generated and that signed copies are available on site, prior to commencing intrusive field work.
- Ensuring that all chemicals not in their original container are in properly labeled containers.
- Ensuring that personnel stay out from under overhead work and temporarily suspended equipment.
- Ensuring monitoring for potential on-site contaminants during field operations is conducted.
- Conducting a site-specific pre-entry health and safety briefing and appropriate follow-on briefings covering known or suspected hazard precautions, emergency actions, etc. including this HASP.
- Remaining on site at all times during hazardous waste operations and activities.
- Designating a qualified substitute to serve while the SHSO is absent.
- Documenting field changes to the HASP.
- Controlling visitor access to the site.
- Keeping track of site personnel radiation exposure status and avoid exceeding radiological Administrative Control Levels.

3.4 FIELD PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations are responsible for:

- Taking all reasonable precautions to prevent injury to themselves and their fellow employees; being alert to potentially harmful situations.

- Performing only those tasks that they believe they can do safely and immediately reporting any accidents and/or unsafe conditions to the SHSO and the Field Operations Manager.
- Notifying the SHSO of any medical conditions (e.g., allergies, diabetes, pregnancy) that require special consideration.
- Reporting all injuries, no matter how minor.
- Abiding by a buddy system so that each on-site worker is responsible for keeping track of his or her partner in the event of an incident.
- Wearing Personal Protective Equipment (PPE) and clothing properly whenever required.
- Assuring they are mentally alert and in physically sound condition.
- Properly removing PPE and clothing to minimize the spread of contamination.
- Recognizing that their actions directly affect contamination control.
- Obeying "evacuate" and "stop-work" orders from personnel promptly.
- Wearing personal monitoring devices where required by Permits, signs, procedures, this HASP, or by H&S personnel. Reporting immediately the loss, damage, or unexpected exposure of personnel monitoring devices to H&S personnel.
- Notifying radiological control personnel of off-site occupational radiation exposures so that worker dosimetry records can be updated.
- Limiting the amount of material taken into contaminated areas.
- Stopping work activities for any unsafe or hazardous conditions.
- Following all the rules in this HASP.
- Attending Tail Gate Safety meetings.

4. SITE OPERATING PROCEDURES

This section presents those general safety rules that apply to the entire project.

- The provisions of the plan are mandatory for all on-site employees and visitors.
- The SHSO will conduct a pre-entry health and safety briefing for personnel new to the site, prior to site access, and ensure that the HASP is available for their use and that a copy of the plan is provided if requested. The pre-entry briefing will be held prior to the commencement of field operations so that field personnel are aware of and are adhering to the HASP. The pre-entry briefing will be documented by requiring individuals to sign and date the field logbook, stating that they have received a pre-entry health and safety briefing and are aware of and have access to the Work Plan and the HASP. Documentation of all personnel training, in accordance with this HASP, will also be required at this meeting. All personnel will provide the site operations manager with documentation of successful completion of training requirements. The pre-entry briefing will address project health and safety protection requirements, including, but not limited to the following:
 - names of personnel and alternatives for the SHSO;
 - safety, health, and other hazards present on site; routes of exposure; signs of overexposure; and potential health effects;
 - type and use of PPE, as well as donning and doffing procedures;
 - personnel decontamination procedures;
 - work practices to minimize risks from hazards;
 - contents of the HASP; and
 - medical surveillance requirements.
- "Tailgate" meetings may periodically be called, as appropriate, during field activities to apprise on-site personnel of any potential health and safety concerns that may change because of unplanned field conditions.

- Inadequate health and safety precautions on the part of any on-site personnel, the belief that personnel are or may be exposed to an immediate health or safety hazard, the belief that the potential exists for significant environmental insult as a result of planned activities, or the belief that a planned activity could have a serious adverse impact on the quality of operations and processes at the K-25, will be sufficient cause for the SHSO to suspend/stop-work and require all personnel to evacuate a potentially hazardous area. Work shall not resume until satisfactory resolution is achieved and concurrence is received from the organization or person initiating the stop-work instructions.
- Contact with potentially contaminated substances should be avoided. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or the ground. Minimize time spent in contaminated areas. Do not place monitoring equipment on a potentially contaminated surface.
- Spills will be prevented to the extent possible. In the event that a spill occurs, contain the material, if possible, and notify the Plant Shift Superintendent, K-25 Site and the SHSO.
- Splashing of contaminated materials should be prevented.
- Good housekeeping will be practiced. Everything will be kept orderly and out of potentially harmful situation.
- Field crew members must be familiar with the physical characteristics of investigations, including:
 - wind direction in relation to the individual's location;
 - accessibility to associated equipment, and vehicles;
 - communications;
 - the exclusion zone and any areas of known or suspected contamination;
 - site access; and
 - the nearest drinking water sources.
 - Contingency Plan Procedures (Section 5)
- All waste generated during the demonstration project will be disposed of in accordance with the Waste Management Plan, provided in Reference 6.
- All injuries will be reported, no matter how minor.

- All workers in the exclusion zone will maintain verbal contact with fellow workers or maintain visual contact if site conditions make hearing difficult.
- Each person will make his/her presence known to the site operations manager daily, and changes in personnel will be noted. A list of workers on the job site will be maintained in the field logbook.
- Copies of MSDSs for all hazardous chemicals known or suspected on site will be maintained in the work area. MSDSs will be available to all employees for review during each work shift.
- All containers received on site will be inspected to ensure the following:
 - all containers will be clearly labeled as to the contents;
 - the appropriate hazard warning will be noted; and
 - the name and address of the manufacturer will be listed.
- All secondary containers will be labeled with either an extra copy of the original manufacturer's label or with generic labels that have a block for identity and the hazard warning.
- Prior to starting work, each employee will attend site-specific hazardous communication training to include information and training on the following:
 - an overview of the requirements contained in the Hazard Communication Standard, 29 CFR 1910.1200;
 - chemicals present in their workplace operations;
 - location and availability of a written hazard communication program;
 - physical and health effects of the hazardous chemicals;
 - methods and observation techniques used to determine the presence or release of hazardous chemicals;
 - how to prevent or lessen exposure to these chemicals through usage of control/work practices and PPE; and

- emergency procedures to follow if they are exposed to these chemicals; how to read labels and review MSDSs to obtain appropriate hazard information; and location of MSDS file and location of hazardous chemical list.
- Emergency telephone numbers and how to obtain help in an emergency.

5. CONTINGENCY PLAN

The K-25 Site emergency response organization will be contacted for response to all emergencies at the site and will utilize the K-25 Site Emergency Plan. The site Shift Superintendent at K-25 coordinates 24-h emergency response coverage from the Plant Protection and Shift Operations Division. The Shift Superintendent on duty is assisted by a well-trained plant emergency squad and is the overall coordinator responsible for directing the response to emergencies such as fires, major equipment failure, hazardous materials releases or spills, natural disasters, sabotage, etc. All personnel working on site will be trained to the awareness level and will be instructed to notify the K-25 emergency response organization for assistance.

5.1 SHIFT SUPERINTENDENT

EMERGENCIES:

Plant Phone: 911

Cellular Telephone Number: 615/574-3282

Radio Number: Station No. 9

Contact the Site Shift Superintendent first. The Site Shift Superintendent is the trained emergency response director.

Listed below are emergency groups and their telephone numbers. A cellular phone may be present in the field and available for use when workers are not in close proximity to a plant phone or radio. Note that 911 will not access the Site Shift Superintendent from a cellular phone.

Table 6. Emergency Phone Numbers

Organization/ Contact	Name	Phone No.	Pager No.
Industrial Hygiene (IH)	Russel Rickard	615/241-2688	615/873-5028
Safety	Keith Gosnell	615/576-7034	615/873-7769
K-25 Site Contact	Frank VanRyn	615/574-1907	615/873-6194

5.2 EMERGENCY PREPAREDNESS

The shift superintendent on duty is the designated Plant Emergency Director who is responsible for coordinating and responding to all emergency situations. The SHSO or the site

operations manager will notify or assign someone to notify the Site Shift Superintendent of an emergency situation as soon as possible.

5.2.1 Reporting an Emergency

The procedures for this are presented in Appendix A, "Excerpts from the K-25 Facility Emergency Procedure, Building K-1414, page 13 of 29."

5.2.1.1 Telephone

- If a plant telephone is accessible, dial **911**. With a cellular phone, dial **615/574-3282**.
- Describe the type of emergency.
- Identify the location of the emergency.
- Identify who is calling.
- Identify the number on the phone being used.
- **In case of an injury, tell whether an ambulance is needed.**
- Listen to and follow any instructions that are given.
- Do not hang up until **after** the Emergency Control Center has hung up.

5.2.1.2 Fire Alarm Pull Boxes

Pulling a fire alarm box automatically transmits the location of the emergency to the Fire Department and the Emergency Control Center. The person pulling the alarm should remain at the alarm box and supply any needed information to the responding emergency squad.

5.2.1.3 Radio

By calling **Station 9**, the Site Shift Superintendent will be alerted of the emergency.

- Report the emergency.
- Report the type of emergency.
- Report the location of the emergency.

- Identify who is calling.
- Identify the radio station number.
- Listen for any instructions.

5.2.2 Alarm Signals

The demonstration site will utilize K-25 Facility Emergency procedure for Building K-1414. A copy of relevant excerpts from this procedure is given in Appendix A. Alarm signals are described in the above referenced document and summarized below:

5.2.2.1 Evacuation Alarms

Evacuation alarms are denoted by a steady or continuous sounding from the plant public address system. The SHSO or site operations manager will designate the evacuation routes. Evacuate the site or area and proceed to the assembly point defined by the SHSO or site operations manager to await further instructions.

5.2.2.2 Radiation Alarms

Radiation alarms are denoted by a steady sound from a clarion horn and rotating red beacon lights. Evacuate the site or area and proceed to the assembly point defined by the SHSO or site operations manager to await further instructions.

5.2.2.3 Take-Cover Alarms

Take-cover alarms are denoted by the intermittent or wailing siren sound from the plant public address system. Seek immediate protective cover in a strong sheltered part of a building. Evacuate mobile structures to a permanent building.

5.2.2.4 Standard Alerting Tone

The standard alerting tone is a high/low tone from the plant public address system. Listen carefully; an emergency announcement will follow.

5.2.3 Site Evacuation Procedures

Evacuation of nonemergency response personnel (full or partial) is ordered by the SED whenever it is determined that a threat to the safety of site personnel exists. Directions on the specific evacuation routes will be provided by the SED. Evacuation is generally by individually owned vehicles. The appropriate decision of a reassembly area and evacuation route is determined based upon site conditions, wind direction, and weather.

1. The site evacuation and possible shutdown instructions will be given over the PA system. The evacuation tone signal is a steady siren over the PA system or continuous sounding of local evacuation devices.
2. If the signal is sounded over the PA system, personnel should secure any classified documents for which they are responsible, evacuate buildings to the nearest assembly station, and wait for further instructions.
3. If a shutdown is directed, proceed according to the appropriate departmental standard operating procedure.
4. Those employees not responsible for shutdown activities should leave the site.
5. When the shutdown is complete, personnel who participated in the shutdown should leave the site.
6. The portals will be locked, and the turnstiles will be left in the exit-only mode. If any of the crash gates in the perimeter fence are used **be sure** they are closed after you exit.
7. After a site evacuation, employees should monitor radio and TV stations. These media may be the only available to the site for communication with employees.
8. When the "all-clear" announcement is made or a request is made from the company, employees should immediately report to their regular work locations.

5.2.4 Important Reminders

- Know the telephone number of the Site Shift Superintendent, **574-3282, 911, or Station 9.**
- Know how to summon an ambulance: Dial **911** and give the location. Wait to meet the arrival of the first-aid personnel. Note that 911 will not access K-25 from a cellular phone.
- Know the quickest way to summon the plant emergency squad: Pull a fire alarm box and wait for the arrival of the Emergency Response Team.

5.3 ON SITE SHELTERING IN PLACE

Certain emergency conditions (i.e., chemical or radioactive material release, tornado warning, fire, security Threat, etc.) may

require that on-site personnel be sheltered in place. Notification of a recommendation of sheltering in place is carried out by the K-25 Site Emergency Director on the emergency public address system. Sheltering in place calls for employees to:

- go indoors immediately;
- close all windows and doors;
- turn off all sources of outdoor air (fans, air conditioners);
- shut down equipment and processes, as necessary for safety; and
- remain indoors and listen for additional information on the public address system.

5.4 ON-SITE RELOCATION

Certain emergency conditions (i.e., chemical or radioactive material release, tornado warning, fire, security threat, etc.) may require that on-site personnel be relocated from their normal work stations and activities to locations more suitable to withstand the threat of the discovered hazardous condition. Notification of on-site relocation is carried out by the K-25 Site Emergency Director on the emergency public address system. Specific instructions on where to relocate will be given with the message to relocate.

5.5 ON-SITE FACILITY EVACUATION

Notification of on-site facility evacuation is initiated by the K-25 Site Emergency Director over the site public address system. Assembly stations serve as gathering points for evacuated personnel. These stations are identified by an orange, disk-shaped sign with the assembly station number in black. The K-25 Site is separated into 10 areas with one assembly station serving each area. Figure 6 illustrates the ten areas and their corresponding assembly station location. If an alarm sounds within the area where employees are working, that mandates their evacuation. Employees should evacuate to the assembly station assigned for that area and immediately report to their supervisor or the assembly station director who will be identified by an orange vest. Employees working at the K-1070 D site will evacuate to assembly station 6, located north of Building 1501. Employees working at the K-1070 C site will evacuate to assembly station 3 inside the security fence immediately to the east of Portal 3. An accountability will be conducted on all personnel who have evacuated. The assembly station has a ring-down telephone to the K-25 Site Shift Superintendent's office and a local public address system. Further instructions and information about the emergency situation will be given to employees by the assembly station director or over the site public address system.

TITLE: Building K-1414

Appendix E
(Page 2 of 3)

DWG. NO. K/G-92-260

Figure 6. K-25 Site Assembly Station Directory.

6. HEALTH AND SAFETY HAZARD ANALYSIS AND CONTROLS

The purpose of the hazard analysis is to identify potential health and safety concerns that may be encountered by site personnel and the hazard controls required for each site task. The SHSO may raise or lower the level of PPE worn by the teams, depending upon the site-specific hazards encountered in the field. Whenever a conflict exists with the PPE requirements, the more restrictive will apply.

The scheduled tasks include soil boring, soil sampling, decontamination system installation, check-out, operation, system demobilization, etc. Personnel and equipment decontamination have also been considered as distinct tasks in this HASP. No confined space entry is planned. In general, the potential for unacceptable exposure to site contaminants, chemical and radiological, appears to be low. Real-time monitoring will be conducted to detect unacceptable exposures and appropriate additional controls will be instituted based upon the requirements in Sect. 10, Monitoring and Sampling.

In this demonstration project the soil will be energized with electrical energy. Up to 150 kW of power may be applied to the electrode array at voltages in the range of 120 to 4,000 V. There is a risk of electrical shock to personnel. It is planned to monitor the site for step-and touch potentials to assure that there is no risk of electrical shock. Similarly, process equipment will require testing, protection and mitigation of spurious electric potential. The exclusion zone will be based on chemical as well as electric shock hazard considerations.

6.1 SUSPECTED CONTAMINANTS

Descriptions of the suspected types of contaminants and their characteristics (if known) are provided in this document. If additional potential contaminants are identified prior to the commencement of activities, they will be provided as an addendum to this document. A listing of some of the contaminants identified to date is given in Table 7. Chemicals used in site decontamination activities also appear in the table. Contaminants listed are based on historical investigations conducted by the K-25 ER Program and existing characterization and monitoring data. The health effects information given in Table 7 may be incomplete. Project personnel are required to refer to their copies of Reference 4 for health effects and recommended PPE information.

6.2 TASK-SPECIFIC HAZARD EVALUATION

Table 8 is a list of major tasks that will be performed in the field. There are five such tasks, one in each column of Table 8.

Table 7. Contaminant Characteristics
(See Notes at End of Table)

Chemical	TLV/PEL/Activity or DAC/STEL/IDLH	Health Effects/ Potential Hazard	Chemical and Physical Properties	Exposure Route(s)
Acetone	OSHA/TWA: 750 ppm STEL: 1000 ppm IDLH: 20,000 ppm	Dermatitis, respiratory irritant, irritant for eyes	Clear liquid, FP: 0°F; IP: 9.69 eV UEL: 13%; LEL: 2.5%	Inhalation Ingestion Contact
Alconox (used for decontamination only)	TLV/TWA: 10 mg/m ³ (dust) NA	Inhalation of powder may cause local irritation to mucus membranes	White powder, odorless, nonflammable	Inhalation Ingestion Contact
Aroclor 1242 (PCB, chlorodiphenyl) [Ca]	OSHA/TWA: 1 mg/m ³ (skin)	Skin, eyes, liver, chloracne, liver damage	Colorless to a light colored viscous liquid FP: ?; UEL: ?; IP: ?; LEL: ?	Inhalation Absorption Ingestion Contact
Aroclor 1254 (PCB, chlorodiphenyl) [Ca]	OSHA/TWA: 0.5 mg/m ³ (skin)	Skin, eyes, liver, acne- form dermatitis	Colorless to pale yellow viscous liquid or solid (below 50°F) FP: ?; UEL: ?; IP: ?; LEL: ?	Inhalation Absorption Ingestion Contact
Benzene [Ca]	OSHA/TWA: 1 ppm ST: 5 ppm IDLH: 3000 ppm	Blood, CNS, skin, bone marrow, eyes, nose, resp. system, giddiness, headache, nausea, staggered gait, depression	Colorless to light yellow liquid with aromatic odor FP: 12°F; IP: 9.24 eV; UEL: 7.9%; LEL: 1.3%	Inhalation Absorption Ingestion Contact
Bis(2-ethylhexyl)phthalate	TLV/TWA: 5 mg/m ³ STEL: 10 mg/m ³	Eye/skin irritant, respiratory system, GI tract	Colorless, oily liquid; insoluble; FP: 42°F	Inhalation Ingestion Contact
2-Butanone	OSHA/TWA: 200 ppm STEL: 300 ppm IDLH: 3000 ppm	Irritant, dizziness, vomiting	IP: 9.54 eV; UEL (200°F): 11.4%; FP: 16°F; LEL (200°F): 1.4%	Inhalation Ingestion Contact
Carbon disulfide	OSHA/TWA: 4 ppm ST: 12 ppm (skin) IDLH: 500 ppm	CNS, PNS, CVS, eyes, kidneys, liver, skin, dizziness, headache, poor sleep, fatigue, psychosis, ocular change	Colorless to faint yellow liquid with sweet ether-like odor FP: -22°F; UEL: 50% IP: 10.8 eV; LEL: 1.3%	Inhalation Absorption Ingestion Contact
1,1-Dichloroethane	PEL: 100 ppm TLV: 200 ppm IDLH: 4000 ppm	CNS, skin, liver, kidney depression, irritant	Colorless oily liquid with a chloroform-like odor; FP: 22°F, IP: 11.06 eV; LEL: 5.6%	Inhalation Ingestion Contact
1,2-Dichloroethene	OSHA/TWA: 200 ppm STEL: 250 ppm IDLH: 4000 ppm	Nasal and eye irritation; liver damage, narcosis, kidney damage, nausea	Volatile colorless liquid with an ether-like odor, FP: 36°F IP: 9.65 eV UEL: 12.8%; LEL: 5.6%	Inhalation Ingestion Contact
Ethylbenzene	OSHA/TWA: 100 ppm STEL: 125 ppm IDLH: 2000 ppm	Eyes, skin, CNS, upper respiratory system irritant	Colorless liquid with an aromatic odor; SOL: 0.015%; LEL: 1.0%; UEL: 6.7%; FP: 55°F; IP: 8.76 eV	Inhalation Ingestion Contact

Table 7. Contaminant Characteristics
(See Notes at End of Table)

Chemical	TLV/PEL/Activity or DAC/STEL/IDLH	Health Effects/ Potential Hazard	Chemical and Physical Properties	Exposure Route(s)
Isophorone	OSHA/TWA: 4 ppm IDLH: 800 ppm	Resp. system, skin irritant, eyes, nose, throat, dermatitis, narcosis	Colorless to a white liquid with peppermint-like odor FP: 184°F; UEL: 3.8% IP: 9.07 eV; LEL: 0.8%	Inhalation Ingestion Contact
Isopropyl alcohol (used for equipment decontamination)	OSHA/TWA: 400 ppm STEL: 500 ppm	CNS, eyes, skin, respiratory system; mild irritant to eyes, nose, throat	Colorless liquid; VP: 33 mm; IP: 10.10 eV; FP: 53°F	Inhalation Ingestion Contact
Methylene chloride	OSHA/TWA: 50 ppm OSHA Ceiling C1000 ppm	Irritant, numbness, tingling, vertigo, suspected carcinogen	Colorless liquid; IP: 11.32 eV; FP: 2°F; SOL: 2%; UEL: 22%; LEL: 14%	Inhalation Ingestion
Naphthalene	PEL: 10 ppm TLV: 10 ppm STEL: 15 ppm IDLH: 500 ppm	Eyes, blood, liver, kidneys, skin, CNS	Colorless to brown solid with an odor of moth balls SOL: 0.003%; IP: 8.12 eV UEL: 5.9%; LEL: 0.9%	Inhalation Ingestion Contact
Pentachlorophenol	OSHA/TWA: 0.5 mg/m ³ (skin) IDLH: 150 mg/m ³	CVS, resp. system, eyes, liver, kidneys, skin, CNS, sneezing, coughing, sweat, headache, dizziness, nausea, vomit, chest pain, dermatitis	Colorless to a white crystalline solid with a benzene-like odor FP: NA; UEL: NA IP: NA; LEL: NA	Inhalation Absorption Ingestion Contact
Polychlorinated biphenyls	TLV: 0.5 mg/m ³	Eye irritation, chloracne, liver damage, suspected carcinogen	VP: 0.00006 mm; SOL: 0%	Inhalation Ingestion Contact
Strontium	2 x 10 ⁹ µCi/mL	Skeletal system, respiratory system damage	Variable	Inhalation Ingestion
1,1,2,2-tetrachloroethane	OSHA/TWA: 1 ppm (skin)	Liver, kidney, CNS, nausea, vomit, abdominal pain, tremor fingers, jaundice	Colorless to pale yellow liquid with a mild chloroform-like odor FP: NA; UEL: NA IP: 11.10 eV; LEL: NA	Inhalation Absorption Ingestion Contact
Tetrachloroethylene (PERC)	PEL: 25 ppm TLV: 50 ppm STEL: 200 ppm IDLH: 500 ppm	Liver, kidneys, eyes, upper respiratory system, CNS irritant; flush face, vertigo; suspected carcinogen	Colorless liquid with odor like ether or chloroform; IP: 9.32 eV; UEL: nonflammable LEL: nonflammable	Inhalation Ingestion Contact
Toluene	OSHA/TWA: 100 ppm STEL: 150 ppm IDLH: 2000 ppm	CNS, liver, kidney damage, skin irritant, causes fatigue, weakness, confusion, & dizziness	Colorless liquid with aromatic odor like benzene; IP: 8.82 eV; FP: 40°F; UEL: 7.1%; LEL: 1.2%	Inhalation Absorption Ingestion Contact

Table 7. Contaminant Characteristics
(See Notes at End of Table)

Chemical	TLV/PEL/Activity or DAC/STEL/IDLH	Health Effects/ Potential Hazard	Chemical and Physical Properties	Exposure Route(s)
1,1,1-Trichloroethane (methyl chloroform)	OSHA/TWA: 350 ppm STEL: 450 ppm NIOSH STEL: 350 ppm, 15 min; IDLH: 1000 ppm	CNS, CVS, eye skin irritant; headaches, drowsiness, impaired judgment, unconsciousness, absorption through skin can affect heart; suspected carcinogen	Colorless liquid, mild chloroform-like odor; between 20 and 500 ppm can become irritant; SOL: 0.4%; UEL: 12.5%; LEL: 7.5%; IP: 11.00 eV; FP: None	Inhalation Ingestion Contact
1,1,2-Trichloroethane [Ca]	OSHA/TWA: 10 ppm (skin) IDLH: 500 ppm	CNS, eyes, nose, liver, kidney, irritant nose, depression	Colorless liquid with a sweet chloroform- like odor FP: NA; UEL: NA IP: 11.00 eV; LEL: NA	Inhalation Absorption Ingestion Contact
Trichloroethylene [Ca]	OSHA/TWA: 50 ppm STEL: 200 ppm IDLH: 1000 ppm	CNS, CVS, eye, skin irritant; headaches, drowsiness, impaired judgment, unconsciousness, suspected carcinogen	Colorless liquid, mild chloroform-like odor; SOL: 0.1%; IP: 9.45 eV; FP: 90°F UEL (77°F): 10.5%; LEL (77°F): 8%	Inhalation Ingestion Contact
Uranium-234	2×10^{-11} μ Ci/mL	Carcinogenic; Respiratory, kidneys, Gastrointestinal	Variable, depends on compounds	Inhalation Ingestion Contact
Uranium-235	2×10^{-11} μ Ci/mL	Carcinogenic; Respiratory, kidneys, Gastrointestinal	Variable, depends on compounds	Inhalation Ingestion Contact
Uranium-238	2×10^{-11} μ Ci/mL	Carcinogenic; Respiratory, kidneys, Gastrointestinal	Variable, depends on compounds	Inhalation Ingestion Contact
Xylenes	OSHA/TWA: 100 ppm STEL: 150 ppm IDLH: 1000 ppm	CNS damage, eye irritant, GI, blood, liver, kidney damage, skin irritant; causes dizziness, drowsiness, staggered gait	Colorless liquid with aromatic odor; SOL: 0.00003%; FP: 63°F; UEL: 7.0%; IP: 8.56/8.44 eV; LEL: 1.0%; FP: 63°F	Inhalation Absorption Ingestion Contact

NOTE:

C - Ceiling concentration
CNS - central nervous system
DAC - derived air concentration
GI - gastrointestinal tract
IP - ionization potential
LFL - lower flammability limit
PEL - permissible exposure limit
SOL - solubility
TLV - threshold limit value
UEL - upper explosive limit
VP - vapor point

Ca - NIOSH occupational carcinogen
CVS - central vascular system
FP - flashpoint
IDLH - immediately dangerous to life and health
LEL - lower explosive limit
NA - not available
PNS - Peripheral nervous system
STEL - short-term exposure limit
TWA - time-weighted average
UFL - upper flammability limit

Table 8. Major Tasks and Associated Sub-tasks				
System Installation	In Situ Heating	Cool Down	Post Demo Sampling	Demobilization
Unload equipment from trailers (1)	Cold checkout of system (6)	Monitor temp. data (6)	Drill bore holes (2)	Remove vapor barrier (5)
Provide AC power service to trailers (7)	Low-power check for operation, step and touch potential (7)	Monitor operation of gas collection system (6)	Obtain sub-surface soil samples (2)	Disconnect cables (3)
Drill bore holes for electrodes, thermowells, gas collection wells (2)	Apply power to soil - start at 5 kW and increase to full operating power gradually (7)		Pack and ship samples (1)	Pull out electrodes (2)
Sample soil from selected bore holes (2)	Measure step/touch potential at each increment of power (7)			Remove water injection and gas collection lines (3)
Install gas collection wells (2)	Measure center row and thermowell temperature data with A/C power off (6)			Dispose scrap (1)
Install electrodes (2)	Monitor operation of vapor collection and water injection systems (7)			Load equipment into trailers (1)
Install thermowells (2)				
Install piping for gas collection, water injection (3)	Monitor video displays from data acquisition units (6)			
Connect power cables between electrodes (3)				
Pack soil borings on top surface of heated zone (4)				
Install vapor barrier (5)				
Connect lines to gas collection and water injection system (3)				
Connect power cables from array to power supply (3)				
Hook-up all safety interlocks and test (3)				
Check for electrical continuity and ground faults (6)				
Install equipment grounding rods, if necessary (6)				

Below each task, is a list of subtasks to be performed. The hazard analysis is presented in Table 9 at the sub-task level. Sub-tasks are assigned to groups based on common features or hazards. Thus, sub-tasks having similar activities, using the same type of equipment, or which pose similar hazards are grouped together. There are 7 such groupings of the subtasks. The group number of each subtasks is also shown in Table 8. Hazard analysis in Table 9 is presented for each of the seven groupings.

Group 1 sub-task activities involve loading, unloading of trailers and preparing samples for shipment.

Group 2 activities involve work in the vicinity of or on a drill rig.

Group 3 activities include work with small hand and power tools for the installation of piping, plumbing, tubing, cold electrical wiring, instrumentation wiring, etc.

Group 4 activity involves moving soil boring on to the heated area and compacting it with a two-man hand compactor.

Group 5 activities involve work with the vapor barrier and thermal insulation. A thermal insulation blanket will be rolled out on top of the vapor barrier. If a ceramic-fiber insulation is used, then respiratory protectors will be needed. MSDS recommended protective devices will be used.

Group 6 activities involve work with voltmeters, grounding rods, sledge hammers, etc. It also involves monitoring and data acquisition during heating. All but one of Group 6 activities will be done with the electrode array de-energized.

All Group 7 activities have the potential of work with energized circuits that provide power to the electrode array. There is significantly increased risk of electrical shock hazard during Group 7 activities. Some of these activities will require special precautions and a higher degree of personal alertness and concentration. It is not planned to work directly on energized circuits. However, it is possible that such work might be necessary when trouble shooting. In such an event, appropriately certified or trained electricians for the exposed voltage levels will be employed. Any work requiring use of high voltage rating gloves will be done by Energy System electricians, and not by IITRI personnel. Special procedures and precautions relating to electrical hazard is presented in Section 6.2.1.

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
1 Unload equipment from trailer	General hazards associated with the operation of a fork lift	PPE (Level D) Minimum for task is: Hard hat if overhead work is involved or when mechanized loading/unloading equipment is in use. Safety glasses Steel-toed, insulated work boots Field work clothes, work gloves Hearing protection in the presence of mechanized loading/unloading equipment	
1 Pack and ship samples			
1 Load equipment into trailers			
	Trips, falls	Keep work area clean. Maintain good housekeeping	Visual
	Strains	Coach personnel on the use of good body mechanics and posture	
	Falling objects	Use proper lifting tools, harnesses, etc. Adequate number of personnel in team lifting objects	
	Heat Stress	Administrative controls (see Section 6.3.1)	Body temperature monitoring as appropriate

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
2 Drill bore holes for electrodes, thermowells, gas collection wells	General drilling hazards (Rotating auger flights, suspended equipment, heavy split-barrel sample tubes, slips, falls, welding, burning, etc.)	PPE (Level D) Minimum for task is: Hard hat if overhead work is involved or when in the vicinity of operating drilling equipment. Safety glasses Steel-toed boots Field work clothes Hearing protection - as specified below	
2 Sample soil from selected bore holes			
2 Install gas collection wells			
2 Install thermowells			
	Noise	Administrative controls (minimize exposure) Hearing protection within 10 ft of rig	
	Fire/Explosion	Control of ignition sources Control of flammable material (quantities limited to a single day use, proper storage) Firefighting equipment suitable to hazards Monitoring of fugitive gases from sampling	Combustible Gas Meter (as necessary)
	Exposure to chemicals (see Table 5)	PPE (level D) Administrative controls	OVA or equivalent and other sampling as appropriate
	Heat stress	Administrative controls (see Heat Stress)	Body temperature monitoring as appropriate WBGT measurements as appropriate
	Electric shock	Identification and clearance of overhead and underground utilities Tool and drop cord inspections See Section 6.2.1	Visual of all work areas
	Radiation	Limit exposure time Establish work area boundaries Shield workers from sources of radiation PPE as required for area Decontamination	Survey for radioactivity, dosimetry, and air sampling if required

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
3	Install piping for gas collection, water injection	PPE (Level D) Minimum for tasks in this group. <u>Level D+ for Work at soil surface level</u>	
3	Connect power cables between electrodes	Hard hat if overhead work is involved	
3	Connect power cables from array to power supply	Safety glasses	
3	Hook-up all safety interlocks and test	One pair of coveralls, such as Tyvek* (breathable)	
3	Disconnect power cables from electrodes	One pair of shoe covers taped to the coverall leg	
3	Remove water injection and gas collection lines	One pair of inner/outer gloves	
	Exposure to volatile chemicals (see Table 5)	PPE Level D minimum	OVA or equivalent and other sampling as appropriate
	Animal hazards (bees, wasps, snakes)	PPE (boots, work clothes)	Visual survey
	Electrical shock from cords, power tools	See Section 6.2.1	
	Heat stress	Administrative controls (see Section 6.3.1)	Body temperature monitoring as appropriate
4	Pack soil boring on top surface of the heated zone	PPE (Level D) Minimum for tasks in this group. <u>Level D+ for Work at soil surface level</u>	
		Hard hat if overhead work is involved	
		Safety glasses	
		One pair of coveralls, such as Tyvek* (breathable)	
		One pair of shoe covers taped to the coverall leg	
		One pair of inner/outer gloves	
	Trips, falls	Keep area clean Maintain good housekeeping	Visual
	Strains	Coaching on proper body mechanics and posture	
	Exposure to chemicals (see Table 5)	PPE Level D minimum	OVA equivalent and other sampling as appropriate
	Heat stress	Administrative controls (see Section 6.3.1)	Body temperature monitoring as appropriate

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
5 Install vapor barrier	General hazards associated with hand tools, industrial silicone adhesives, fiberglass insulation	Level D PPE minimum for hands-on work. <u>Level D+ for Work at soil surface level</u> Hard hat if overhead work is involved Safety glasses One pair of coveralls, such as Tyvek [®] (breathable) One pair of shoe covers taped to the coverall leg One pair of inner/outer gloves Cap while working with insulation	
	Exposure to chemicals (see Table 5)	PPE Level D minimum	OVA or equivalent and other sampling as appropriate
	Exposure to insulation fibers	PPE as above with respiratory filter as recommended by the insulation MSDS Recommended: cap.	
	Animal hazards (bees, wasps, snakes)	PPE (boots, work clothes)	Visual survey
	Heat stress	Administrative controls (see Section 6.3.1)	Body temperature monitoring as appropriate

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
6 Check for electrical continuity and ground faults	General hazards associated with the use of small hand tools, power cords, instruments, monitoring activities outside the electrical hazard exclusion zone, or in a de-energized state	Level D PPE minimum	
6 Install grounding rods, if necessary		Hard hat if overhead work is involved	
6 Cold check (no power) of the heating system		Safety glasses	
6 Measure temperature data with A/C power to array off		Steel-toed boots	
6 Monitor temperature data, during cool down		Field work clothes	
		Hearing protection if working within 10 to 15 ft. of heavy machinery	
	Trips, falls, slips	Keep area clean Maintain good housekeeping At nighttime ensure that there is proper illumination, at least 10 foot-candles	Visual to assure area is clean
	Fugitive emissions of chemicals (see Table 5)	Level D PPE minimum	OVA monitoring
	Heat stress	Administrative controls (see Section 6.3.1)	Body temperature monitoring as appropriate
	Electrical shock Touch & Step	See Section 6.2.1 Stay outside of electrical exclusion zone unless de-energized, locked and tagged out	Periodic measurement of Step & Touch potentials

Table 9. Hazards Analysis for In Situ EM Technology Demonstration

Group/Subtasks	Safety and Health Hazards	Controls	Monitoring
7 Provide AC power service to trailers	General electrical hazards associated with high power, high voltage circuits	Level D PPE minimum	
7 Low power operational check of the electrode array and Step & Touch potential survey		Hard hat if overhead work is involved	
7 Gradually increase power to array in increments, Step and touch potential survey at each increment		Safety glasses	
7 Monitor operation of vapor collection and water injection system		Steel-toed, insulated work boots	
		Field work clothes, work gloves	
		Hearing protection if working within 10 to 15 ft. of heavy machinery	
7 Monitor video display(s) of data acquisition units in the trailer	Step potential shocks	See Section 6.2.1	Measure step potential. See Section 6.2.1
		Establish and regularly monitor the 2V/meter step potential exclusion zone.	
		Reduce power	
	Touch potential	See Section 6.2.1	Measure touch potential. See Section 6.2.1
		Identify structures with touch potential exceeding 6 V	
		Establish exclusion zone	
		Warning signs	
		Reduce power	

6.2.1 Precautions and Procedures for Mitigating Electrical Shock Hazards

This section presents precautions and procedures for mitigating electrical shock hazards. This section is sub-divided into 6 parts: General, System Installation, System Operation, System Shake Down and Check-Out, Procedures for Making Step Potential & Touch Voltage Measurements, and Daily Operations.

General

The following guidelines are to be followed by all site personnel while performing any work on the site:

- No jewelry or ties are to be worn by any site personnel while on the site.
- No metal ladders or buckets are to be utilized or be present on the site. Any such ladders and/or buckets are to be removed from the site.
- All site electrical receptacles used for power tools, etc., are to be protected by a GFI device.
- All extension cords used are to be UL approved grounded 3-wire.
- Extension cords with damaged or excessive wear are to be discarded.
- All power tools are to be either grounded 3-wire or double insulated 2-wire.
- Should it be necessary to work within 10 feet of energized overhead electrical wires, work is to be suspended until the utility company has de-energized and grounded the overhead wires.
- All site personnel are responsible for wearing the prescribed PPE insulated work boots. The work boots are to be inspected at start of each work day to insure that no metallic objects are protruding from the soles and/or heels, and no holes are present.

System Installation

The following guidelines are to be followed by all site personnel during the installation phase:

- The main disconnect switch for the 200 kVA power supply is to be locked out at the end of everyday with an "administrative" lock. During working hours, the source shall be locked and tagged as per Lockout/Tagout Procedures. The lock out and tag are to be checked at the start of each work day.
- On the Monday of each week, each GFI device is to be tested prior to the first use. If a GFI device is found to be defective, the receptacles protected by the defective GFI are to be tagged and the circuit is to be de-energized if possible. The defective GFI and protected receptacles are not to be used until repaired/replaced by a qualified person.
- Power tools are to be inspected prior to the first use every work day. Any tools with cracked housings or damaged/worn electrical cords are not to be used until repaired. On grounded 3-wire tools, the grounding pin on the plug must be present.
- Extension cords are to be inspected prior to the first use every work day and any cords with damaged or excessive wear are to be discarded.
- Movement and installation of metallic pipes used for the EM heating array must be performed in a safe manner such that a clearance of at least 10 feet is maintained from any energized overhead electrical wires.

There are overhead electrical transmission lines that cross portions of the sampling locations of K-1070 C/D Classified Burial Ground. Prior to placing the sampling equipment at an auger hole location, the Field Operations Manager or his designee will verify that the sampling equipment will not be placed where any part of the drill rig mast enters within a minimal radial distance of 10 ft. from electrical transmission lines or as specified in Table 10. All personnel should stay out from under overhead work and temporarily suspended or moving equipment.

System Operation

The following guidelines are to be followed by all site personnel during the operational phase, which includes system shake down check-out, and daily operation.

**Table 10. Safe Working Distances From Electrical
Transmission Lines for Equipment**

Normal Voltage, Phase-to Phase (kV)	Minimum Required Clearance (ft)
<i>When operating near high-voltage power lines</i>	
0 to 50	10
51 to 200	17
201 to 350	22
351 to 500	27
501 to 750	35
751 to 1000	44
<i>While in transit with mast, boom, shovel, etc. lowered and secured</i>	
All voltages	10

Source: 20 CFR 1910.180j(1).

System Shake-Down and Check-Out

- All site operational personnel will be instructed as to possible electrical hazards associated with the operation of the EM heating array.
- Extension cords are to be inspected prior to each use and any cords with damaged or excessive wear are to be discarded.
- Power tools are to be inspected prior to the first use every work day. Any tools with cracked housings or damaged/worn electrical cords are not to be used until repaired. On grounded 3-wire tools, the grounding pin on the plug must be present.
- Each GFI device is to be tested prior to the first use on any given day. If a GFI device is found to be defective, the receptacles protected by the defective GFI are to be tagged and the circuit is to be de-energized if possible. The defective GFI and protected receptacles are not to be used until repaired/ replaced by a qualified person.

- Movement and storage of surplus metallic pipes must be performed in a safe manner such that a clearance of at least 10 feet is maintained from any energized overhead electrical wires. Storage of metallic pipes is only permitted in the storage area designated by the site manager.
- No metallic object is to be dragged across the ground in the area of the demonstration site while the EM heating array is energized.
- No metallic object is to be rested against any structure in the area of the demonstration site.
- Step potential measurements will be made during system shake-down activities. These measurements will require the application of low power levels to the soil while trained personnel make the measurements. The applied power will be in the range of 5 to 10 kVA. All measurements will be made in an area outside the electrode array. The purpose of these measurements is to verify the calculated step potential contours at 100 and 150 kW of applied power. In particular, these measurements will be used to verify the calculated location of the 2 V/m step potential contour. This will help in locating the electrical exclusion fence which will enclose areas in which the step potential is higher than 2 V/meter.

Figures 9 and 10 illustrate the calculated contours of step potential for two soil conditions. Figure 9 depicts the initial condition where the soil conductivity inside and outside the array is the same, viz, 0.01 mhos/meter. Figure 10 depicts the dried out condition wherein soil inside the array has a conductivity of 0.001 mhos/meter while the outside conductivity remains unchanged at 0.01 mhos/meter.

Step Potential And Touch Voltage Measurements

In order to make step potential and touch voltage measurements, it is necessary to energize the EM heating array. The following guidelines are to be followed by all site personnel while making either step potential or touch voltage measurements.

- Only persons trained in making step potential/touch voltage measurements will be permitted to perform step potential and touch voltage measurements. IITRI will be responsible for training the necessary persons.

- All trained personnel will be instructed as to possible electrical hazards associated with performing step potential and touch voltage measurements.
- All trained personnel performing step potential and/or touch voltage measurements are responsible for wearing fully encompassing clothes and rubber-soled work boots. The work boots are to be inspected prior to making measurements to insure that no metallic objects are protruding from the soles and/or heels and no holes are present. Clothing shall not be synthetic or polyester. Cotton will be worn.
- The person(s) performing step potential measurements, must not, at any time, pick up or drag any metallic objects laying on the ground.
- While performing step potential measurements, the trained person(s) must not come in physical contact with any structure or other person.
- Step potential measurements are to be performed utilizing a step potential measurement device manufactured by IITRI and consists of 2 rods separated by 1 meter. The rods are connected to a portable digital voltmeter via insulated test leads.
- All measuring equipment is to be inspected for damage prior to each use. Any test leads that are damaged or worn are to be replaced prior to use. Instrumentation should have been calibrated within 12 months. Instrument batteries are to be checked prior to each use.
- Step potential and touch voltage measurements performed at initial start-up are to be made with reduced power applied to the EM heating array.
- IITRI has determined that a safe step potential of 2 volts/meter or less will provide a high level of confidence that no electrical current will be perceived. These values are based upon ANSI/IEEE Standard⁵ 80-1986 and data acquired from IITRI's ELF program.
- Utilizing an IITRI model of projected step potential contours, step potential measurements are to

be taken and logged, starting at a point furthest from the array. A minimum of 4 radial paths, each 90° apart shall be mapped working from outside the exclusion zone towards the center of the electrode array. Figures 9 and 10, (Section 7) are contour plots of calculated step potentials. The safety zone will be set-up such that the 2V/meter contour is inside the exclusion zone.

- Step potential measurements will be taken at various locations outside the exclusion zone fence as determined by the site manager.
- Should any step potential measurements outside the exclusion zone exceed the 2 volt/meter limit, the power applied to the EM heating array will be reduced to a level such that the step potential measurements do not exceed the 2 volt/meter limit. The reduced power shall remain in effect until the step potential hazard is mitigated.
- Mitigation of the step potential hazard is to be made via accepted methods including, but not limited to, spreading crushed rock over the hazard area or controlling access to the hazard area. The mitigation method will be determined by the site manager on a case by case basis.
- Upon mitigation of the step potential hazard, step potential measurements are to be repeated to determine the effectiveness of the mitigation.
- Touch voltage measurements are to be performed utilizing a portable digital voltmeter, insulated test lead with conductive tip, and an earth or secondary conductive probe.
- IITRI has determined that a 6 volt or less touch voltage will provide a high level of confidence that the resultant current would be less than the average let-go current of 10.5 to 16 mA. These values are based upon ANSI/IEEE Standard⁵ 80-1986.
- Touch voltage measurements will be made at various structures, including fences, outside the safety zone fence as determined by the site manager.
- Should any touch voltage measurements exceed the 6 volt limit, the power applied to the EM heating array will be reduced to a level such that the

touch voltage measurements do not exceed the 6 volt limit. The reduced power shall remain in effect until the touch voltage hazard is mitigated.

- Mitigation of the touch voltage hazard is to be made via accepted methods including, but not limited to, spreading crushed rock over the hazard area, controlling access to the hazard area, or inserting nonconducting spacers and adding electrical insulation. The mitigation method will be determined by the site manager on a case by case basis.
- Upon mitigation of the touch voltage hazard, touch voltage measurements are to be repeated to determine the effectiveness of the mitigation.
- The trained person(s) performing the touch voltage measurements, must not, at any time, pick up or drag any metallic objects laying on the ground or place such objects against any structures.
- While performing touch voltage measurements, the trained person(s) must not come in physical contact with any structure or other person.

Daily Operation

The following guidelines are to be followed by all site personnel while performing daily operational tasks, during system operation.

- No personnel are permitted to enter the area delineated by the "exclusion zone fence" while the EM heating array power is energized.
- The exclusion zone fence incorporates an electrical interlock, which will remove electrical power to the EM heating array in the event a person attempts to breach the fence. EM heating array power will not be re-energized by clearing the fence fault.
- The 200 kVA power supply is to be locked out and tagged prior to performing any maintenance on the electrical, vapor collection, or water injection subsystems when the area of maintenance is located on the array side of the respective electrical isolators. IITRI's lock-out/tagout program is provided in Appendix B.

- Only Energy System personnel will be permitted to work on energized electrical equipment. It is envisioned that such work will be required for trouble shooting only, but it will be undertaken as a last resort, after appropriate consideration by the SHSO, FOM, and IITRI's electrical engineers.
- The buddy system is to be utilized when working on any energized electrical equipment.
- Prior to entry into the exclusion zone fence, each worker entering must place his/her lock on the lock out device on the 200 kVA power supply main disconnect switch. The lock-out condition must be verified prior to entry into the exclusion zone.
- The 200 kVA power supply is to be locked out and tagged prior to the collection of temperature data, by the persons making the measurement.
- Temperature measurements taken from array thermowells are to be made at the individual thermowells using a manually inserted thermocouple and digital thermometer. Thermocouple must be removed from thermowells before the EM array is re-energized.
- Temperature measurements taken from array electrodes are to be made at the temperature data collection box. The temperature data collection box is to be opened only when power to the EM heating array is turned off. The temperature data collection box incorporates an electrical interlock which will remove power to the EM heating array in the event the cover is opened.
- Water is not to be added to the water injection system reservoir while power is applied to the EM heating array. The 200 kVA power supply must be locked out and tagged prior to adding water to the reservoir.
- The lock out and tag on the 200 kVA power supply can only be removed after a visible inspection of the EM heating area has been made to insure no tools or persons are in the area.
- Prior to removing the 200 kVA power supply lock out and tag, all site personnel are to be verbally notified that the lock-out is being removed and power will be applied.

- Activation of the 200 kVA power supply main disconnect switch will illuminate an amber warning light. The amber warning light will be mounted outside the 200 kVA power supply trailer in a location that is visible from the EM heating array. The amber light indicates that the potential exists to apply power to the EM heating array and that no personnel are to be inside the area delineated by the exclusion zone fence.
- The 200 kVA power supply incorporates an electrical interlock system which will remove power from the EM heating array, in the event the interlock string is broken. Interlocks will be installed in the exclusion zone fence, access gate in the safety zone fence, temperature data collection box, and high voltage cabinets mounted inside the 200 kVA power supply trailer.
- An audible alarm will be sounded one-minute prior to the application of power to the electrode array.
- Application of power to the EM heating array will illuminate a red warning light. The red warning light will be mounted outside the 200 kVA power supply trailer, adjacent to the amber warning light. The red light indicates that the interlock string system is functional and power is applied to the EM heating array. Red light will stay lit as long as power is applied to the array.
- Interrupting the interlock system will remove power from the EM heating array and extinguish the red warning light. The amber warning light will remain illuminated, indicating that although power has been removed from the EM heating array, the 200 kVA power supply is not locked out and tagged.
- Upon shutting off the 200 kVA power supply and leaving the site, the 200 kVA power supply main disconnect switch must be locked out and tagged. The lock utilized for this procedure is an "administrative lock" not assigned to an individual worker. This lock will be placed by the FOM or the SHSO.

6.2.2 Electrode Array, Gas Collection Well, and Thermowell Installation

The task team will normally consist of a driller, a driller's helper, and two sampling personnel. A geologist or a soil technician will also be present during system installation activities to provide a description of the soil lithology.

Bore holes will be drilled for the formation of the electrode array, thermowells, and gas collection wells. Figure 8 of the Design Report (Reference 1) illustrates the plan view of the electrode array. Thirty one electrodes will be installed in three parallel rows. The middle row will have 9 electrodes, while the two outer rows will have 11 electrodes each. In addition, there will be 7 thermowells and 4 gas collection wells. These 42 soil borings will be made in an area which is approximately 25 ft. by 22 ft. Post demonstration soil samples will be made by making 14 new borings after the demonstration.

Soil samples will be collected in split sampling tubes containing liners. When a core is retrieved, the split barrel will be opened to remove the liner containing the soil sample. The samples will be shipped from the field inside the liners. The ends of the liner tubes will be taped with Teflon tape and then capped. The liners will be placed in glass jars and shipped to the laboratory in a cooler.

During drilling the breathing zone and the bore-hole opening will be monitored with an OVA for the presence of volatile contaminants. The breathing zone of the personnel responsible for packing the sample liners will also be monitored. The SHSO will decide whether the respiratory protection is adequate or whether the level of PPE needs to be raised. All workers will be required to wear hearing protection and safety glasses with safety shields. Other PPE requirements are given in Table 9.

Primary contaminants and hazards that the soil sampling team may encounter are identified in Tables 7 and 9. Team members should exercise care at all times to prevent their skin from coming into direct contact with any of the soil sampled. In addition, members of the sampling team should shower as soon as practical after completing sampling and personal decontamination procedures.

Heavy equipment (drill rigs) used in the collection of soil samples may also present a specific hazard to the workers. Prudent safety measures should be adhered to when working around the drill rig. In addition to the potential hazard associated with rotating auger flights, all personnel should be aware of temporarily suspended equipment along the mast of the drill rig. It is imperative that the driller and the driller's helper be aware of

the location of team members when they approach or work around the drill rig. The driller and the driller's helper will conduct most of their activities at the drill rig within the exclusion zone.

6.2.3 Decontamination

Decontamination personnel involved with the efforts at K-1070 C/D Classified Burial Ground potentially may be exposed to a variety of hazards. The potential contaminants of concern are outlined in Table 7. Decontamination personnel will be responsible for decontaminating equipment used for drilling/soil sampling. Enclosure requirements for equipment decontamination depend upon the radiological contamination levels encountered. Enclosure of decontamination activities will be evaluated on a case-by-case basis.

Decontamination personnel may also be exposed to burns, splash, or backspray through the use of the portable hot-water washer. Use of a splash shield for the face is required for all personnel conducting decontamination operations that require use of the hot-water washer. This splash shield will be worn in combination with splash goggles.

The potential for elevated noise levels may exist near the hot-water washer. Hearing protection is required for decontamination personnel when the decontamination trough is affixed to the decontamination trailer and personnel are working within a radial distance of 10 ft. from the hot-water washer.

Hazards associated with inhalation of exhaust from the internal combustion engine that powers the hot-water washer may also be encountered. This potential problem may be avoided by ensuring that the exhaust always trails away from decontamination personnel.

6.2.4 Subsurface Soil Sampling

Subsurface soil sampling will be performed in conjunction with drilling. The anticipated hazards include physical hazards such as contact with rotating or falling drilling equipment, dropping heavy objects such as split spoons, slips, falls and heat stress. Airborne exposure hazards will consist of volatile or particulate contaminants generated by drilling. Skin contact with samples and drill cuttings presents some hazard. General protective measures include minimizing contact with cuttings and samples, and showering as soon as practical after work.

6.3 SPECIAL HAZARDS

In addition to the physical, chemical, and electrical hazards, other types of potential hazards are present on site. All site personnel may potentially be exposed to the hazards outlined below.

6.3.1 Heat Stress

Activities being conducted at the demonstration site may be physically demanding during much of the system installation and demobilization efforts. Physical demands placed upon personnel may be compounded through the use of protective clothing/equipment, moderate to heavy workloads, ambient air temperatures, relative humidity, and exposure to nonionizing radiation.

Two important factors will help personnel function in hot environments: acclimatization and consumption of fluids. Acclimatization of workers to hot environmental conditions may require up to 1 or 2 weeks. During this period especially, workers should concentrate on maintaining a balanced diet, consuming plenty of fluids (while outside contaminated areas) throughout the day, and remaining aware of telltale signs of heat-related stress. Headaches, dizziness, high body temperature, and increased heart rate are all early warning signals of heat stress. It is imperative that the SHSO be informed if a worker experiences these signs. All activities that take place at the investigative site require the use of a buddy system, and as field activities continue, all personnel should be apprised of their buddy's condition with respect to heat stress.

If necessary, in the judgment of the SHSO, a work/rest regimen will be instituted to help in combatting heat-related disorders. The SHSO will develop the work/rest regimen in accordance with best professional judgment using the heat stress TLV published by the American Conference of Governmental Industrial Hygienists as a guideline. If a work/rest regimen becomes necessary, physiological monitoring will also be instituted. This monitoring will consist of monitoring employee's pulse rates before and after each break. To re-enter the exclusion zone, an employee's pulse rate must be no greater than 150% of his/her resting pulse rate.

6.3.2 Animal Hazards

Field conditions may present a variety of animal hazards. Examples of these hazards may be but are not limited to bee stings, ticks, snake bites, etc.

6.3.3 Ergonomics

Potential hazards related to the interaction of personnel with their working environment may be present at this site. The primary ergonomic hazards that may exist may be lifting heavy load, equipment vibrations, body positioning, and physical obstacles associated with traversing ditches and brush. Personnel should always position themselves properly and lift from the legs when attempting to lift equipment. Personnel should rely on their buddy to assist in lifting loads that are too heavy for one person to properly lift and carry. Back strain, the most common ergonomic hazard in the field, may be easily avoided, provided the on-site workers always ask for assistance when they need it.

A certain degree of vibration may be encountered by drilling personnel when operating the drill rig. If any ergonomic symptoms are encountered in the field, the SHSO should be notified immediately.

7. SITE CONTROL MEASURES

The following sections will be used to determine work zones for the K-1070 C/D Classified Burial Ground site.

7.1 ZONE 1: EXCLUSION ZONE

The exclusion zone is the area where the greatest potential exists for exposure to contamination and/or electrical shock. The electrical exclusion zone will be such that it encloses within it the step potential contour of 2 Volts/meter under all operating conditions of the array. All structures in the site vicinity will be monitored for touch potential to ensure that the touch potential is at or below 6 Volts. Control and mitigation steps will be taken if the touch potential is greater than 6 volts. The contamination exclusion zone will be the area of the site where soil will be disturbed as a result of system installation activities. Figure 7 shows in general the three exclusion zones. Figure 8 shows the conceptual site layout with the Zone 1 marked on it. Step potential calculations were done for the array at an input power levels of 100 kW. These show that the 2 V/meter step potential contour can be completely enclosed within a circle of radius 32 ft centered about the electrode array. These were done for an input power of 100 kW and an initial soil resistivity of 0.01 mhos/meter inside and outside the array. Figure 10 illustrates the worst-case when the soil inside the array has dried out and the surrounding soil is still wet. Calculations summarized in Figure 10 were based on inside soil resistivity of 0.001 mhos/meter and outside soil resistivity of 0.01 mhos/meter.

All personnel entering the exclusion zone will wear the prescribed level of protective clothing, as determined by the SHSO. An entry and exit checkpoint will be visually defined at the periphery of the exclusion zone to regulate the flow of personnel and equipment. The entry and exit checkpoint will be delineated with the use of ropes, flags, or signs at the discretion of the Field Operations Manager and/or the SHSO. The exclusion zone will be fenced by means of an orange construction fence made from plastic material. Entry into the contamination reduction zone or the exclusion zone is prohibited without the approval of the Field Operations Manager or SHSO. The number of people and equipment in the exclusion zone will be minimized in accordance with workspace requirements for safe site operation.

Certain activities and items are prohibited in the exclusion zone. These are: beards and long sideburns (if respiratory protection is required), any items or material intended to be placed in the mouth, and any personal articles such as watches, rings, etc.

Figure 7. Site Work Zones

Figure 8. Conceptual Site Layout Showing Electrical Exclusion Zone

Figure 9. Contour Plot of Step-Potential at 100 kW.

Figure 10. Contour Plot of Step-Potential at 100 kW, "Dried-Out Condition".

7.2 ZONE 2: CONTAMINATION REDUCTION ZONE

As shown in Figure 7 a contamination reduction zone is established outside the exclusion zone to provide a transition from and a buffer between the exclusion zone (potentially contaminated zone) and the support zone (clean zone). The contamination reduction zone provides additional assurance that the physical transfer of contaminating substances on personnel or equipment or in the air is limited through a combination of decontamination, distance between exclusion and support zones, air dilution, zone restrictions, and work functions. At the boundary between the exclusion and contamination reduction zones, personnel decontamination stations will be established and constructed as detailed in Section 11. Section 11 also establishes equipment decontamination procedures.

7.3 ZONE 3: SUPPORT ZONE

The support zone (clean zone), shown in Figure 7 will be marked and protected against contamination from the work site. Primary functions of the support zone are:

- entry area for personnel, material, and equipment;
- exit area for decontaminated personnel, materials, and equipment;
- a clean storage area for safety and work equipment; and
- an area for rest breaks, consumption of food and beverage, and all other activities.
- an area for office trailer and communications equipment.

8. TRAINING REQUIREMENTS

All personnel who participate in any sort of work conducted during the demonstration activities at the K-1070 C/D Classified Burial Ground are subject to the following training requirements.

- All personnel working on the site must have received the following training. Table 11 summarizes the training requirements for persons entering the demonstration site.

SARA/OSHA 40-h Hazardous Waste Site Worker
SARA/OSHA 8-h Manager/supervisor (Supervisors only)
SARA/OSHA 8-h Annual Refresher
SARA/OSHA Hazardous Waste Site Worker Field Experience
Energy Systems General Employee Training (GET)
Energy Systems General Employee Training - RAD
(non-radiation contaminated areas, spring,
surface water sampling)
Hazard Communication Training (included in GET,
4-h course)
Site-specific hazardous communication training
Respiratory Protection Training required for wearers
Hearing Conservation Training in compliance with
29 CFR 1910.95
Respiratory Protection Training required for issuers
Training in Lockout/Tagout Procedures

- All personnel working on the site must have attended the pre-entry health and safety briefing, and documentation of the topics covered as well as the signatures of those attending must be entered in the field logbook before site access will be granted.

**Table 11. Training Requirements for Workers and Visitors at the
EM Demonstration Site**

Training	Notes	Worker	Supervisor	Unescorted Visitor	Escorted Visitor
General Employee Training ^e	a	✓	✓	✓	✓
SARA/OSHA ^e	b	✓	✓	✓	x
Lockout/Tagout Procedures		✓	✓	x	x
Site Specific Hazards Communication and Access		✓	✓	✓	✓
SARA/OSHA Annual Refresher		✓	✓	✓	x
SARA/OSHA supervisors Training		x	✓	x	x
Waste Generation	c/d	✓	✓	x	x
<p>✓ = Required x = Not Required</p> <p>a Required for all employees and any visitor who visits the controlled area of the K-25 Site to perform work for more than 10 working days per year.</p> <p>b 24-hr. training required. Visitors may be escorted by SARA/OSHA trained personnel.</p> <p>c Required for operations personnel who generate hazardous waste.</p> <p>d Required for waste certification officers (CWOs) and alternate WCOs who manage 90-day accumulation areas.</p> <p>e General Hazards Communication Training is included as a part of both GET and SARA/OSHA.</p>					

9. PERSONAL PROTECTIVE EQUIPMENT

All Personal Protective Equipment (PPE) for site activities, tasks, and work zones is based upon potential site-specific contaminants and may involve conservative additions to personnel protection by the Field Operations Manager. Protective equipment may be selected for chemical or electrical hazards. In cases where all types of hazard are present, a combination of protective equipment will be selected so that adequate protection is provided for all three hazards.

The level of protection selected is based upon the following:

- type and measured concentration of the chemical substance in the ambient atmosphere and its toxicity;
- potential for exposure to substances in air, soil, liquids, or other direct contact with materials due to work being done; and
- knowledge of chemicals on site along with properties such as toxicity, route of exposure, and contaminant matrix.

In situations where the type of chemical, concentration, and possibilities of contact are not known, the appropriate level of protection must be selected based on professional experience and judgment until the hazards are further evaluated. When hazards are unknown, the SHSO is responsible for determining PPE requirements.

The level of protection provided by PPE shall be upgraded or downgraded based upon a change in site conditions or findings of investigations. Criteria indicating a possible need for reassessment of PPE selection include the following:

- commencement of new work phase
- change in job tasks;
- change of season/weather
- when temperature extremes or individual medical considerations limit the effectiveness of PPE;
- hazards other than those previously identified are encountered;

- change in airborne concentration of chemical/radiological hazards; and
- change in work scope which effects the degree of contact with contaminants.

Levels of protection that may be used to protect against chemical hazards at this site include:

- Level B Protective Equipment
 - full-face, self-contained breathing apparatus (SCBA)
 - hooded Saranax-coated Tyvek® with all openings taped
 - 2 pair chemical-resistant gloves; (appropriate for chemical and task)
 - Rubber soled, insulated, steel-toed boots
 - hard hats
- Level C Protective Equipment
 - half- or full-face respirator and air purifying cartridges capable of filtering out organic vapors and radionuclides
 - hooded chemical-resistant clothing (Polyethylene-coated Tyvek®) with all seams and openings taped
 - gloves (chemical-resistant inside and outside)
 - Rubber soled, insulated, steel-toed boots
 - shoe cover
 - hard hats - as required
 - safety glasses with half-face respirators.
- Level D+ Protective Equipment
 - (polyethylene-coated) Tyvek® clothing
 - chemical-resistant gloves, taped
 - Rubber soled, insulated, steel-toed boots
 - hard hats - as required
 - safety glasses
- Level D Protective Equipment
 - coveralls/field clothes
 - safety glasses
 - rubber soled, insulated steel-toed boots
 - hard hats - as required

The outer protective garment for Levels C and D+ will be made of a chemical-resistant material (coated Tyvek® or equivalent)

that forms a protective barrier against detrimental chemicals for a specific period of time based on the chemical in question. **Each chemical has its own permeating ability, and the resistance of the protective clothing will vary with each chemical.** For some chemicals, the risk of chemical permeation increases when an outer protective garment becomes damp from soil or water contact. Based upon a consideration of the chemicals that are suspected to be present at the demonstration site, an employee whose outer protective suit becomes wet should replace the wet garment as soon as possible with a new Tyvek® suit.

9.1 PROTECTIVE CLOTHING DONNING PROCEDURE

The protective clothing donning procedure ensures that on-site personnel are instructed in the proper way to don protective clothing. Failure to adhere to this procedure may result in the protective clothing being ineffective against a potential contaminant. The following donning procedure is given as a requirement and may be altered by the SHSO if improvements can be made to the procedure and if changes are warranted in the field. In addition, some articles of protective clothing/equipment detailed below may not be necessary for the particular site task. Personnel should consult the SHSO for the appropriate protective equipment combination daily.

- Inspect clothing and respiratory equipment before donning.
 - Visually inspect for:
 - imperfect seams
 - nonuniform coatings
 - tears
 - malfunctioning closures
 - pinholes
 - cracks caused by flexing
 - shelf deterioration
- Don and secure hard hat.
- Place boot covers over the steel-toed safety boots if required.
- Standing or sitting, place legs in suit, pull steel-toed boots through, gather up at the waist, place arms in sleeves, pull upper portion of the suit over the shoulders, and zip the suit closed. Tape the zipper closed to provide a seal. Tape the leg of the suit to the boot covers, providing a seal, and tab the tape to permit removal.

- Don the respirator after performing the initial qualitative checks of the respirator's integrity.
- Perform the necessary qualitative respirator fit test.
- Draw hood up around the respirator. Seal exposed facial areas between the suit and the respirator with duct tape.
- Don one or two pairs of chemical-resistant gloves as specified in Table 5.1; pull the sleeve of the suit over the cuff of the glove and seal it to the glove with tape. A tab should be provided on the tape to ease removal of gloves during decontamination procedures.

9.2 DURING THE WORK TASK

Employees will continue to monitor the condition of protective equipment during work activities. They will be alert for the following conditions:

- Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects.
- Closure failure.
- Tears.
- Punctures.
- Seam discontinuities.

9.3 PROTECTIVE CLOTHING DOFFING PROCEDURE

The protective clothing doffing procedure ensures that all on-site personnel are instructed in the removal of protective equipment. Failure to adhere to this procedure may result in unnecessary exposure to a potential on-site contaminant. The following doffing procedure is given as a requirement and may be altered by the SHSO if improvements can be made to the procedure and changes are warranted in the field. In addition, some protective equipment/clothing listed below may not be required for a specific site task. Personnel should consult the SHSO for the appropriate protective equipment combination.

- Step into the decontamination pad.

- Observe established step-off procedures and use step-off pads.
- Remove any extraneous disposable clothing/equipment (e.g., outer gloves, hard hat, boot covers, and tape) and dispose of it in the appropriate receptacle. Note: **Do not remove respirator.**
- Unzip protective suit.
- Remove one arm at a time from the suit, turning the suit inside out. Inner gloves should still be worn at this time.
- Sitting, if possible, remove one leg from the suit at a time, turning the suit inside out.
- Dispose of the suit in the appropriate receptacle.
- Remove respiratory equipment.
- Remove inner disposable gloves by rolling them off each hand, inside out, and dispose of them in the appropriate receptacle.

Personnel should familiarize themselves with this guidance and with the personnel decontamination procedures in Sect. 10, as both procedures need to work in harmony.

9.4 RESPIRATORY PROTECTION

Personnel at the Demonstration site will be covered by a respiratory protection program that meets the requirements of 29 CFR 1910.134. IITRI's Respiratory Protection Program is provided in Appendix C. This program has the following elements:

- A program administrator.
- Standard operating procedures for selecting and using respirators.
- Proper selection of respirators based on hazard.
- Training of personnel in use and limitations of equipment.
- Regular cleaning and maintenance of equipment.
- Proper storage of equipment.

- Routine monthly inspections of equipment and inspections before and after use.
- Constant monitoring of work area for adverse conditions and worker stress.
- Continual evaluation of respiratory compliance program, once in operation.
- Determination of medical fitness of potential user.
- Use of only approved equipment and only after proper fit testing has been performed. The fit test is used to determine the user's ability to obtain a satisfactory fit with a specific type, make, size, and model of respirator for use by the wearer.

The following policies should also be adhered to in the fitting and use of respirators:

- An employee must have passed the fit test and medical evaluation within the past 12 months to use a respirator and must present a respirator card prior to being issued a respirator.
- If an employee cannot obtain a good respirator-to-face seal because of facial or medical characteristics, that employee will not use a respirator and/or enter an atmosphere that requires the use of a respirator.
- Facial hair such as beards, sideburns, or certain mustaches that may interfere with the fit test are not allowed.
- Persons requiring corrective lenses will be provided with specially mounted lenses inside the full-face mask.
- A person may use only the specific make(s) and model(s) of air-purifying respirators for which he has obtained a satisfactory fit via the quantitative fit-testing procedures. Under no circumstances will a person be allowed to use any make or model respirator for which he has not passed a fit test.

The determination of medical fitness of the potential user is generally based on evaluating the individual for physiological/psychological limitations. Examples of problems that may render an employee unfit to use a respirator include:

- pulmonary problems;

- cardiovascular problems;
- skin sensitivity, diabetes, perforated eardrum, deviated septum;
- claustrophobia, anxiety, and discomfort.

IITRI's respirator training program and other related WSPs are presented in Appendix C.

10. MONITORING AND SAMPLING

Because airborne concentrations cannot be accurately predicted from soil concentrations, real-time assessment of potentially hazardous chemical concentrations and surficial radiological levels will be performed while conducting operations at K-1070 C/D Classified Burial Ground to assure that contaminant concentrations do not exceed acceptable levels. Action levels have been established for this monitoring. In addition to real-time monitoring, the SHSO, at his own discretion, may require personnel to wear personal monitoring equipment to measure potential site-specific chemical contaminants/hazards. The deployment of monitoring equipment will depend upon the site-specific activities being conducted. Monitoring requirements and action limits are presented in Table 12. This monitoring program is designed to protect all on-site personnel from potential chemical and radiological contaminants. Routine real-time and integrated industrial hygiene measurements will be conducted by IITRI personnel. Results will be recorded and maintained on site by the SHSO.

Air monitoring for volatile organics will be conducted using an Organic Vapor Analyzer. Although not all volatile organic chemicals can be detected in this fashion, some of the site contaminants, such as trichloroethene, acetone, and toluene, will be detected. The presence of these materials will serve as a marker for other materials, which the instrument will not detect. The default action levels for unknown organics have been set conservatively, to compensate for the inability of the instrument to detect some of the site contaminants. This instrument will be calibrated daily, or more frequently, as required by the SHSO, using the requirements set forth by the manufacturer.

Air monitoring for combustible gases and oxygen will be conducted using a combination combustible gas indicator such as a Gastech GX-86 or similar device if site conditions suggests the potential for flammable concentrations of solvents or other airborne gases or vapors. Indications of such potential include elevated (greater than 500 ppm) total organic measurements at the borehole opening or at a sampling point. Another indication will be any information suggesting the potential for the presence of methane. This instrument will be calibrated daily, or more frequently, as required by the SHSO, using the requirements set forth by the manufacturer.

- All personnel will monitor or be monitored for radioactive contamination prior to entering the support zone from the contamination reduction zone.

Table 12. Site Monitoring Action Limits			
Hazard or Measured Parameter	Interval	Limit	Action
Surface radiological contamination of equipment	Entry and exit from K-25 Site	>Table 13 values	Stop work; monitor personnel; notify HP area supervisor; do not re-enter until authorized by HP
Breathing zone chemical samples	As needed	PEL or TLV	Variable, may include administrative, engineering personal protection controls
OVA Meter (breathing zone, 2-3 ft from borehole or 14 in. in front of employees' shoulder)	Intermittent	<p><2 ppm</p> <p>2-10 ppm (over background for 2 minutes or longer)</p> <p>10-25 ppm</p> <p>>25 ppm</p>	<p>Continue</p> <p>APR (Level C, see Section 9) or withdraw and wait. SHSO to monitor area with instruments and when safe allow resumption of work.</p> <p>Withdraw, wait and continue to monitor as above.</p> <p>Withdraw; wait; SHSO to monitor area with instruments and when safe, allow resumption of work.</p>
Comb. gas indicator (at the surface of the borehole, or at any other point where dangerous concentrations of combustible gases might occur)	Intermittent (30 minutes or less if flammable materials are present)	<p><5% LEL</p> <p>5-10% LEL</p> <p>>10% LEL</p>	<p>Continue</p> <p>Evaluate source</p> <p>Withdraw</p>

APR - air purifying respirator
 FOM - field operations manager
 HSD - Health and Safety Division
 LEL - lower explosive limit
 PEL - permissible exposure limit
 TLV - threshold limit value

Table 13. Summary of Contamination Values		
Nuclide ^a	Removable (dpm/100 cm ²) ^b	Total (Fixed + Removable) (dpm/100 cm ²) ^c
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above. Includes mixed fission products containing Sr-90.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO and metal tritide aerosols	10,000	10,000

^a The values in this Table apply to radioactive contamination deposited on , but not incorporated into the interior of the contaminated item. Where contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for the alpha-and beta-gamma-emitting nuclides apply independently.

^b The amount of removable radioactive material per 100 cm² of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm², the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231 and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removal contamination.

^c The levels may be averaged over 1 square meter provided the maximum activity in any area of 100 cm² is less than three times the values in this table.

Source: DOE Radiological Control Manual, Radiological Standards, Chapter 2, Table 2-2, December 1992.

The K-25 HP department will conduct surveys to include pre-entry and exit (site) equipment and area surveys. The frequency and extent of surveys may be changed if conditions warrant.

11. DECONTAMINATION PROCEDURES

11.1 PERSONNEL DECONTAMINATION PROCEDURES

Personnel decontamination procedures are designed to eliminate/limit the contaminated materials workers may encounter and to limit the spread of contaminated materials from the exclusion zone and contamination reduction zone. Decontamination procedures for C, D+, and D levels of protective equipment are included and are quite similar. The SHSO is responsible for the establishment of the exclusion, contamination reduction, and support zones and levels of protection when radioactive material/contamination is involved. In addition, the SHSO will ensure the construction of a decontamination station on site and will instruct personnel on its proper use. Figures 10 and 11 depict minimum requirements of the decontamination stations.

The following procedures have been provided as requirements for personnel decontamination and, dependent upon site conditions, may be modified by the SHSO if improvements are needed. These guides are worst-case scenarios; therefore, all personnel will check with the SHSO to determine the site-specific requirements.

11.1.1 Level D Protection Decontamination

Station 1: Segregated equipment drop.

Deposit equipment used on site (tools, sampling devices, containers, monitoring equipment, clipboards, etc.) on a plastic drop cloth or a container with a plastic liner.

Equipment necessary: containers
 plastic liners
 55-gal compatible waste drum

Station 2: Outer garment, boots gloves, hard hat, safety glasses, and scrubbing and rinsing tools and agents.

Scrub outer boots and gloves, when chemical resistant gloves and boots are worn, with a laboratory-grade detergent (Liquinox or equivalent) and rinse with potable water. disposable boots and gloves need not be scrubbed and may be disposed of in the compatible waste drums. Clean safety glasses and hard hat in the same fashion. All decontamination should take place while personnel are standing in large wash tubs, if decontamination of boots is required, so that all decontamination solutions can be caught and drummed in accordance with the Waste Management Plan, which is included in Vol. 2 of this report.

Figure 11. Minimum Decontamination Requirements for Level D+ Protection.

Figure 12. Minimum Decontamination Requirements for Level C Protection.

Equipment necessary: two or three wash tubs
one hand-pump sprayer
water
detergent
scrub brushes
paper towels
55-gal drum with liner for paper towels and protective clothing

Station 3: Boot, glove, safety glasses, and hard hat removal.

Equipment necessary: alpha detector
beta/gamma detector

Station 4: Field wash.

Thoroughly wash hands and face. Shower as soon as possible.

Equipment necessary: water
wash basin/bucket
soap

11.1.2 Level D+ Protection Decontamination

Follow the above steps for Level D decontamination; the only difference is the removal of the disposable chemical protective coverall at Station 3 and depositing of the coverall in a lined 55-gal compatible waste drum. Level D+ protective clothing is deemed necessary when sampling operations may produce excessive splashing of surface or subsurface materials, yet the action level does not require the use of a respirator and taped, protective chemical-resistant suits.

11.1.3 Level C Protection Decontamination

Station 1: Segregated equipment drop.

Deposit equipment used on site (tools, sampling devices, containers, monitoring instruments, clipboards, etc.) on plastic cloths or in different containers with plastic liners. Each piece of equipment will be decontaminated to a different degree, which is the reason for separating the equipment. Segregation of the equipment at the drop site reduces the possibility of cross-contamination.

Equipment necessary: various containers
plastic liners

plastic drop cloths
55- gal lined compatible waste
drum

Station 2: Outer garment, boots, and gloves scrubbing and rinsing.

Scrub used outer garment, boots, and gloves with laboratory-grade detergent and water and rinse with potable water. All wash water and rinsing solutions will be disposed of in accordance with the Waste Management Plan in vol. 2 of this report.
Note: *This station is not necessary when disposable PPE is used.*

Equipment necessary: wash tubs
water
detergent
scrub brushes
one-hand pump sprayer

Station 3: Remove outer boots and gloves.

Remove tape from outer boots and outer gloves. Remove outer boot covers and outer gloves. Deposit gloves and covers in plastic trash bags.

Equipment necessary: plastic trash bags

Station 4: Cartridge change

If a worker has left the exclusion zone for the sole purpose of changing a canister/cartridge of the respirator, this is the last step of the decontamination procedure. Once the worker's canister/cartridge has been replaced, the outer boots and gloves will be replaced and retaped so that all potential pathways to the skin are sealed. The used canister/cartridge will be placed in the plastic bag and will be disposed of in accordance with the Waste Management Plan.

Equipment necessary: respirator cartridges/canisters
tape
extra gloves
boot covers (if worn)
plastic trash bags

Station 5: Disposable outer garment removal.

Remove disposable outer garment, deposit in a plastic trash bag, and dispose in accordance with the Waste Management Plan.

Equipment necessary: bench or stool
 plastic trash bags

Station 6: Respiratory protection and disposable inner glove removal.

The respirator is the next-to-last item for removal. The cartridges/canisters are placed in a plastic trash bag and disposed of in accordance with the Waste Management Plan. The respirator is placed in a plastic bag dedicated for used respirators only. Remove disposable inner gloves last and deposit them in a plastic trash bag, in accordance with the Waste Management Plan.

Station 7: Field wash.

Wash hands and face thoroughly with soap and water.

11.2 EQUIPMENT DECONTAMINATION

The equipment decontamination personnel at K-1070 C/D Classified Burial Ground may be exposed to a variety of potential hazards. Some of the potential contaminants known at the time of publication were listed in Table 5.

Decontamination personnel will be responsible for conducting decontamination of all equipment used for the soil and water sampling. Personnel decontamination procedures are outlined in Sect. 11.1 Equipment decontamination will generally require Level D+ protective equipment, including eye protection. Decontamination personnel may be exposed to splash or backspray during cleaning operations; therefore, protective clothing like Tyvek® or a protective apron will be worn in additions to a face shield mounted on a hard hat. Because of high noise levels emitted from the hot-water washer, hearing protection will be required, as directed by the SHSO and dependent upon the location and placement of the decontamination trough during operation.

12 REFERENCES

1. Demonstration system design (draft), DT&E of In Situ Soil Heating, Contract No. DE-AC05-93OR22160, IITRI Project C06787, March 1994.
2. Phase 2 Remedial Investigation Work Plan for the K-1070 C/D Classified Burial Ground at Oak Ridge K-25 Site, Oak Ridge, TN; Vol 3: Health and Safety Plan, DoE/OR-1025/V3 & D3, July 1993.
3. Personal Communication, dated 1-14-94. Mr. Frank VanRyn, Martin Marietta Energy Systems, Inc. Site Programs Organization.
4. NIOSH Pocket Guide to Chemical Hazards. NIOSH Publications Number 90-117.
5. ANSI/IEEE Standard 80-1986, IEEE Guide for Safety in AC substation Grounding, Distributed by Wiley InterScience, 1986.
6. Treatability Study Work Plan (Revision 1). Demonstration Testing and Evaluation of In situ Soil Heating. DoE Contract No. DE-AC05-93OR22160, IITRI Project No. C06787, July 1994.

APPENDIX A

EXCERPTS FROM:

K-25 FACILITY EMERGENCY PROCEDURE,

TITLE: BUILDING K-1414

Appendix B

EMERGENCY ALARM SIGNALS

EMERGENCY ALARM SIGNALS

When an emergency occurs at the K-25 Site that could endanger the health and safety of personnel, alarm signals and protective actions will be initiated either locally or site-wide, depending on the extent of the problem.

The four plant-wide signals which you, as an employee, should recognize are as follows: (1) the evacuation signal, (2) the radiation alarm signal, (3) the take-cover signal, and (4) the standard alerting tone.

Evacuation Signal

The evacuation signal, a steady, prolonged sound from the site public-address (PA) speakers, is sometimes accompanied by a steady sound from local evacuation horns. When you hear these sounds, leave the building, proceed to your designated assembly station, and listen for a PA announcement or an announcement from the assembly station director.

Radiation Alarm Signal

The radiation alarm signal is a clarion horn that sounds like a locomotive whistle. This sound indicates a radiation emergency and is accompanied by rotating red beacon lights on the outside of buildings that might be affected. As an employee, you should respond to the alarm by evacuating the area immediately, performing only those necessary crash or scram shutdown procedures that can be done without delay, and proceed to your designated assembly station (keeping away from buildings with rotating red beacon lights). Further instructions over the plant PA system or from the assembly station director will be provided following the activation of a radiation alarm.

Take-Cover Signal

The take-cover signal is a wailing, siren-like sound from the site PA speakers. When this sound is heard, you should seek refuge in a strong, sheltered part of a building. If you are in a mobile structure, you should leave and take cover in a permanent building or lie flat in the nearest ditch or depression. This signal may be accompanied by further instructions over the plant PA system.

Standard Alerting Tone

A standard alerting tone is used at all Energy Systems sites and will be sounded prior to emergency announcements made over the PA system. This standard alerting tone is an alternating high-low tone. It is intended to say to you, "Listen carefully, an important announcement is coming up." A recording of the tone is available for you to hear by dialing 3-241-7800.

Appendix C
(Page 1 of 2)
REPORTING AN EMERGENCY

Discovery

The person who discovers an emergency should immediately report the emergency and attempt to establish control only if the incident is minor in magnitude. Where such measures are obviously inadequate or not successful in controlling the incident, you should initiate a call for emergency help.

Initial Emergency Response

When an emergency occurs, someone is always in charge. Initially, this will be the person who discovers the emergency or the operation supervisor, who will assume command as the On-Scene Commander (OSC) and will remain in command of the incident until a relief is appointed by the Site Emergency Director (SED). In the absence of a facility supervisor, the first arriving response officer will assume command and control as the OSC.

The OSC will:

1. Declare an emergency, notify the Plant Shift Superintendent (PSS) or Fire Department, and establish control of the incident.
2. Use any of the following methods for prompt notification:
 - Fire Alarm (pull box)
 - Telephone (911 or 4-3282)
 - Radio (station 9) or
 - Messenger
3. Arrange for evacuating personnel from the immediate danger area.
4. Evaluate the magnitude of the problem.
5. Ascertain that emergency response units have been summoned and make arrangements to meet at the designated assembly station.
6. Promptly notify the SED of the seriousness of the conditions involved and keep the SED informed of additional manpower and equipment needs and of the progress made in resolving the emergency.
7. Use the first available radio to establish a field command post.

Appendix C
(Page 2 of 2)

8. Direct operational changes as may be necessary.
9. Inform emergency response units of the emergency status.
10. Set in motion applicable prearranged plans and procedures.
11. Direct the actions of emergency response units at the incident scene.

Appendix D
(Page 1 of 7)

GENERAL EMERGENCY RESPONSES

Plant-Wide Incident

Emergency conditions that involve the entire K-25 Site will be evaluated by the Site Emergency Director (SED); the SED will instruct employees, by means of the plant-wide public-address (PA) system, regarding the course of action to be followed. The possible emergency conditions that would involve all personnel and the suggested response for each are:

1. Major Fire and/or Explosion

- A. Personnel in the affected building should immediately actuate the nearest fire alarm (if it was not actuated automatically by the fire protection system) or call 911 and report the emergency.
- B. If the building in which the incident occurred is equipped with an evacuation horn, it should be actuated. If a local PA system is available, all facility personnel should be instructed to evacuate the building.
- C. If practical, persons familiar with various electrical and/or process equipment should shut down the equipment before evacuating the building and, if there is any literature (e.g., log books, this emergency procedure, etc.) considered to be of value in evaluating the incident, remove it from the building and deliver it to the assembly station director (ASD) or the on-scene commander (OSC).
- D. Alert facility emergency wardens and have someone meet the firefighting and emergency crews. Assist them as needed in accounting for workers in the affected area and in handling the injured.
- E. Those individuals familiar with the building and/or the work performed within the building should be notified of the incident and should assist the emergency crews as needed.
- F. If the severity of the incident warrants an evacuation of adjacent areas or the site, such action will be initiated by the SED, based upon an evaluation of the situation by the OSC.
- G. Conceivably, the worst conditions could develop in a relatively short period of time (e.g., water mains may be ruptured, other fires may start, radioactive materials may contaminate much of the area); therefore, it is imperative that instructions issued over the plant-wide PA system be followed in an orderly manner. The consequences of mass panic are generally worse than the original problem. Searches for trapped or injured victims should be done by emergency personnel or as directed by the SED.

Appendix D
(Page 2 of 7)

- H. After the emergency is over, check for any personal injury; look for fires or fire hazards; examine utility lines and equipment for damage. Deenergize nonessential electrical equipment. Do not smoke or use flame-producing devices until gas leaks have been ruled out. Check alarm systems to ensure their continued operation, especially in areas containing radioactive or hazardous materials. The status of the various areas will be announced over the PA system. Do not re-enter any building or area without the specific approval of the SED.

2. Air Attack

- A. Following a determination by the North American Air Defense Command that an air attack against our country has been detected, the warning message will be disseminated over the National Warning System. Immediately upon receipt of this message, the SED will initiate the take-cover signal (a wailing siren-like sound from the site PA system).
- B. Personnel in this building will immediately shut down all operating equipment. They will then exercise their option of (1) proceeding to the off-site shelter according to the personal plan of each individual, or (2) take refuge in a strong sheltered part of a permanent building. Government vehicles, other than emergency and security units, may be used to evacuate the plant, if necessary.
- C. After an air attack, check for any personal injury; look for fires or fire hazards; examine utility lines and equipment for damage. Deenergize nonessential electrical equipment. Do not smoke or use flame-producing devices until gas leaks have been ruled out. Check alarm systems to ensure their continued operation, especially in areas containing radioactive or hazardous materials.
- D. If there is no attack, the SED will recall personnel by appropriate means, upon receipt of a cancellation of the warning from the DOE-Oak Ridge Operations (ORO) Manager, the DOE-ORO Emergency Operations Center (EOC), or Martin Marietta Energy Systems, Inc., management. Operations will be resumed as quickly as possible.

3. Earthquake

Damaging earthquakes are rare in the Oak Ridge area. Based on current information, should an earthquake occur, it would probably be of moderate severity and produce only minor damage, such as broken pipes, toppled bookcases, jarred and broken bottles, and minor structural damage to buildings.

A. During the Quake

Indoors. If indoors, be alert for falling objects, such as light fixtures, plaster, bookcases, and filing cabinets. If threatened by a falling object, crawl under a desk or table located in a strong corner away from windows or move to a strong doorway. Do not panic. Do not attempt to rush outside; elevators may lose power, stairways may be unsafe, and exits may be jammed with people trying to evacuate.

Appendix D
(Page 3 of 7)

Outdoors. If outside, avoid high buildings, walls, power poles, and other tall objects. Do not run through the streets. If driving an automobile, stop in the safest place possible. Move to a safe, open area.

B. After the Quake

After the earthquake has occurred, check for any personal injury; look for fires or fire hazards; examine utility lines and equipment for damage. Deenergize nonessential electrical equipment. Do not smoke or use flame-producing devices until gas leaks have been ruled out. Check alarm systems to ensure continued operations, especially in areas containing radioactive or hazardous materials.

Engineering will make an examination of all structures for serviceability and report the findings to the EOC.

The Security Patrol will ascertain which security alarm systems have failed and make provisions for adequate coverage until systems are restored.

A determination regarding the status of the site utility services is required. Ruptured gas lines may prove a major hazard. If leaks are detected, natural gas supplies will be shut off and buildings checked for leaks until full gas service is restored. If water, steam, air, or nitrogen system leaks are discovered, systems will be isolated until repairs can be effected.

C. Aftershocks

Within 12 to 24 hours following a major earthquake, a series of aftershocks of approximately the same intensity can occur. A recovery strategy will consider the potential to lessen the damage from these aftershocks by securing, as soon as possible, material loosened by the initial shocks.

4. Tornadoes

Tornadoes are one of nature's most destructive weapons. Like the thunderstorms that spawn them, tornadoes can form any time of the day or night. A tornado is formed by winds rotating at very high speeds in a counterclockwise direction.

While there is no such thing as an average tornado, the typical tornado moves from the southwest to the northeast, following the parent thunderstorm. A tornado can move in any direction and can change direction at any time. Tornadoes travel at various speeds, usually 25 to 40 miles per hour, and can be 2 yards to 2 miles wide. The typical tornado is on the ground for less than 10 minutes.

Weather conditions indicative of tornadoes are black, churning funnel clouds; hail; heavy rains; high winds; and lightning.

Appendix D
(Page 4 of 7)

Standard weather warnings for tornados are as follows:

- A. **Tornado Watch.** A notice that weather conditions indicate tornados are expected to develop.
- B. **Tornado Warning.** A notice that a tornado has actually been sighted or indicated on radar.
- C. In the event a tornado occurs, use the following guidelines:

(1) **During the Tornado**

Indoors. If indoors, personnel should take cover in the basement of the building in which they are domiciled. If the building does not have a basement, the bottom or ground floor is the safest area, preferably in a small closet or hallway nearest the center of the building, away from windows and under heavy furniture, if possible. Trailers and other mobile structures should be vacated.

Outdoors. If outdoors and time permits, proceed immediately to a safe shelter, preferably a basement area or strong building. If unable to find shelter, lie flat in the nearest ditch or depression. Stay out of mobile structures—they are most vulnerable to tornados.

(2) **After the Tornado**

After the tornado has passed, check for personal injury; look for fires or fire hazards.

Be alert for such dangers as loose electrical and high voltage wires; damaged structures; or broken or cracked gas lines that may be releasing flammable, toxic, or inert gas. Deenergize nonessential electrical equipment. Do not smoke or use flame-producing devices. Check alarm systems to ensure continued operations, especially in areas containing radioactive or hazardous materials.

Engineering will make an examination of all damaged structures for serviceability and report the findings to the EOC.

The Security Patrol will ascertain which security alarm systems have failed and make provisions for adequate coverage until systems are restored.

A determination regarding status of site utility services in affected facilities is required. Service lines such as gas, water, steam, air, or nitrogen may be ruptured and prove to be a major hazard. If leaks are discovered, isolate the system until repairs can be made.

Appendix D
(Page 5 of 7)

5. Radiation Emergency

Of special importance at the K-25 Site are those incidents in which radiation and/or radioactive materials are involved. Unlike many other potentially hazardous conditions confronted in industry, radiation cannot be detected by an individual's senses alone. Consequently, it is intended that highly specialized radiation detection equipment and trained personnel will alert other workers and/or emergency crews of emergency conditions involving radioactive materials.

Each employee responds to a radiation emergency evacuation signal by evacuating the area without delay and reporting to an assembly station. Each employee should:

- A. Perform only those necessary crash or scram shutdown procedures that can be done without delaying evacuation.
- B. Make a visual check along the evacuation route for persons unable to evacuate and report such cases to the assembly station director as soon as possible. Also report any other pertinent information.
- C. Stand by at the assembly station for instructions from the employees's supervisor, the assembly station director, or the Plant Shift Superintendent (PSS) and respond accordingly. A partial/total site evacuation may be effected from the assembly station.

6. Bomb Threat or Device

The receiver of a telephone threat should:

- A. Obtain as much and as accurate information as possible and have as many people as possible listen to the telephone call—the DOE operator, PSS's office, and others, if available. Use the form on the back inside cover of the DOE telephone book.
- B. Immediately notify the PSS and the discoverer's immediate supervisor.
- C. Attempt to keep the caller talking. Try to determine:
 - (1) Location of the suspected item
 - (2) Time of detonation
 - (3) Size, type, and arming device
 - (4) Who planted the device, why, and how
 - (5) Where, when, and under what circumstances the device was planted
 - (6) Who gave this information to the caller and
 - (7) Background noises such as music, television, aircraft noise, etc.

Appendix D
(Page 6 of 7)

The recipient of a written threat should:

- A. Protect and preserve the written communication. Do not handle the communication excessively.
- B. Immediately notify the PSS and the discoverer's immediate supervisor.
- C. Release the written communication only to authorized personnel as directed by the EOC or the SED.

The recipient of personal contact should:

- A. Obtain as much and as accurate information as possible from the person to whom you are talking.
- B. Immediately notify the PSS and the discoverer's immediate supervisor.
- C. Detain the person, if possible, without a show of force. If this is not possible, attempt to obtain identification and address.

Discovery of a bomb, device, or suspicious object:

Bombs or explosive devices may be discovered accidentally by employees; suspicious objects may be observed; and packages that are suspect may be received by mail or other shipping methods. The discoverer should:

- A. Ensure that the object is not disturbed or moved.
- B. Immediately notify the PSS and the discoverer's line management, and
- C. Control access to the area.

7. Toxic Material Release

A major mission at the K-25 Site is the treatment, storage, and disposal of hazardous waste. In addition to large quantities of hazardous wastes, significant quantities of hazardous materials are also present, including toxic and carcinogenic materials. Releases to the environment must be anticipated and plans must be made for their release.

Discovery of a toxic material release:

- A. Immediately report the event to the PSS and/or the immediate supervisor.

NOTE: The exact location of the discharge and identity of the material should also be reported at this time if readily known.

Appendix D
(Page 7 of 7)

- B. Take corrective action prior to notification, if practical.
- C. If the release is a large one or cannot be immediately controlled, the area should be evacuated. The evacuation alarm should be actuated if it does not automatically actuate.
- D. If a fire alarm pull box is actuated, await the arrival of emergency response units, if possible, to provide directions and information regarding the release.

An incident that occurs in one building but may affect nearby buildings:

With the exception of a national defense alert, any of the types of emergencies listed in the preceding sections is applicable. The decision to alert adjacent buildings will be the responsibility of the SED and/or the local facility warden. The suggested responses are also applicable.

An incident that occurs in a section of a building but would not necessarily involve personnel in the entire building:

With the exception of a national defense alert, any of the types of emergencies listed in the preceding sections can occur on a relatively small scale so that personnel in the entire building do not have to be evacuated. Such emergencies may be successfully handled by the individual discovering the emergency or by the local facility warden. The SED and/or site emergency crews may not be involved; however, for the purpose of records and future prevention, the incident should be reported to the SED.

An incident that occurs within the Site's perimeter but not inside any building:

For emergency conditions involving utilities (e.g., a rupture of a water line beneath the street pavement, lightning striking a transformer), several facilities will probably be affected. Personnel in **affected** facilities should notify the PSS (4-3282) of the problem. Personnel **unaffected** by the emergency should remain clear of the immediate area.

Appendix E
(Page 1 of 3)
PROTECTIVE ACTIONS

Protective Action Guides

The decision to recommend that on-site personnel or visitors take action to protect themselves from the possible consequences of an emergency involving the K-25 Site is a complex one. The risk to be avoided by the recommended protective action must be weighed against the risks and costs incurred by taking the action. Furthermore, this decision will most likely be made under emergency conditions without all of the information needed on which to base the decision.

On-Site Sheltering-in-Place

Notification of sheltering-in-place is initiated by the Site Emergency Director (SED) on the site public-address (PA) system. Sheltering-in-place calls for employees to:

1. Go indoors immediately.
2. Close all windows and doors.
3. Turn off all sources of outdoor air (fans, air conditioners).
4. Shut down equipment and processes, as necessary for safety, and
5. Remain indoors and listen for additional information on the site PA system.

On-Site Relocation

Certain emergency conditions (i.e., tornado warning, fire, security threat, etc.) may require that on-site personnel be relocated from their normal work stations and activities to locations more suitable to withstand the threat of the discovered emergency condition. Notification of on-site relocation is carried out by the SED on the site PA system and/or by means of communications with assembly station directors.

On-Site Facility Evacuation

Notification of on-site facility evacuation is initiated by the SED over the site PA system. Assembly stations serve as gathering points for evacuated personnel. These stations are identified by an orange, disk-shaped sign with the assembly station number in black. The K-25 Site is separated into 10 areas with one assembly station serving each area (refer to Figure E.1.). If an alarm sounds within the area where you are working that mandates your evacuation, you should evacuate to the assembly station assigned for that area and immediately report to your supervisor or the assembly station director who will be identified by an orange vest. The assembly station has a ring-down telephone to the Plant Shift Superintendent's (PSS's) office and a local PA system. Further instructions and information about the emergency situation will be given to you by the assembly station director or over the site PA system.

TITLE: Building K-1414

Appendix E
(Page 2 of 3)

DWG. NO. K/G-92-260

Figure E1. K-25 Site assembly station directory.

Appendix E
(Page 3 of 3)

Site Evacuation

Evacuation of nonemergency response personnel (full or partial) is ordered by the SED whenever it is determined that a threat to the safety of site personnel exists. Directions on the specific evacuation routes will be provided by the SED. Evacuation is generally by individually owned vehicles. The appropriate decision of a reassembly area and evacuation route is determined based upon site conditions, wind direction, and weather.

1. The site evacuation and possible shutdown instructions will be given over the PA system. The evacuation tone signal is a steady siren over the PA system or continuous sounding of local evacuation devices.
2. If the signal is sounded over the PA system, personnel should secure any classified documents for which they are responsible, evacuate buildings to the nearest assembly station, and wait for further instructions.
3. If a shutdown is directed, proceed according to the appropriate departmental standard operating procedure.
4. Those employees not responsible for shutdown activities should leave the site.
5. When the shutdown is complete, personnel who participated in the shutdown should leave the site.
6. The portals will be locked, and the turnstiles will be left in the exit-only mode. If any of the crash gates in the perimeter fence are used **be sure** they are closed after you exit.
7. After a site evacuation, employees should monitor radio and TV stations. These media may be the only available to the site for communication with employees.
8. When the "all-clear" announcement is made or a request is made from the company, employees should immediately report to their regular work locations.

APPENDIX B
IITRI'S LOCKOUT/TAGOUT PROGRAM

LOCKOUT/TAGOUT

PROGRAM

CONTROL OF HAZARDOUS ENERGY SOURCES

IIT RESEARCH INSTITUTE

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE No.</u>
I. GENERAL	B-5
II. LOCKING DEVICES AND TAG ATTACHMENTS	B-6
III. TRAINING AND RECORDKEEPING	B-7
IV. RESPONSIBILITIES	B-8
V. PERMITTING REQUIREMENTS	B-11
VI. EXCLUDED EQUIPMENT	B-12
VII. PROCEDURE REQUIREMENTS	B-14
VIII. CONTRACTOR LOCKOUT/TAGOUT	B-16
IX. DEFINITIONS	B-17

LOCKOUT/TAGOUT PROGRAM

The purpose of this program is to insure the proper protection for all IITRI employees during service and maintenance of machines and equipment in which the unexpected energization or start-up of such machinery or equipment or release of stored energy could cause injury. This program defines practices and procedures required to ensure the personal safety of workers by preventing the release of potentially hazardous energy during servicing and maintenance activities. This program does **NOT** cover the following: normal production operations including repetitive, routine minor adjustments, and maintenance covered under machine guard standards; work on cords plug connected electrical equipment when the equipment is unplugged, and the employee working with the equipment has complete control of the plug; and hot tap operations involving gas, steam, water , or petroleum products when the continuity of service is essential, shutdown is impractical, and documented procedures are followed and special equipment is used which will provide proven, effective protection for the employee.

GENERAL

This program applies to:

- ◆ The lockout/tagout (LO/TO) of energy sources that could cause injury to personnel from the unexpected energizing or releasing of stored energy while personnel are participating in such activities as, but not limited to, constructing, installing, adjusting, repairing, inspecting, testing, or maintaining systems or equipment.
- ◆ All forms of energy, both latent and residual, including electrical, hydraulic, pneumatic, mechanical, chemical, radiation from radiation-generating machines, toxic, and other potentially hazardous sources.
- ◆ All voltage above 50 volts that are not considered Power Operations.

Source References:

- ◆ 29 CFR 1910, Subpart S, "ELECTRICAL"
- ◆ 29 CFR 1910.147, " Control of Hazardous Energy (Lockout/Tagout) "
- ◆ 29 CFR 1910.333, "Section and Use of Safe Work Practices"
- ◆ "IITRI" (Written Standard Practice) WSP SAF. No. 6-1

LOCKING DEVICES AND TAG ATTACHMENTS

1. All locks used for lockout devices shall meet the following requirements:
 - ◆ Locks shall be substantial and painted or clearly marked with the color red.
 - ◆ Locks shall have accompanying tags that are marked with the issuing employee's name, badge number, and date on which the lockout occurred.
 - ◆ Locks shall be of a type that are single-keyed and those keys shall remain in the possession of the personnel who initiated the lockout procedure. (In the event that the lockout procedure lasts more than a single shift the lockout lock keys may be placed in a lockbox with the responsible employee's name attached.)
2. Red locks shall not be used for any other purpose.
3. All permitted energy isolating devices capable of being locked shall be locked and tagged prior to commencement of service and maintenance.
4. All energy isolating devices that are not capable of being locked shall be tagged by the responsible employee (operator, electrician, mechanic, or technician) with a **"DANGER - DO NOT OPERATE"** tag.
5. When a lock cannot be used to secure the tag to the energy isolating device, the attachment means shall be of a nonreusable type, self-locking, and nonreleasable with a minimum unlocking strength of not less than 50 pounds and at least equivalent to a one-piece, all-environment-tolerant nylon cable tie.
6. A **"DANGER - DO NOT OPERATE"** tag, when used alone, shall be considered the equivalent of a lock.
7. Tags shall be used only once.
8. Information on tags shall be completed in ink. Markouts are not allowed.
9. Whenever replacement, major repairs, renovation, or modification of machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machines or equipment shall be designed to accept a lockout device.

III

TRAINING AND RECORDKEEPING

A. Training

1. All personnel shall receive applicable initial training in this procedure.
2. Whenever major changes are made to the procedure, all personnel shall receive re-training.
3. Authorized personnel shall receive training annually.
4. IITRI's Environment Safety and Health Office (ES&H) shall maintain all training documents in the Personnel Training Records Logbook located in the ES&H Office. All off sites locations shall keep duplicate training files at each location.

B. Recordkeeping

1. Lockout/Tagout Permits, shall be maintained on site by the Issuing Authority for a period of one year from the date of which they were closed-out.
2. A Lockout/Tagout permit Log Book shall be maintained and controlled at each site by a designated Issuing Authority.
3. All Lockout/Tagout Permits issued by the Issuing Authority shall be recorded in a log book.
4. A quarterly review of all permits must be conducted by the Issuing authority of all permits in place more than 90 days to ensure that the permits are still needed.

IV

RESPONSIBILITIES

A. Department Managers

1. Ensure that their departments' implementation of and compliance with this program.
2. Ensure that all personnel are initially trained and that they receive re-training as required.
3. Ensure that an Issuing Authority has been appointed for each department or off site location and that he/she is thoroughly familiar with the procedures set forth in this program.
4. Ensure that all personnel in their departments are familiar with the corresponding Written Standard Practices (WSP No. SAF. 6-1) and that it is made available for their review as needed.

B. Issuing Authority

1. Ensures that any work requiring a Lockout/Tagout permit in their area on any equipment, systems, or process has been thoroughly evaluated.
2. Prepares and issues Lockout/Tagout Permits.
3. Ensures that effective energy isolating devices are chosen. If needed, they should obtain appropriate technical assistance from the ES&H Officer to determine the proper safety measures and energy isolating devices.
4. Ensures that equipment or systems are stopped, isolated, and restored in accordance with normal procedures.
5. Ensures that energy isolating device(s) are always tagged out and locked out where possible.

6. Prior to issuing a Lockout/Tagout permit for services and maintenance, ensures, either by visual inspection or by checking of signatures, that energy isolation devices are in place.
7. Maintains a Lockout/Tagout logbook.
8. Authorizes removal of Lockout/Tagout protection when the service and maintenance is complete.
9. Retains the completed Lockout/Tagout permit for a period of one year.
10. Conducts a quarterly review of permits in effect for more than 90 days.
11. Directs personnel working on the affected equipment or system to affix a personal lock to each energy isolating device.
12. Ensures that all locks under his/her control are removed and that the system is ready. Signs permit and documents, date and time releasing protection for his/her portion of the work.

C. Employee

1. Reviews Lockout/Tagout permit, signs permit accepting protection listed, and performs verification.
2. Applies personal lock to the energy isolating devices before beginning any service/maintenance work on equipment/systems requiring energy isolation under this procedure.
3. Advises supervisor and/or Issuing Authority when work under Lockout/Tagout program will extend beyond his/her shift.
4. Removes personal locking device at the direction of supervisor and/or Issuing Authority or upon completion of required work.
5. Become familiar with and follow IITRI's WSP No. SAF. 6-1 which governs the Lockout/Tagout program.
6. Does not attempt to operate equipment or systems that has a
" **DANGER - DO NOT OPERATE**" tag affixed to it.

D. Environment Safety and Health Officer

1. Ensures the conduct of Lockout/Tagout training.
2. Ensures that the appropriate training records are maintained.
3. Provides interpretation and administration of this procedure.
4. Surveys departments to insure that the program is being conformed with.

E. Facility Operations

1. Ensures that new installations and modifications to existing installations are designed to incorporate lockable energy isolating means.
2. Functions as a Service Supervisor for Construction Contracts.
3. Requires the service contract personnel overlock the required energy isolating devices.
4. Requires the contractors to implement Lockout/Tagout procedures and ensures that the practices are adequately executed on construction activities.

V

PERMITTING REQUIREMENTS

The Lockout/Tagout Permit is not required under the following conditions:

1. The machine or equipment has no potential for stored or residual energy or the re-accumulation of stored energy after shutdown that could endanger employees.
2. The machine or equipment has a single energy source that can be readily identified and isolated.
3. The isolation and locking out of a single energy source will completely de-energize and de-activate the machine or equipment.
4. The machine or equipment is isolated from the energy source and is locked out during servicing or maintenance.
5. A single lockout device will achieve a locked-out condition.
6. The lockout device is under the exclusive control of the authorized person(s) performing the servicing or maintenance.
7. The servicing or maintenance does not create hazards for other personnel.
8. No history exists of any accidents involving the unexpected activation or re-energization of the machine or equipment during service maintenance.
9. The isolation does not disable equipment or systems necessary for employee safety/health or other necessary equipment/systems.
10. The owner of the equipment must notify the appropriate affected personnel of the planned lockout.

VI

EXCLUDED EQUIPMENT

If the conditions of exclusion are met, this procedure does not apply to the excluded equipment listed in the attached table.

Equipment Excluded	Conditions of Exclusion	Examples of Excluded Equipment
Minor tool changes and adjustments and other minor servicing activities that take place during normal production operations.	The work is performed using alternative measures that provide effective protection.	Minor tool changes and adjustments that are routine, repetitive, and integral to the use of the equipment of production.
Work on live parts that operate at less than 50 volts to ground.	<ol style="list-style-type: none"> 1. There will be no increased exposure to electrical burns or to explosion due to electrical arcs. 2. The electrical circuit is verified to be less than 50 volts. 3. The work on an energized electrical circuit has been approved by a qualified electrical supervisor in accordance with 29 CFR 1910, Subpart S, "Electrical" 	Security alarm systems, fire alarm systems, or telephone systems.
Work on cord and plug-connected electric equipment.	<p>Exposure to the hazards of unexpected energizing or startup of the equipment is controlled by:</p> <ul style="list-style-type: none"> ◆ Unplugging the equipment from the energy source, and ◆ Having the plug under the exclusive control of the employee performing the servicing or maintenance. 	Copiers, lamps, or refrigerators.
Hot tap operations on pressurized pipelines involving transmission and distribution systems for substances.	The continuity of service is essential or shutdown of the system is impractical.	Gas, steam, water, or petroleum products.
<p>Working on or near live parts if it is determined that de-energizing:</p> <ul style="list-style-type: none"> ◆ Introduces additional or increased hazards, or ◆ Is infeasible due to equipment design or operational limitations. 	The work on energized electrical circuits is approved by a qualified electrical supervisor in accordance with 29 CFR 1910, Subpart S, "Electrical"	<p>Additional hazards include, but are not limited to, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment.</p> <p>Infeasible design or operational limitations include testing of electrical circuits that can be performed only with the circuit energized.</p>

VII

PROCEDURE REQUIREMENTS

A. Lockout/Tagout Pre-Job Requirements

1. Conduct a pre-job review to determine the need for a Lockout/Tagout permit.
2. If a Lockout/Tagout permit is required, evaluate and identify the Lockout/Tagout requirements to ensure adequate protection for employees.
3. During electrical Lockout/Tagout of a draw-out type circuit breaker, tag and lock, if possible , all means of remote control (i.e. push button, control handle, supervisory switch, or fuse control) to prevent remote operation during rack-in/rack-out.
4. Ensure that the appropriate personnel are notified of the equipment being removed from service.

B. Issuing the Lockout/Tagout Permit

1. Issuing Authority signs the permit.
2. The Area Supervisor is notified by the Issuing Authority that a Lockout/Tagout procedure has been implemented and the Area Supervisor signs the Lockout/Tagout permit.
3. The Issuing Authority provides a copy of the permit to the Environment Safety & Health Office and all affected Area Supervisors (upon request).
4. Place the original copy of the Lockout/Tagout permit in the Lockout/Tagout log book and record on a log sheet in the front of the book the status of the permit.

C Program Procedures

1. All IITRI employees actively involved in the service, operation, and maintenance of machines and equipment in which the unexpected energization or start-up of such machinery or equipment or release of stored energy could cause injury shall abide by the following :
 - ◆ Follow procedures set forth in Safety WSP No. SAF. 6-1 Lock-out/Tagout of Hazardous Energy Sources.
 - ◆ Notify all employees and supervisor.

VIII

CONTRACTOR LOCKOUT/TAGOUT

All construction and other contractors needing Lockout/Tagout protection must work under the protection of the IITRI Lockout/Tagout program. Permit requirements, except for excluded equipment listed in section (VI) shall be mandated. Construction and other contractors shall be required to overlock according to their internal procedures.

Service Contractor Coordinator Responsibilities:

1. Designate a representative(s) to serve as the authorized individual(s) to interface with Facility Operations and assist with the determination of energy isolation devices and to request, process, and release Lockout/Tagout permits.
2. Ensure contractors establish and follow the following responsibilities:
 - ◆ Preparing and implementation of their own Lockout/Tagout procedures to protect construction and IITRI personnel against unexpected energy releases.
 - ◆ Designate an authorized individual(s) to interface with Facility Operations on determination of energy isolating devices, and requesting, processing, and releasing Lockout/Tagout permits.
3. Require that the contractor personnel overlock the required energy isolating devices.

IX

DEFINITIONS

Listed below are definitions which are relevant to the Lockout/Tagout Program and will aid in the understanding of this program:

Affected Employee	An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout or whose job requires him/her to work in an area in which such servicing or maintenance is being performed.
Authorized Employee	A person who locks or implements a tagout system procedure on machines or equipment to perform the servicing or maintenance on that machine or equipment. An authorized employee and an affected employee may be the same when the affected employee's duties also include performing maintenance or servicing on a machine or equipment which must be locked or a tagout system implemented.
Capable of Being Locked Out	An energy isolating device will be considered to be capable of being locked out either if it is designed with a hasp or other attachment or integral part to which or through which a lock can be fixed, or if it has a locking mechanism built into it. Other energy isolating devices will also be considered capable of being locked out if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device or permanently alter its energy control capability.
Energized	Connected to an energy source or containing residual or stored energy.
Devise Energy Isolation	A mechanical device that physically prevents the transmission or release of energy including, but not limited to, the following: a manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected;

a slide gate; a slip blind; a line valve; a block; and any similar device used to block or isolate energy. The term does not include a push button, selector switch, and other control circuit devices.

Energy Source	Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.
Hot Tap	A procedure used in the repair, maintenance, and servicing activities which involves welding on a piece of equipment (pipelines, vessels, or tanks) under pressure in order to install connections or appurtenances. It is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water, steam, and petrochemical distribution systems.
Lockout	The placement of a lockout device on an energy isolating device in accordance with an established procedure ensuring that the energy isolating device and the equipment being controlled cannot be operated until a lockout device is removed.
Lockout Device	A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment.
Normal Operations	The utilization of a machine or equipment to perform its intended function.
Servicing and/or Maintenance	Workplace activity such as constructing, installing, setting up, adjusting, inspecting, modifying, maintaining and/or servicing machines or equipment. These activities include lubrication, cleaning, or unjamming of machines or equipment and making adjustments or tool changes where the employee may be exposed to the unexpected energization or start-up of the equipment or the release of hazardous energy.
Setting Up	Any work performed to prepare a machine or equipment to perform its normal production operation.

Tagout

Placement of a tagout device on an energy isolating device in accordance with an established procedure to indicate that the energy isolating device and the equipment being controlled may not be operated until a tagout device is removed.

Tagout Device

A prominent warning device such as a tag and a means of attachment which can be securely fastened to an energy isolating device in accordance with an established procedure to indicate that the energy isolation device and the equipment being controlled may not be operated until the tagout device is removed.

APPENDIX C

IITRI'S RESPIRATORY PROTECTION PROGRAM

AIR PURIFYING RESPIRATORS AND THEIR USE

RELATED TO SPECIFIC HAZARDS ...

WRITTEN STANDARD PRACTICE

RESPIRATORY PROTECTION PROGRAM

Prepared by:
Environmental Health and Safety Officer
IIT Research Institute
Chicago, IL 60616

May 11, 1994

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE NO.</u>
I. General	2
II. Selection and Use of Respirator/Protective Devices	3
III. Employer and Employee Responsibility	4
IV. Medical Aspects of Respiratory Equipment Usage	5
V. Classification and Description of Respirators	6
VI. Selection and Limitations of Respirators	13
VII. Training, Face Fit and Leak Testing	14
VIII. Maintenance and Care of Respirators	26
IX. Routine Inspections	29
X. Storage	30
XI. Work Area Surveillance	31
XII. SCBA Inspection and Use	32
XIII. Emergency Equipment	35

RESPIRATORY PROTECTION PROGRAM

The purpose of this program is to ensure the protection of all IITRI employees from respiratory hazards, through proper use of respirators. A Respiratory Protection Program is hereby established to coordinate the use and maintenance of respiratory protective equipment as determined necessary to (1) reduce employee exposure to toxic chemical agents; and (2) allow employees to work safely in potentially hazardous work environments which may be encountered.

I. GENERAL

- A. Respirators are considered an acceptable method for protecting the health of IITRI personnel under the following circumstances:**
 - (1) when it has been determined that there are no feasible engineering or work practice controls that can be used to adequately control the hazard.**
 - (2) during the interim periods when engineering controls are being designed and/or installed.**
 - (3) during emergencies.**
 - (4) during intermittent, non-routine operations.**
- B. The Environmental Health and Safety Officer/or designated medical authority shall evaluate respiratory hazards, identify locations, or areas where respiratory protection is required and provide guidance in the conductance of the Respiratory Protection Program.**
- C. Each department, or personnel in charge of operating activities in his/her department will insure that their personnel are provided with approved respirators, after all medical requirements have been identified by the installation medical authority. and insure compliance of the Respirator Protection Plan.**
- D. Individuals provided with respirators shall use them in accordance with instructions, written standard practices (WSP SAF 1-1 and SAF 1-2) and training received.**
- E. Respirators shall be assigned to individual workers for their exclusive use only.**

II. SELECTION AND USE OF RESPIRATOR/PROTECTIVE DEVICES

The correct respirator shall be specified for each job. No respirator shall be purchased or used unless their use for the intended application has been approved by the Environmental Health and Safety Officer or designated medical authority. The IITRI medical authority or Environmental Health and Safety Officer shall, on the basis of environmental evaluations and/or requirements set forth in 29 CFR 1910, Subpart Z, for specific substances, determine the type of respiratory protective device best suited for the task. Respirator selection and use shall take into account Health and Safety factors, such as nature of the hazard, intended use and limitations of respirator/protective devices, movement and work rate limitations, and training requirements.

III. EMPLOYER AND EMPLOYEE RESPONSIBILITY

A) Employer Responsibility

- 1) Respirators shall be provided by the employer when they are necessary to protect the health of the employee.
- 2) The employer shall provide the respirator which is applicable and suitable for the intended purpose and provide training to all employees who may be required to use respirators.
- 3) The employer shall be responsible for the establishment and maintenance of a respiratory protection program.

B. Employer Responsibility

- 1) The employee shall use the respiratory protection in accordance with instructions and training received.
- 2) The employee shall be responsible for cleaning, inspection, storage, and minor repairs on their respirators (if necessary) in accordance with instructions and training received.
- 3) The employee shall report any trouble or malfunctions of the respirator to their supervisor.
- 4) The employee shall inform his/her immediate supervisor immediately of any changes in physical or medical conditions that could affect the persons ability to wear a respirator in a safe manner.
- 5) The employees shall follow all SOP's designed for general or specific use of respiratory products.

IV. MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

The Respiratory Protection Program at IITRI conforms to OSHA regulations (29 CFR 1910.134). Each individual requiring the use of a respirator must receive a baseline pulmonary function test and a medical history. (An electrocardiogram is advised to assess cardiac function for those individuals who may be required to wear a respirator for long periods of time, e.g., surety program staff. Based on the test results, a physician will determine if that individual is physically capable of wearing a respirator. Once a respirator has been issued, a pulmonary function test and a medical history shall be required annually. Further medical monitoring will be given if deemed necessary by the designated medical authority or Environmental Health and Safety Officer.

V. CLASSIFICATION AND DESCRIPTION OF RESPIRATORS

Industrial respiratory protective devices have been designed, tested, and approved for protection against specific industrial exposures. These devices are conveniently grouped into two general classifications according to mode of operation.

A. Air Purifying Respirators

(1) Gas masks and chemical cartridge (gases and vapors)

- (a) Half-mask Respirators: The half mask respirators available at IITRI are cartridge respirators which fit over the nose and mouth (Figure 1-1). Half-mask respirators typically offer a protection factor of 10X---that is according to NIOSH respirator decision logic and (ANSI) standard Z88.2. The half-mask respirator will protect the wearer in an atmosphere containing 10X. The Permissible Exposure Limit (PEL) of the target chemical. Half-mask respirators can be equipped with a number of cartridges to filter out organic vapors acid gases, formaldehyde, ammonia, particulate, and other types of chemicals.
- (b) Full Face Respirators: A full-face respirator covers the entire face of the individual wearing the mask (Figure 1-2). Full-face respirators offer a protection factor of 50X or the mask will protect the wearer in an atmospheric concentration containing 50X the PEL of the target chemical recommended by NIOSH. Like the half-mask respirators, the full-face respirators available at IITRI are

Figure 1-1

Figure 1-2

the cartridge type. They can be equipped with the same type of cartridges as the half-mask respirators.

- (c) Powered Air Purifying Respirators: A powered air purifying respirator or PAPR for short is much like the other air purifying respirators with some minor exceptions. In the PAPR's, air is pulled through the filter (cartridges mechanically and blown into the face piece. This action creates a positive pressure inside the mask to give a higher protection factor. PAPR's mask will protect the wearer in an atmospheric concentration containing 100X the PEL of the target chemical's recommended by NIOSH. Like the two other APR's the powered air purifying respirator are the cartridge type. They can be equipped with the same type of cartridges as the other air purifying respirators. The only drawback to PAPR respirators is that since the unit is powered by a battery pack, batteries must be recharged daily.

APR-PAPR FILTER CARTRIDGES

Filters and cartridges, as mentioned above, respirator filters and cartridges are available for a wide variety of chemicals. The Environmental Health and Safety Office should be consulted when deciding which cartridge type should be used.

The two most commonly used cartridges at IITRI are the HEPA filter and the acid gas/organic vapor cartridge. The HEPA filter is rated at 99.97% efficiency for particles as small as 0.3 microns (um). HEPA filters are rated for protection from dusts, mists, fumes, and radionuclides. The acid gas/organic vapor cartridge (Figure 1-2) offers protection in environments up to 1000 parts per million (ppm) of various organic vapors and 10 ppm of chloride, 50 ppm hydrogen chloride, and 50 ppm sulfur dioxide.

Although different makes of filters and cartridges are not identical in appearance, all are color coded in a consistent manner. Below is a breakdown:

<u>Filter/Cartridge</u>	<u>Color Assigned</u>
HEPA	Pink/Purple
Acid Gas	White
Organic Vapors	Black
Acid Gas/Organic Vapors	Yellow
Ammonia	Bright Green
Other Vapors and Gases	Drab Green

The lifetime of the filters and cartridges varies according to the chemicals being filtered and the frequency of usage. Particulate filters should be changed when breathing becomes relatively difficult (as the filters become "clogged"). Other cartridges should be changed on a routine basis (e.g., monthly) before odor breakthrough is detected. To increase the life of filters and cartridges, they shall be kept in plastic bags when not in use. Finally, if either a cartridge or a filter becomes wet, or an odor breakthrough is detected, it must be discarded immediately.

B. Single-Use Respirators

Single-use respirators are commonly referred to as dust masks (Figure 1-3). Two types are available at IITRI--one provides HEPA filtration and the other provides moderate particulate filtration. As the name implies, these units are disposable; they are not to be worn longer than one day. The single-use respirators are designed to be used only under the lowest concentrations of a given chemical on dust. Under no circumstances are they to be used in areas where APR full-or half-mask respirators are required.

C. Atmospheric Supplied Respirators

- (a) Self-Contained: Self-contained breathing apparatus include all completely assembled, portable, self-contained devices

Figure 1-3

designed to use as respirator/protection during entry into and escape from a hazardous atmosphere (Figure 1-4). In such apparatus spent air is vented to the atmosphere and not rebreathed. Use is permissible in atmospheres immediately dangerous to life and health. The period over which the device will provide protection is limited by the amount of air oxygen in the apparatus. A warning device is provided to indicate to the wearer when the service life has been reduced to a low level (usually 5 minutes). This allows the wearer enough time to escape the hazardous atmosphere.

- (b) **Supplied Air Respirators:** Supplied air respirators include all completely assembled respirators designed for use during entry into or escape from hazardous atmosphere. The respirator air supply is not limited to the quantity an individual can carry. Thus the devices are lightweight and relatively simple.

TYPE 1 GRADE D BREATHING AIR COMPRESSED GAS ASSOCIATION COMMODITY SPECIFICATION FOR AIR

1. The oxygen content of the compressed air should be between 19.5-23.5 percent oxygen and the rest mainly nitrogen;
2. Hydrocarbon concentrations must not exceed 5 parts per million;
3. Carbon monoxide concentration must not exceed 20 parts per million;
4. Carbon dioxide concentrations must not exceed 1000 parts per million; and
5. There must not be any pronounced odor present.

Figure 1-4

VI. SELECTION AND LIMITATIONS OF RESPIRATORS

A. Degree of Respiratory Hazard

The degree of respiratory hazard depends upon the atmospheric oxygen concentration; contaminants physical state, toxicity, and concentration; the presence of other contaminants or stress factors in the working environment; and worker exposure time and susceptibility. Respiratory hazards may be classified as gas and vapor contaminants (immediately or not immediately dangerous to life or health) particulate contaminants (immediate or not immediate dangerous to life or health), and oxygen deficiencies. Each classification requires a different degree of respirator/protection.

The importance of proper respiratory selection is emphasized by the fact that improperly fitted or improperly selected respiratory protection devices and devices with deteriorated or depleted canisters/filters cartridges may provide reduced respiratory protection. Preparation must also be taken to insure acceptable air quality.

VII. TRAINING, FACE FIT AND LEAK TESTING

All IITRI personnel who are required to use or to supervise using respiratory protection devices shall be provided the following training:

A. Training

Unless the reasons for the use of respirator protection devices and instructions on proper selection, use and maintenance are thoroughly understood, and ongoing training provided, the devices may not be used or may not work properly. Both supervisors and workers shall be instructed by competent persons, knowledgeable in the area of respiratory protection. Training shall provide individuals an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period and finally to wear it in a test atmosphere. The minimum training shall include:

- (1) Instructions in the nature of the hazard, whether acute, chronic, or both, and a frank appraisal of what may happen if the respirator is not used.
- (2) Explanation of why more positive engineering or process-oriented controls are not immediately feasible to reduce or eliminate the need for respirators.
- (3) A discussion of why this is the proper type of respirator for the particular purpose.
- (4) A discussion of the respirator's capabilities and limitations.
- (5) Periodic instructions (annually) and training in actual use of the respirator. Training shall also include recognition of the end of the service life of cartridges/canisters or filters (e.g., smelling

organic vapors through the cartridges, manufacturers specified termination data, or an increase in breathing resistance.

- (6) Classroom and field training to recognize and cope with emergency situations.
- (7) Detailed instructions or cleaning, maintaining and storage of the respirator.

B. Face-Fit and Leak Testing

Every respirator wearer shall receive fitting instructions, including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly.

- (1) Respirators are generally uncomfortable to wear. If a good facepiece to face seal can be obtained only by very tight strap tension, the respirator shall not be worn for prolonged periods and its use shall be avoided. Even though maximum breathing resistance is specified by NIOSH, there are differences among approved respirators and one type may be more acceptable to the worker than the other. Face structure varies considerably from one individual to another, and since a given respirator may only be made in one size, a successful fit cannot always be achieved for all persons. Different sizes of the same model or different models of approved respirators have been obtained (see WSP SAF 1-1 and 1-2) to provide employees adequate respiratory protection.
- (2) Before initial use, each respirator shall be properly fitted, leak tested, and the facepiece to face seal tested in a realistic test situations. Records of the fit test along with respirator training, Medical Release Form and maintenance records shall be kept in the employees files in the Environmental Health and Safety

Office. The medical records, which are generated as a result of the Respirator Protection Plan, are kept in employee medical files. All records shall be maintained on their appropriate IITRI forms. These forms include the Respirator and Qualitative Fit Test Form, the Respirator Inspection Record Tag and the Respiratory Medical Release Form.

- (3) Proper fitting of respiratory protective devices for individuals wearing corrective spectacles or goggles is a problem. A proper seal cannot be established if the temple bars or straps extend through the sealing edge of the facepiece. Contact lenses shall not be worn in a hazardous environment. Contact lenses shall not be allowed for use with respirators equipped with full facepiece, helmet, hoods, or suit. Systems or kits for mounting corrective lenses inside full facepieces shall be purchased with the facepiece if required. When an employee must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by the Environmental Health and Safety Officer to provide good vision, comfort, and a gas tight seal.
- (4) Each time the wearer puts on the respirator, positive and negative pressure checks shall be conducted to insure a satisfactory face fit. Respirators shall not be worn nor will workers be permitted to perform tasks that require respiratory protection when conditions such as a growth of beard sideburns, temple pieces of correction spectacles or goggles, or the absence of one or both dentures present a good face to facepiece seal.

Positive Pressure Test: Close the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can

be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires the wearer to first remove the exhalant valve cover and then carefully replace it after the test.

Negative Pressure Test: Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the seal(s), inhale gently so that the facepiece collapses slight, and hold the breath for 10 seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

(5) Qualitative Protective Mask Fit Testing Procedures

Isoamyl Acetate Test

(a) Overview

- 1) The test depends on the odor of isoamyl acetate (so-called banana oil because of its odor).
- 2) The test consists of two parts, odor sensitivity check and mask fit check.
- 3) Select a location for testing that is free of sources of ignition because isoamyl acetate is flammable. The flash point is 77 degrees F and the lower explosive limit in air is 1 percent. The safe limit in air is 0.25 percent.
- 4) Test chamber should be in a well ventilated room separate from where the facepiece selection and

sensitivity check are performed in order to avoid olfactory fatigue.

- 5) Chamber consists of a plastic enclosure about 24 inches in diameter that covers the head and upper body of the test subject.

(b) Equipment and Supplies

- 1) Four (4) one (1) liter glass jars with metal lids.
- 2) A stock solution of 1 ml of isoamyl acetate in 800 ml of odor-free water in a one (1) liter container from 4) above. Fresh solutions will be made up weekly.
- 3) Two (2) one (1) liter containers from 4) above, each containing 500 ml of odor-free water. These will be the blank solutions in the sensitivity test.
- 4) A sensitivity solution of 0.5 ml of stock solution in 500 ml of odor-free water in a one (1) liter container from 4) above. Fresh solutions will be made daily.
- 5) Preparation or expiration date should be marked on the containers of the stock and sensitivity solutions.

(c) Odor Sensitivity Test

- 1) In a room separate from the test chamber set up the two (2) containers of blank solutions and the container of the sensitivity solution in random order.

- 2) Instruct the test subject to identify the container of the sensitivity solution (isoamyl acetate solution) by opening lids and inhaling.
- 3) If subject is unable to distinguish between the odor of the liquid in containers, olfactory impairment is assumed and paragraph B-2 applies.
- 4) Don and adjust protective mask prior to entering the test chamber room.

(d) Fit Check

- 1) Hang absorbent paper, which has been folded in half and wetted with 0.5 ml of isoamyl acetate, on the hook in the top of the chamber (examiner may accomplish prior to subject being tested).
- 2) Wait two (2) minutes before allowing the test subject to enter the chamber. This allows the isoamyl acetate concentration to reach the required level of 150 ppm (nominal).
- 3) Instruct the test subject to enter the test chamber and perform each exercise listed below for 30 seconds:
 - Normal breathing.
 - Deep breathing. Be certain breaths are deep and regular.
 - Turn head from side to side. Be certain movement is complete, with one turn every second. Avoid bumping of the respirator on the shoulders.

- Nod head up and down. Be certain motions are complete and made about every second. Avoid bumping of the respirator on the chest.
 - Talking. Read a paragraph that incorporates the full range of speed sounds such as the so-called rainbow passage used by speech therapists. Be certain the paragraph is read aloud and slowly. (See Figure 1-5).
 - Normal breathing.
- 4) Mask fit is deemed adequate if the isoamyl acetate (banana oil) odor is not detected at any time during the fit test.
 - 5) Terminate the test if the isoamyl acetate odor is detected at any point during the test. Detection of the banana oil odor of the isoamyl acetate by the subject indicates that the mask does not fit or is defective.
 - 6) Remove the wetted paper after the subject leaves the test chamber and deposit in a closed container.
 - 7) If test is not passed satisfactorily, either because of improper mask size or mask is found to be defective, instruct test subject to obtain a new mask and repeat the entire fit test sequence.
 - 8) If mask is found to be defective, a new mask will be issued and the defective mask identified and turned in as unserviceable.

(e) Irritant fume protocol

KEEPING TRACK OF MANY THINGS

Have you ever thought of how many times a day you try to keep track of something? Probably not-so as a simple exercise, try to keep track of how many times a day you use the expression "keep track." If you are a relatively verbal person, I would hazard to guess that you will be using the term upwards of six times a day. Most of your phrases will be relatively simple, such as "A list helps me to keep track of my families' birthday" or "I keep track of all the little things I have to do everyday in a notebook," or simply, "I always keep track of that."

- 1) When an individual's olfactory senses are impaired, it will be necessary to test the mask for fit and leakage with irritant smoke.
- 2) The test subject will be allowed to smell a weak concentration of the irritant smoke to familiarize him or her with the characteristic odor.
- 3) The test subject will properly don the mask and wear it for at least 10 minutes before starting the fit test.
- 4) The test conductor will review this protocol with the test subject before testing.
- 5) The test subject will perform the conventional positive pressure and negative pressure fit checks. Failure of either check will be cause to select an alternate mask.
- 6) Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part no. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to delivery 200 ml per minute.
- 7) Advise the test subject that the smoke can be irritating to the eyes and that his or hers eyes must be closed while the test is performed.
- 8) The test conductor will direct the stream of irritant smoke from the tube towards the face seal area of

the test subject. Testing will begin at least 12 inches from the facepiece and gradually move to within one (1) inch, moving around the whole perimeter of the mask.

- 9) The following exercises will be performed while the mask seal is being challenged by the smoke. Each exercise will be performed for one (1) minute.

- Normal breathing.
- Deep breathing. Be certain breaths are deep and regular.
- Turning head from side to side. Be certain movement is complete. Alert the test subject not to bump the mask on the shoulders. Have the test subject inhale when his or her head is at either side.
- Nodding head up and down. Be certain motions are complete. Alert the test subject not to bump the mask on the chest. Have the test subject inhale when the head is in the fully up position.
- Talking slowly and distinctly, count backwards from 100.
- Normal breathing.

- 10) If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor will stop the test. In this case, the tested mask is rejected and another mask will be selected.

- 11) Each test subject passing the smoke test without evidence of a response will be given a sensitivity

check of the smoke from the same test tube to determine whether the test subject reacts to the smoke. Failure to evoke a response will void the fit test.

12) Steps in 5, 8, and 9 above will be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.

13) Masks successfully tested by a protocol may be used in a contaminated atmosphere.

(6) Mask Wearing Procedure and Protective Mask Leak Testing

Donning the protecting mask.

The mask is donned using the following procedures:

- Stop breathing. Do not take a deep breath.
- With left hand, pull open the carrier flap, and with the right hand reach into the carrier, grasp the front portion of the facepiece in the area of voicemitter-outlet valve assembly, and withdraw the mask from the carrier.
- Grasp the left side of the facepiece with the left hand and the right side of the facepiece with the right hand. Slip the thumbs under the head harness straps. Separate the hands to open the facepiece.
- Seat the chin in the chin pocket and slip the head harness straps over the head to pull the mask up onto the face (do not slip the head harness straps over the head and then pull the mask down over the face).
- Make sure that the head harness straps lie flat against the head.
- Place the palm of one hand over the openings in the bottom of the outlet valve cover. Expel the air that has

been held in the lungs, forcing exhaled air to escape around the facepiece, therefore, clearing the mask of contaminated air.

- Press the palms of the hands over the canister inlet or the inlet valve caps. Inhale lightly and hold breath for approximately 10 seconds to determine whether an airtight seal of the mask against the face has been obtained as indicated by collapse of the facepiece.
- Resume normal breathing.
- Fasten neck strap.

Doffing the protective mask.

- Remove the protective mask only in an area known to be free of agent contamination, including personal contamination.
- Unfasten neck strap.
- Pull up from the chin and remove over the head.

VIII. MAINTENANCE AND CARE OF RESPIRATORS

When respirators are issued to an individual, the individual is responsible for primary maintenance and care of his or her respirator. All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used shall be inspected monthly to assure that it is in satisfactory working condition. Self-contained breathing apparatus shall be inspected monthly. Air oxygen cylinders shall be fully charged according to the manufacturer instructions. Regulator and warning devices shall be inspected to determine that they are functioning properly.

Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tubes and filter cartridges. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with massaging action will keep them pliable and flexible and prevent them from hardening or stiffening during storage.

The employee shall keep a record of the inspection dates, findings and corrective actions on their mask inspection tags (Figure 1-6). These inspection tags shall be maintained with the respirator for a period of one year, from the date they were issued. They shall then be returned to the Environmental Health and Safety Office for a replacement tag, with the completed tag being maintained in the Environmental Health and Safety Respiratory files.

Respirators issued to specific individuals shall be cleaned and disinfected as frequently as necessary to insure that skin penetrating and dermatitis causing contaminants are removed from respirator surfaces. The following procedures are recommended for cleaning and disinfecting respirator and will be covered during training exercises:

Figure 1-6

☐ Facepiece
☐ Eyelenses
☐ Optical Inserts
☐ Cyclic Date

☐ Headharness
☐ Nosecup
☐ Inlet/Outlet Valves

☐ The user must perform a negative and positive fit test by clearing and sealing the mask to insure that a seal can be maintained.

The following items are provided for your information on the monthly inspection. The following items must be checked monthly:

Mask Inspection Tag

Mask # _____

Name _____

Date Insp _____	Insp By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____

Date Due Insp _____

Date Insp _____	Insp By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____
Monthly Insp _____	By _____

Date Due Insp _____

- (1) Remove any filters, cartridges or canisters, and disassemble the major respiratory tags.
- (2) Wash facepiece and breathing tubes in a cleaner-disinfectant solution. A brush may be used to facilitate dirt removal at about 120°F.
- (3) Rinse completely in clean, warm water to remove all traces of detergent.
- (4) Air dry in a clean area.
- (5) Clean other respirator parts as recommended by the manufacturer.
- (6) Inspect valves, headstraps and other parts; replace defective parts with new ones.
- (7) Place in plastic bag or other closed container for storage. Respirator shall be packed or stored so the facepiece and exhalation valve will not be damaged by being subject to crossing or cramping.
- (8) Cleaner-disinfectant solution will be provided by the Environmental Health and Safety Office/or designated medical authority.

IX. ROUTINE INSPECTIONS

Respirator protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by the user, and semi-annual/as noted by the EHPS officer/designated medical authority officer to assure that respirators are properly used, cleaned and maintained.

Respirators used routinely will be inspected during cleaning. In the event worn or deteriorated parts are found, the respirator will be turned in immediately for replacement or repair to the Environmental Health and Safety Officer/or designed medical authority. No attempts shall be made to replace components or to make adjustments or repairs beyond the manufacturer's recommendations. Reducing admission valves or regulators shall be returned to the manufacturer for adjustment or repair. Respirators for emergency use, such as self-contained devices, shall be thoroughly inspected at least once a month and after each use and written records kept of inspection dates and findings.

X. STORAGE

- A. Respiratory protective equipment shall be stored so as to protect it from dust, sunlight, heat, extreme cold, excessive moisture, and damaging chemicals.**
- B. Respirators shall be stored in a convenient, clean, and sanitary location where they are protected against damage or distortion by overcrowding or by contact with tools as in a tool box.**
- C. Routinely used respirators may be placed in clean plastic bags.**
- D. Respirators shall be stored in a single layer with the facepiece and exhalation valve in a near normal position to prevent the rubber or plastic parts from taking a permanent distorted set.**
- E. Respirators kept ready for rescue purposes or emergency use shall be stored in a cabinet or case located in a non-contaminated, but readily accessible area.**

XI. WORK AREA SURVEILLANCE

Periodic air sampling shall be done to determine the continued necessity of respiratory protections and to assure that the proper respirators are being used, if necessary. Employees may be required to wear personal air sampling equipment for this purpose.

XII. SCBA INSPECTION AND USE

Training for self-contained breathing apparatus (SCBA) will be given annually to employees requiring their use. Employees will become more familiar with the proper techniques of inspecting, donning, doffing, and use of the SCBA's. The employees will wear SCBA's and become more confident using it. The Environmental Safety and Health Officer shall instruct the employees on the proper methods of inspection and storage of SCBA's. The following checkout procedure will be followed in the use of SCBA's:

SCBA CHECKOUT	
1. MONTHLY INSPECTION	
	Check cylinder label for current hydrostatic test date.
	Inspect cylinder for large dents or gouges
	Inspect cylinder gauge for damage.
	Complete full checkout procedure (Steps 3 through 8).
	Fill out appropriate records with results and recommendations.
2. REGULAR INSPECTION	
	Immediately prior to donning.
	Prior to storing after cleaning and sanitation.
3. BEFORE PROCEEDING, CHECK THAT:	
	High-pressure hose connector is tight on cylinder fitting.
	By-pass valve is closed.
	Mainline valve is closed.
	Regulator outlet is not covered or obstructed.

SCBA CHECKOUT	
4. BACKPACK AND HARNESS ASSEMBLY	
	Visually inspect straps for wear, damage, completeness.
	Check wear and function of buckle.
	Check backplate for damage and attachment to cylinder.
5. CYLINDER AND HIGH-PRESSURE HOSE ASSEMBLY	
	Check cylinder to assure that it is firmly fastened to backplate.
	Open cylinder valve; listen or feel for leakage around packing and hose connection.
	Check high-pressure hose for damage or leaks.
6. REGULATOR	
	Cover regulator outlet with palm of hand.
	Opening mainline valve.
	Note stoppage of air flow after positive pressure builds.
	Close mainline valve.
	Remove hand from regulator outlet.
	Open by-pass valve slowly to assure proper function.
	Close by-pass valve.
	Cover regulator outlet again with palm of hand.
	Open mainline valve.
	Note pressure reading on regulator gauge.
	Close cylinder valve while keeping hand over regulator outlet.
	Slowly move hand on the outlet to allow air to flow slowly.

SCBA CHECKOUT	
	Note pressure when low pressure warning alarm sounds; it should be between 550-650 psi.
	Remove hand from regulator outlet.
	Close mainline valve.
	Check regulator for leaks; blow air into regulator for 5-10 seconds, suck air from outlet for 5-10 seconds. If a positive pressure or vacuum cannot be maintained, do not use that SCBA. It is leaking.
7. FACEPIECE AND CORRUGATED BREATHING TUBE	
	Inspect head harness and facepiece for damage, serrations, and deteriorated rubber.
	Inspect lens for damage and proper seal in facepiece.
	Inspect exhalation valve for damage and dirt buildup.
	Stretch breathing tube and carefully inspect for holes and deterioration.

XIII. EMERGENCY EQUIPMENT

- A. Possible emergency use of respiratory protective equipment should be anticipated and planned for.**
- B. Written procedures shall be prepared covering the safe use of the equipment in dangerous atmospheres that might be encountered in an emergency.**
- C. Periodic training sessions shall be held for those individuals most likely to use the equipment in an emergency. Training shall include demonstration and practice in putting on the respirator, testing for fit, discussion of the capabilities and limitations of the equipment, etc. The equipment manufacturer's instructions should be closely followed.**
- D. If the atmosphere involved is immediately dangerous to life or health, standby persons must be present with suitable rescue equipment, which is specified by procedures for the lab.**

**IIT RESEARCH INSTITUTE
CHICAGO, ILLINOIS**

WRITTEN STANDARD PRACTICE

WSP No. Saf. 1-1

Environment Safety & Health Office

EFFECTIVE: 5/01/94

SUBJECT: Air Purifying
Respirators and Their Use Related
to Specific Hazards

REVISED: (NEW)

REVIEW: 5/01/97

PREPARED BY: ES&H Office Page 1 of 5

I. **PURPOSE**

To establish parameters related to the basis of inhalation hazards for which an employee may require respiratory protection.

II. **POLICY**

To provide guidelines for application of inhalation equipment related to hazardous chemicals and/or materials, refereed in **OSHA**, 1910.134, C-3, and American National Standard Practices for Respiratory Protection, 288.2-1969.

III. **RESPONSIBILITY**

A. The Environment Safety & Health Office is responsible for:

1. Developing and implementation of a respirator training program for all user's
2. Provide the respirator which is applicable and suitable for the intended purpose.
3. Developing and implementation of a respiratory protection program.
4. Provide the employee's respirators when they are necessary to protect the health of the employee.

B. Employee Responsibility

1. The employee shall use the respiratory protection in accordance with instructions and training received.
2. The employee shall be responsible for the cleaning, inspecting and making minor repairs on their respirator (if necessary) in accordance with instruction and training received.
3. The employee shall report any trouble or malfunction of the respirator to their supervisor.

4. The employee shall inform his/her immediate supervisor immediately of any changes in physical or medical conditions that could affect the person's ability to wear a respirator in a safe manner.

IV. PROCEDURE

- A. Respirators will comply with Table No. (1) of this **WSP**, which relates to type of equipment with specific chemicals and/or materials. Any specific application not covered in this **WSP** must be referred to the Environment Safety & Health Office for guidance.
- B. All of the respiratory equipment listed in Table No. (1) can be used only in relatively low concentrations of their respective contaminants. Their limited to atmospheres where the threshold limit value (TLV) is not less than 0.1 milligrams per cubic meter (mg/m³) or 2.4 million particles per cubic foot of air, with the exertion of self contained breathing apparatus (see, WSP Saf. 1-2). All air purifying respirators can only be used in atmospheres that contain a minimum of 19.5% oxygen, have a known concentration of their target chemical/material, and are not Immediately Dangerous to Life or Health.
- C. If questions arise to the applicability of a respirator in any given atmosphere, call the Environment Health & Safety Office for further guidance.
- D. Each employee using any type respiratory equipment shall be required to complete a Qualitative Fit Test before performing duties in any atmosphere contaminated with toxic substances. Supervisors shall be responsible for ensuring that all of their employee's practice proper procedures when, wearing respiratory protection. Each time the wearer puts on the respirator, positive and negative pressure test shall be conducted to insure a satisfactory face fit. Respirators shall not be worn nor will workers be permitted to perform tasks that require respiratory protection when conditions such as a growth of beard, sideburns, temple pieces on corrective spectacles or goggles, or the absence of one or both dentures prevent a good facepiece-to-face seal.

NOTE: All Air Purifying Respirator users must be clean shaven.(See Attachment #1)
Any facial hair on user that may prohibit the sealing of the mask is strictly prohibited.

- E. The **RESPIRATORY PROTECTION PROGRAM** will establish guidance for the use and maintenance of respirator protection equipment at IITRI. These written procedures will be followed in all respiratory protection areas.

TABLE NO. (1)

<u>POLLUTANT</u>	<u>ATMOSPHERIC CONCENTRATION LEVEL</u>	<u>CARTRIDGE No.</u>	<u>CARTRIDGE COLOR</u>
Acetone	> 1000 ppm	7253 7251	YELLOW BLACK
Acid Gases	> 10x pel	7253 7252	YELLOW WHITE
Alcohol	> 1000 ppm	7253 7251	YELLOW BLACK
Ammonia	> 300 ppm	7254	BRIGHT GREEN
Asbestos	> 0.05 mg/m3	7255	MAGENTA
Chlorine	> 10 ppm	7252 7253	WHITE YELLOW
Dust, Fumes and Mists	> 0.05 mg/m3	7255	MAGENTA
Formaldehyde	> 10 ppm	7275	OLIVE GREEN
Hydrogen Chloride	> 50 ppm	7252 7253	WHITE YELLOW
Hydrogen Fluoride	> 10x pel	7253	YELLOW
Methylamine	> 100 ppm	7254	BRIGHT GREEN
Organic Vapors	> 1000 ppm	7253 7251	YELLOW BLACK
Radionuclides	> 0.05 mg/m3	7255	MAGENTA
Sulfur Dioxide	> 50 ppm	7252 7253	WHITE

* The cartridge numbers above are for the 3M type respirators. Prefilters such as the HEPA/MAGENTA cartridge can be added on top of another cartridge to increase the protective range of contaminants.

TABLE NO. (2)

Airborn Concentrations of A Given

Material	Respirator Required
Not in excess of 2 ppm (10 x PEL)	Half mask air purifying respirator equipped with appropriate filters.
Not in excess of 10 ppm (50 x PEL)	Full facepiece air purifying respirator equipped with appropriate filters.
Not in excess of 20 ppm (100 x PEL)	Any powered air purifying respirator equipped with appropriate filters.
Not in excess of 200 ppm (1000 x PEL)	Full facepiece supplied air respirator operated in pressure demand mode.
Greater than 200 ppm (< 1000 x PEL) or unknown concentration	Full facepiece supplied air respirator operated in pressure demand mode equipped with self-contained breathing apparatus.

DISTRIBUTION:

Prepared by:

4-28-94
Date

Reviewed by:

Date

Reviewed by:

Date

Signed by:

Date

APPENDIX D

ANSWERS TO THE DRAFT HEALTH AND SAFETY

PLAN REVIEW QUESTIONS FROM DOE

ANSWERS TO THE DRAFT HEALTH AND SAFETY PLAN REVIEW QUESTIONS

1. *What safety design considerations have been incorporated into the vapor recovery and treatment system to safely handle flammable vapors? Where will the power plant be located in respect to the treatment system? Are electrical components rated for NEC Class 1 locations?*

The primary factor that assures safe operation of the vapor collection system is the low concentration of the hydrocarbon gases in the collected gases and absence of ignitions sources.

The concentration and total inventory of the hydrocarbons in the soil is also low. Table 5 of the Work Plan provides an estimate of the concentration and inventory of volatile hydrocarbons present in the soil. This estimate is based on soil characterization studies from bore holes SB-71 and SB-76. Based on these, we have estimated that the heated zone has 4 to 45 lbs of VOCs distributed in 400 tons of soil. The average concentration of VOCs in the soil ranges from 5 to 45 ppm. It is planned to extract between 50 to 200 scfm of soil gas comprising of air, steam and VOC vapors. The estimated composition of the volatile hydrocarbons in the extracted soil gas is in the range of 0.3 to 13 ppm. Table 7 gives the vapor phase concentration for the lower and upper explosion limits (LEL, UEL) for several contaminants found in the Classified Burial Ground. The LEL ranges from 0.9% (900 ppm) to 14% (14,000 pm).

Figures 6 and 7 of the Work Plan illustrate the vapor collection system. This system comprises of gas collection lines which are manifolded together and connected to a source of vacuum. Figure 6 illustrates such a system with a electric blower. In this system the only powered equipment items are the blower, the heat tracing on the power lines and the instrumentation. Figure 7 illustrates the alternative collection system in which vacuum is provided by a compressed air ejector. In this system the only powered equipment items are the externally wrapped heat tracing on the gas lines and the instrumentation. Air is provided by means of a hose connected to a diesel compressor.

The system shown in Figure 7 is safer because it does not use any large electric powered equipment. In addition the introduction of air into the ejector will dilute the gases further and ensure that the LEL is not exceeded.

Both types of vapor collection systems have been safely used in the past during in situ heating demonstrations performed with Radio frequency energy.

The gas collection lines are made from black iron pipe. They have an insulating section to prevent the flow of electric currents through the remaining portion of the system. The heat tracing for the gas lines will be a constant wattage type designed to maintain the pipe temperature at 100° C. The cable will be rated for Class 1, Division 2 hazardous areas. A local temperature controller will be used which will also be rated for Class 1, Division 2 hazardous area. A humidity sensor and flow meter will also be used. These will also be rated for hazardous location service.

The "power plant" consists of an isolation transformer (60 Hz, 200 KVA) and associated controls. These are mounted in a 16-ft trailer. The electrical components in the power source trailer are housed in NEMA-1 rated enclosures. Figure 8 of the Work Plan indicates the location of the power source and the vapor collection system which will be skid mounted and kept outside in an open environment.

2. *How is it ensured that step potentials remain at safe levels outside the heating grid area? Calculations applicable to steady state current applied to a buried electrode grid system need to be shown for worst case conditions. What is the soil resistivity value used? With nonhomogeneous soils and varied moisture conditions how are safe step and touch potentials ensured? What is the safe step potential voltage for long duration exposures (i.e. greater than 3 sec)?*

Soil surface exhibiting a step potential of 2 volts/meter is considered safe for working, walking, etc. The location of the 2 volt/meter step potential depends upon the input power level and the electrical conductivity of the soil. Higher the input power level or less conductive the soil, the more the step potential contours will spread out from the heated zone. The heating grid area has dimensions of 16 ft width and 25 ft length. The area outside of the heating grid which exhibits step potentials in excess of 2 volts/meter will be cordoned off and excluded. This area will be the safety exclusion zone. Any areas exhibiting step potentials of less than 2 volt/meter will be safe for walking and working. The continuing safety of the area outside of the initial exclusion zone will be ensured through actual re-measurement and mapping of step potentials in the field.

The initial exclusion zone fence will be set up based on the results of calculations of the step potential contours. The boundary of the fence will be determined based on a worst case calculation. The worst case will correspond to a dried out heated zone surrounded by native soil. However, the worst case may not be much different than the initial case. The correct location of the fence will be verified by making actual field measurements starting at a low power input and gradually increasing the power and

verifying that the fence is correctly located for the maximum operating power level planned. During operations step potential measurements will be made whenever the power transformer's output taps are reconfigured, that is, whenever the applied voltage to the soil is changed. Step potential measurements will also be made at regular time intervals and also when the soil resistance measurements indicate significant loss of conductivity due to removal of water.

Measurements will utilize a IITRI-designed test probe and will be taken at various points along radial lines (minimum of four perpendicular lines) from the heated array. Measurements are taken starting at a point on a radial line known to contain a safe step potential level and then measurements are taken by moving closer to the heated array. Measurements along a radial line are taken until the 2 volt/meter location is found or the exclusion zone fence is reached. These points will be recorded and marked in the field.

If the 2 volt/meter level is determined to be outside the existing exclusion zone fence, then the site manager will determine if the exclusion zone fence needs to be relocated or that power needs to be reduced to a level that will result in the 2 volt/meter step potential not extending beyond the exclusion fence.

IITRI has performed calculations of step potentials expected to be present at the K-25 site. Initial, wet soil, conductivity of 0.01 mhos/meter was used as the basis of these calculations. Figure 9 illustrates the step potential contours at an input power level of 100 kW. at the above conductivity. Extrapolation to higher power levels is easily done by noting that power is proportional to voltage squared. Figure 10 illustrates the calculated step potentials at a dried-out condition when the inside soil has a conductivity of 0.001 mho/meter and the outside soil has 0.01 mhos/meter.

As long as the step potential is below 2 volt/meter, site workers can perform their duties without concern for the duration of exposure.

3. *At what locations must an individual take measurements while the grid is energized? Theoretically, can there be voltage gradients near the heating grid where voltage gradients over short distances greatly exceed 2 volt/meter?*

Figure 8 illustrates the location of the safety exclusion zone around the heated zone and the location of the various process equipment systems such as the AC power source, the vapor treatment system, etc. There are several places where measurements will be

made at various times during the course of the demonstration project. These places are:

- Inside the Power Supply Trailer
- On the vapor treatment system skid
- Array thermocouples in the array
- Step potential measurements outside the exclusion zone
- Touch potential
- Water injection system skid

The safety exclusion zone will establish an area inside which the step potential is equal to or greater than 2 Volts/meter at the operational power level. The exclusion zone shown in Figure 8 was based on a power input of 100 kW. In the field this will be verified using the procedure for the measurement of step potential described in Section 6.2. No process measurements will be made inside the exclusion zone by any person when the power is on. Safety measurements at low power levels will be made inside the exclusion zone by qualified technicians. During normal demonstration operations, no entry to the exclusion zone will be permitted when the power is on. The exclusion zone will be protected by interlock switches at all access points designed to remove power from the array. Entry into the exclusion zone will require that the power source be locked out and tagged prior to entry.

Outside the 2 volts/meter exclusion zone it will be safe to take measurements at any time. So, measurements will be made inside the power supply trailer and the vapor recovery system skid at any time. The touch potential will also be measured outside the safety zone to make sure that no hazardous voltage levels are present on various structures that the operating personnel could touch.

Should touch potential be greater than 6 volts, the site manager will determine in consultation with the SHSO if additional mitigation is needed or if the power input to the array be reduced to a level that would produce a safe touch potential.

Soil temperature measurements will require that the power to the array be switched off. Soil temperature measurements will be made in two ways: First, by connecting a bundle of thermocouple wires to a PC placed in one of the three trailers outside the exclusion zone. Inside the exclusion zone there will be a thermocouple cable disconnect point at which the cables will be disconnected so that there is no way that AC voltages could propagate on instrumentation wire to the PC. The thermocouple disconnect point will be protected with an interlock so that if the cables are left connected, then it will prevent power from being applied to the array. The second way of measuring temperature will require the insertion of thermocouples into plastic thermowells

placed in the soil. These measurements will also be made with the power to the array shut off. Temperature will be read on a hand held, battery powered meter. After the temperatures have been read, the thermocouple will be pulled up and out of the thermowell, disconnected from the meter and left coiled inside the exclusion zone, some distance away from the heated volume.

Figure 11 of the System Design Report¹ illustrates the water injection system. This system will be placed inside the exclusion zone. Its operation will be monitored by removing power from the array and going inside the exclusion zone.

Measurements of step potential will be made many times during the demonstration project. There will be an initial measurement of the step potential to confirm the calculations. These measurements will be made whenever the input power level is raised and also at other times to evaluate the effect, if any, of drying of the soil. The procedure for the measurements is described in Section 6.2.

The step potentials in the immediate vicinity of the heated zone will be greater than 2 v/m as shown by the step potential contours shown in Figure 9. But outside the safety exclusion zone the step potentials will be less than 2 v/m.

4. *Why must a test area be selected that such serious personnel safety hazards such as overhead power lines and grounded perimeter fencing in close proximity to the operation. What is so unique about this location that similar soil contaminant levels cannot be found elsewhere? Further the plan is vague in describing how these physical hazards will be controlled.*

The purpose of the demonstration is to show decontamination of soils containing volatile organic hydrocarbons in clayey soils at a DOE facility. The site was selected because it has higher volatile organic contaminants (VOCs) concentration levels than any other area sampled outside the Q-cleared fence. Process operations will require 24-hour operational access to the system and so logistics dictate that the demonstration be located outside the Q fence.

The overhead power line will be de-energized before site preparation activities start and it will remain so until site demobilization is completed.

It is our understanding that the existing L fence is to be declassified and it may be removed from the vicinity of the demonstration site. If the fence is physically present, then touch potentials will be measured at each power level starting at the lowest input power level to the array. Unsafe touch potentials will be mitigated as per procedures described in Section 6.2.

IITRI has developed a considerable body of experience in electrical shock hazard measurement and mitigation due to its on-going effort on US Navy's Extremely Low Frequency (ELF) Communications system in Wisconsin and Upper Michigan. In the ELF project IITRI routinely monitors electric potential on fences, buried and overhead utility lines, cable TV systems, poles, etc., and provides mitigation as required. Step potential measurements were also made in this project. These measurements have been made over an area encompassing 2600 sq. miles.

The touch potential to the Q fence will also be measured and it may require mitigation over a portion of its total length as estimated by the step potential calculations. Mitigation of this fence may be accomplished by restricting access to those portions which exhibit elevated and potentially unsafe levels of electric potential. This will be done by cordoning off the affected parts of the fence from both inside and outside.

Other means of mitigation include the spreading of a 6- to 8-in thick layer of coarse gravel around the affected portion of the fence and spreading of a thick (6 mils) plastic sheeting along the length of the fence exhibiting high touch potentials.

5. *The potential for ignition of flammable vapors while drilling bore holes must be addressed. What site characterization has been performed to prevent the possibility of drilling into buried drums.*

The selected site is outside the Q fence. Prior records show that the drum and solvent disposal activities occurred in the Pits which are inside the Q fence. Further, several bore holes were drilled in the vicinity of the proposed test site. During these drilling activities no drums were encountered. As Figure 8 shows, bore holes 74 and 75 are less than 30 ft. from the center of the heated area. Further, the demonstration area is located on the shoulder of the external perimeter road of the Classified Burial Ground. Because of this there is good reason to believe that waste disposal activities would not have occurred on this shoulder.

During the drilling activities it is planned to monitor the vapor phase volatile organic concentration at the bore hole opening and in the breathing zone. Along with these measurements a LEL meter will be used to ensure that the atmosphere does not pose an explosion hazard. Should high concentrations of the vapors or a LEL of 10 percent is encountered, all activities will stop until the atmosphere becomes safe as measured by the meters. Table 12 gives a summary of monitoring plan and the action thresholds for measured vapor phase concentration and LEL levels.

Several bore holes have been drilled in the area of the demonstration site. These are numbered SB-71, SB-73, SB-74, SB-75, SB-76, SB-80. Many others have been drilled outside as well as inside the Q fence. Bore holes drilled at the site are shown in Figure 3. Driller's log for the bore holes SB-71, SB-75, SB-76 and SB-80 show that the OVA/HNU readings were in the range of 0 to 600 ppm with most of the readings being less than 110 ppm. Readings towards the high end of the range were encountered only in Bore hole SB-80. The measured reading are low vapor phase concentrations as far as explosion hazards are concerned. Table 7 give the vapor phase concentrations for the lower and upper explosion limits (LEL, UEL) for several contaminants found in the Classified Burial Ground. The LEL ranges from 0.9% (900 ppm) to 14% (14,000 ppm).

6. *What is the potential for ignition of flammable vapors during the electromagnetic heating process. What controls the potential for resistance arcing at power cable connection points on the electrodes?*

The question of potential ignition of flammable vapors below ground is addressed in this answer. Safe handling of vapors in the above ground equipment is addressed in response to Question 1.

The potential of vapor ignition below ground is low due to the following reasons:

- Low concentration as well as low total inventory of volatile hydrocarbons in the site. Table 5 of the Work Plan⁶ presents an estimate of the total inventory of volatiles in the heated zone. It was estimated that the soil has between 5 to 45 lbs of volatile hydrocarbons distributed in 400 tons of soil with an average concentration in soil of 6 ppm and a maximum concentration of 55 ppm. These data are based on the results of characterization performed on nearby soil borings SB-71 and SB-75.
- Low final temperature of the soil. The final temperature of the soil will be less than the native boiling point of water. This is so because the electromagnetic process requires the presence of water in the soil to dissipate and conduct electrical energy. It is estimated that the final temperature of the heated zone will be in the range of 85° to 95° C.
- The treatment zone is located in a hydrocarbon plume apparently originating inside the Q cleared fence. There are no known drums of the waste material disposed in this

area. Thus localized pockets of high concentration or pure product are not likely to be present below ground.

- Low energy density. It is planned to heat the soil by the application of up to 150 kW of AC power. Average power density in the soil will be 0.41 watt/kg of soil.
- Low gas phase concentration of the hydrocarbons. It is planned to extract between 50 to 200 scfm of soil gas comprising of air, steam and hydrocarbon vapors. The steam is formed as the soil moisture is boiled out along with the injected water. The estimated composition of the volatile hydrocarbons in the extracted soil gas is in the range of 0.3 ppm to 13 ppm.
- No ignition source. The electrical connections to the steel pipe electrodes will be made at the surface. The method for doing this is briefly described in this answer, below. Once the electrical connections to the electrode top has been made, the entire array will be over packed with native soil obtained from the soil borings.

All electrical connections to the electrodes will be made via industry standard connection blocks and threaded bolt/lock washers. Since there is no vibration or flexing of the cables, there is no concern that the cable connections will become intermittent and thus lead to sparks.

7. *What confidence does the contractor have in the safe operation of this test demonstration? Has prior full scale testing/demonstration been performed by the contractor with this system under similar conditions or will this be the first time this specific equipment has been assembled?*

We have a high degree of confidence in the safe operability of the proposed demonstration system. This is based on our past experience with similar above ground vapor handling systems and with in situ electrical systems based on both 60 Hz (EM Heating) and RF heating.

The specific system that will be tested at Oak Ridge is a new System that has not been tested in the past in the field. However, the electrical power source and its associated safety interlock system will be tested in Chicago using a small above ground resistive load. The same power source will be utilized during an in situ decontamination demonstration at Sandia National Laboratory (SNL) later this year. Current schedules indicate that the SNL demonstration will be performed before that at Oak Ridge. In the past IITRI has safely performed in situ pilot scale heating experiments utilizing isolation transformers as a power source for 60 Hz AC heating. The power source used for this demonstration is also an isolation transformer.

The above ground vapor collection system planned for the Oak Ridge demonstration is a new system which has not been used in the past although similar systems have been used during demonstrations of in situ heating performed by IITRI. Due to the low concentration and total weight of the hydrocarbon contaminants the vapor handling system is essentially a collection system. It is proposed to vent the collected vapors to the atmosphere after adjustment of humidity to ensure that the discharge stream is above its dew point. The collection system consists of steel pipes manifolded together and connected to a source of vacuum. One of two alternative means of providing the vacuum will be utilized. These are: a blower with an electric motor or a compressed air ejector system. Compressed air will be delivered by means of an on site compressor. Figures 6 and 7 of the Work Plan⁶ illustrate the two alternatives. Similar collection systems are routinely used for in situ venting (ISV) projects although they may utilize plastic collection pipes.

In the past IITRI has utilized gas collection systems which also incorporated a treatment step. These condensed the hydrocarbons and the water vapor followed by carbon treatment of the vent gas stream. In one demonstration an ejector based collection system was used which transported the gases to a flare.

The triplate (three rows) electrode array has been used in many field experiments although we have not used one made from black iron pipe. We have not performed a field demonstration in which 60 Hz. power was applied to the triplate array although six RF field demonstrations have been done ranging in power from 40 to 80 kW. We have performed two pilot scale experiments (in the lab.) in which an array of electrodes was energized with 60 Hz. power. One was a triplate array and the other one was a bi-plate array. In each of these experiments approximately 2 tons of soil was heated.

8. *The Health and Safety Plan does not make any reference to the Safety Assessment and to the Demonstration Test Plan that are required by the contract Statement of Work. This information should be included along with approximate time frame that it will be submitted for DOE review. Also the contractor should identify that a Readiness Review Meeting will be held to further assure that all identified concerns have been thoroughly addressed prior to initiation of the test.*

The Safety Assessment will be done as per DOE and MMES requirements.

A Test Plan was submitted for review. After incorporating the review comments the Test Plan was renamed "Treatability Study Work Plan." A separate Test Plan document will not be written because

there is no need for one. It is planned to revise the Work Plan once more upon receiving comments from DOE.

A Demonstration System Design report has been prepared and submitted. Review comments have been received. These will be incorporated in a revision. The two documents will be referenced in the Foreword to the HASP.

A Readiness Review will be held in the field. This review will be done at the end of the system installation task and prior to system check-out. Another review may be necessary when the system check-out is deemed complete and prior to actual operation.

9. *Will cutting and welding operations be necessary? If it is necessary to monitor for combustible/flammable gases, is the potential significant enough to require non-sparking tools as well as rated electrical equipment*

Welding operations at the test site will not be necessary. Cutting (sawing) of steel pipe and unistrut will be required during the system installation task. These operations will not be carried out near open bore holes or near active drilling equipment. In addition LEL measurements will be made in the area where cutting will be done.

The System Installation task will require several sub tasks. A list of these is presented in Table 8. After the electrodes and thermowells have been inserted into the bore holes and the holes have been back filled with soil only then will the majority of the above ground system installation activities begin. Thus during these subsequent sub-tasks the risk of flammable mixture of vapors forming in the open area will be low. Prior measurements of volatile organic vapor concentration near open bore holes during drilling operations were low (See response to question 5). Nevertheless, a LEL monitor will be used as per Table 13 to survey the open area above the electrode array where the installation activities are underway.

Thus the use of non-sparking tools for activities involved with above ground system installation is not required or planned. Electrical tools will be used outside in well ventilated areas after bore holes have been filled and the area has be monitored with an LEL meter as per Table 13 requirements. Power tools will not be rated for explosive or flammable atmosphere service.

10. *There is no reference to any type of digging/excavation permit requirement.*

An excavation/digging permit will be required. This permit will be obtained with the assistance of MMES Point of Contact,

Mr. Frank Van Ryn, based on the bore hole layouts already provided in the System Design document.

APPENDIX E
ANSWERS TO THE REVISION 1 HEALTH AND SAFETY
PLAN REVIEW QUESTIONS FROM DOE

ANSWERS TO THE REVISION 1 HEALTH AND SAFETY PLAN

REVIEW QUESTIONS FROM DOE

1. Page 45, bullet two, states no personnel are permitted to enter the exclusion area while the EM heating array power is energized. On page D-5 of their response to DOE questions, it is stated that Safety measurements at low power levels will be made inside the exclusion zone by qualified technicians. Which statement is accurate? If the latter is required, will the technician be in a potentially unsafe environment (step potentials over 100 Volt-meter)? What is considered "low power levels" and what associated step potentials may the technician encounter while protected with electrically insulating PPE?

Page 44 was missing in Revision 1 copies. Text of Page 44 has been added in Revision 2.

The list of bullets given on page 45 refers to safety precautions to be followed during system shake-down and check-out. The second bullet on page 45 refers to normal operations of the heating system and it should be moved to the subsection on "Daily Operations" which begins on Page 49 of the HASP. Such change has been made in Revision 2.

Statements made on Page D-5 of Appendix D regarding step potential measurements at low power are correct. These measurements will be made during initial shake-down of the AC heating system. The purpose of these is to verify through field measurements that the contours of step potential calculated by a computer program are correct. This is important because it will define the location of the safety exclusion fence which is to be placed outside the 2 V/meter contour.

The power level used for the "low power" test will be 5 to 10 KVA and is expected to produce step potentials no greater than 7 V/m within the exclusion zone. These step potential measurements at low power are used to confirm the predicted step potential contours. Once the exclusion zone fence is established, the step potential profiles external to the fence are measured/monitored to determine continued safe operation at full power. After the exclusion zone fence is in place, no personnel are permitted to enter the area it delineates while the heated array is energized with EM power.

2. Calculations used to describe worse-case (high power level, high soil resistivity) step potentials near the

square array of vertical ground rods was requested and not provided by the contractor. Formulas describing the resistance of square array of rods can be found in Military Handbook, MIL-HDBK-419, Grounding, bonding, and Shielding for Electronic Equipments and Facilities.

Figure 10 (Page 60) provides the "worst case" predicted step potential contours for the EM heated array. It was derived using an IITRI proprietary computer code which models the individual electrodes within the soil. The electrical conductivity of the soil cells utilized in the model are varied based on field data and predictions of the process parameters, as the soil is heated and dries. The worst case predictions used a soil conductivity of 0.001 mhos/meter for the soil within the heated zone and 0.01 mhos/meter for the soil external to the array. The computer model provides the voltage profile within the soil for each designated cell. The soil surface voltage profiles are then used to compute the step potential contours shown in the figure.

3. The soil resistivity value of 0.01 ohm-meter used in the initial wet soil step potential calculations, as stated on Page D-4, appears quite low by a factor of 1000 for wet soils. Is this value realistic? Higher soil resistivity values should be used to estimate worst case step potentials near the array.

The sentence referred to on Page D-4 reads incorrectly, it should read:

"An initial, wet soil, conductivity of 0.01 mhos/meter was used". The worst case calculation of the step potential was done for the case when the soil inside the array has "dried out" while the soil outside retains its initial conductivity. Figure 10 (Page 60) illustrates this case.

4. Based on information contained in the Treatability Study Work Plan, the concentration of volatile organic appear quite low. However, on Page D-2, a preference is shown for the compressed air ejector method as safer than the large electric blower for use with the vapor collection system. If there is a potential hazard for concentration of flammable vapors above LEL levels (e.g., while array is heated and vacuum system not operating, or during initial start-up blower) the electric motor must be located out of the potentially hazardous, Class 1, Division 2 area.

The final design for the vapor collection system resulted in the selection of an electric blower due primarily to problems of cost, maintenance and reliability of a diesel compressor needed to

operate an air ejector system. This blower will be placed 65 to 85 ft. from the center of the array (see box labelled Vapor Recovery System in Figure 8 on Page 58) where the concentration of fugitive emissions, if any, will be low and the step and touch potentials will also be low (see Figures 9 and 10 on Pages 59 and 60). We have retained the ability to dilute the vapor stream entering the blower with clean air. We plan to measure the presence of flammable vapors in the area near the blower.