LOCKHEED MARTIN

ORNL/ER-326/R1

ENVIRONMENTAL RESTORATION PROGRAM

Environmental Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee

This document has been approved by the
ORNL Technical Information Office
for release to the public. Date: 1/12/98

UNCONTROLLED COPY

ENERGY SYSTEMS ER

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

UCN-17560 (6 8-95)

DISCLAIMER

ORNL/ER-326/R1

Environmental Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee

S. N. Burman
P. F. Tiner
R. C. Gosslee

Date Issued—January 1998

Prepared by
Life Sciences Division
Oak Ridge National Laboratory

Prepared for
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EX20

Environmental Management Activities at
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

Author Affiliation

S. N. Burman, P. F. Tiner, and R. C. Gosslee are members of the Measurement Application and Development Group, Life Sciences Division, Oak Ridge National Laboratory.

APPROVALS

Environmental Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee (ORNL/ER-326/R1)

J. E. Rushton
MSRE Project Manager

1/13/98
Date

R. L. Faulkner
MSRE Facility Manager

1/13/98
Date

J. E. Francis
MSRE Radiological Protection Coordinator

1/13/98 jef
Date

D. G. Rowland
Safety and Health Evaluation and Support Team (SHEST) Representative

1/13/98
Date

S. N. Burman
MSRE ES&H Manager

1/13/98
Date

PREFACE

This Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory was prepared as part of the Oak Ridge National Laboratory Environmental Restoration Program Decontamination and Decommissioning activities. This report (ORNL/ER-326/R1) was prepared to ensure safety of personnel and the environment during remediation activities at the Molten Salt Reactor Experiment. This work was performed under Work Breakdown Structure1.12.06.10.02.01 (Activity Data Sheet ADS3700) "ORNL Decontamination and Decommissioning Program." The report details required health and safety documentation, roles and responsibilities of health and safety personnel, potential site hazards, site access requirements, frequency and types of monitoring, site work zones and control measures, decontamination procedures, standard operating procedures, and emergency contingency plans.

CONTENTS

FIGURES

TABLES

ABBREVIATIONS

ACB	auxiliary charcoal bed
ACGIH	American Conference of Governmental Industrial Hygienists
AHERA	Asbestos Hazard Emergency Response Act
AHJ	authority having jurisdiction
AIHA	American Industrial Hygiene Association
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute, Inc.
ARAR	applicable or relevant and appropriate regulation/requirement
BIO	basis for interim operations
CAA	Clean Air Act
CAAS	Criticality Accident Alarm System
CCE	Center for Continuing Education
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNS	central nervous system
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CWA	Clean Water Act
D	daily
DAC	derived air concentration
D&D	decontamination and decommissioning
DCGs	derived concentration guideline
dBA	decibels on the A-weighted scale
DOE	U.S. Department of Energy
ECC	Emergency Communications Center
EMEF	Environmental Management and Enrichment Facilities
EMS	emergency medical services
Energy Research	Lockheed Martin Energy Research Corp.
Energy Systems	Lockheed Marietta Energy Systems, Inc.
EZ	exclusion zone
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ES&H	environmental safety and health

FID	flame ionization detector
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FFCA	Federal Facilities Compliance Act
FP	flash point
GET	General Employee Training
GI	gastrointestinal tract
H&R	hoisting and rigging
HASP	health and safety plan
HAZMAT	hazardous materials
HAZWOPER	hazardous waste operations and emergency response
HEPA	high efficiency particle absorber
HP	health physics or health physics technician
H&S	health and safety
IA	implementation assumption
IDLH	immediately dangerous to life and health
IG	inspector general
IH	industrial hygiene or industrial hygienist
LEL	lower explosive limit
LLW	low-level (radioactive) waste
LSS	Laboratory Shift Superintendent
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
MSRE	Molten Salt Reactor Experiment
NCP	National Contingency Plan
NCS	nuclear criticality safety
NE	not established
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission

ORC	Office of Regional Council
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
ORP	ORNL Office of Radiation Protection
ORS	Occurrence Reporting System
OSHA	Occupational Safety and Health Administration
OSHP	Office of Safety and Health Protection
PAPR	powered air-purifying respirator
PCBs	polychlorinated biphenyls
PCCB	project configuration control board
PEL	permissible exposure limit
PHA	project hazard analysis
PHASP	Project Health and Safety Plan
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RDF	Radiochemical Development Facility
REAC/TS	Radiation Emergency Assistance Center/Training Site
REL	recommended exposure limit
RGR	reactive gas removal
RGRS	reactive gas removal system
RPP	Radiation Protection Procedure
RWP	Radiological Work Permit
SCBA	self-contained breathing apparatus
S&H	safety and health
SHEST	Safety and Health Evaluation and Support Team
SHPO	state historic preservation officer
SLLW	solid low-level (radioactive) waste
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
STEL	short-term exposure limit
SWP	Safety Work Permit

TCA	Tennessee Code Annotated
TDEC	Tennessee Department of Environment and Conservation
TN	Tennessee
TLD	thermoluminescent dosimeter
TLV	threshold limit value
TRU	transuranic
TSCA	Toxic Substances Control Act
TSHASP	Task-Specific Health and Safety Plan
UDR	Uranium Deposit Removal Project
UEL	upper explosive limit
W	weekly
WBGT	wet bulb globe thermometer
W/B/H	welding, burning, and hot work activities
WOCC	Waste Operations Control Center
WP	work package
WSS	work smart standards
Y	yearly

EXECUTIVE SUMMARY

The Lockheed Martin Energy Systems, Inc. (Energy Systems) policy is to provide a safe and healthful workplace for all employees and subcontractors. The accomplishment of this policy requires that operations at the Molten Salt Reactor Experiment (MSRE) facility at the Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) are guided by an overall plan and consistent proactive approach to environmental protection and safety and health (S&H) issues.

The policy and procedures in this plan apply to all MSRE operations. The provisions of this plan are to be carried out whenever activities are initiated at the MSRE that could be a threat to human health or the environment. This plan implements a policy and establishes criteria for the development of procedures for day-to-day operations to prevent or minimize any adverse impact to the environment and personnel safety and health and to meet standards that define acceptable management of hazardous and radioactive materials and wastes. The plan is written to utilize past experience and the best management practices to minimize hazards to human health or the environment from events such as fires, explosions, falls, mechanical hazards, or any unplanned release of hazardous or radioactive materials to the air.

This plan explains additional task-specific health and safety requirements such as Work Packages (WPs) and Task-Specific Health and Safety Plans (TSHASPs), which should be used in concert with this plan and existing established procedures. This plan, and any addenda addressing S&H issues, shall be available for on-site inspection and review by all subcontractor, Energy Systems, and DOE personnel and shall be easily accessible for on-site personnel. During on-site activities, all personnel, including subcontractors and visitors, are expected to comply fully with the requirements of this plan and other ORNL, Energy Systems, and DOE policies and procedures. Site activities shall be performed in accordance with DOE Order 5400.5, applicable Occupational Safety and Health Administration standards (29 CFR 1910 and 1926), applicable Occupational Radiation Protection standards (10 CFR 835), and applicable Environmental Protection Agency requirements and consensus standards.

It is understood that it may not be possible to determine actual working conditions in advance of the work. Therefore, this plan allows the opportunity to provide a range of protection based upon actual working conditions that could be encountered while conducting on-site activities. Task-specific information will be presented in TSHASPs to the extent possible.

1. INTRODUCTION

This Project Health and Safety Plan (PHASP) is prepared for the safety of personnel and the environment for efforts related to operations conducted at the Molten Salt Reactor Experiment (MSRE) facility. This plan complies with the Occupational Safety and Health Administration (OSHA) requirements of 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response* (HAZWOPER), for investigations and cleanup at hazardous waste sites and decontamination and decommissioning activities. This plan also follows the requirements of 10 CFR 835, *Occupational Radiation Protection.*

This PHASP provides information applicable to scheduled Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities at the MSRE facility including:

1. interim corrective measures to mitigate safety concerns of the MSRE,
2. removal of uranium hexafluoride (UF_6) and other related gases (Reactive Gas Removal System),
3. removal of uranium deposit and chemical conversion of uranium, and
4. removal of the fuel salts.

This project plan and subsequent task-specific documents will be specific to the MSRE facility, the removal activities, and associated corrective measures.

Specific tasks will be addressed on a task-by-task basis. Task-specific work packages will be prepared to address all aspects of the job [e.g., scope of work, health and safety, and standard operating procedures (see Sect. 2.1)]. In addition to the work packages, Task-Specific Health and Safety Plans will be prepared for all tasks that fall under the scope of 29 CFR 1910.120.

To ensure that all plans comply with applicable regulations and procedures, this PHASP and subsequent related documents will be reviewed and approved by the MSRE Environmental Safety and Health (ES&H) Manager, personnel listed on the document's approval page, and other independent reviewers.

1.1 FACILITY DESCRIPTION

The MSRE was operated from 1965 through 1969 to investigate the possibility of using molten salt reactor technology for commercial power applications. The reactor used a fluoride salt mixture of lithium, beryllium, and zirconium fluorides with uranium tetrafluoride as the fuel components. The reactor was initially fueled with ^{235}U, which was replaced with ^{233}U in 1968. An addition of less than one kilogram of plutonium trifluoride was produced in 1969. When the reactor was shut down, the fuel salt was drained into two fuel drain tanks in the drain tank cell where it was cooled and solidified. Following a post-operation examination, the facility was placed under a program of surveillance and maintenance awaiting eventual decontamination and decommissioning (DOE December 1994). A diagram of the MSRE facility is shown in Fig. 1.1.

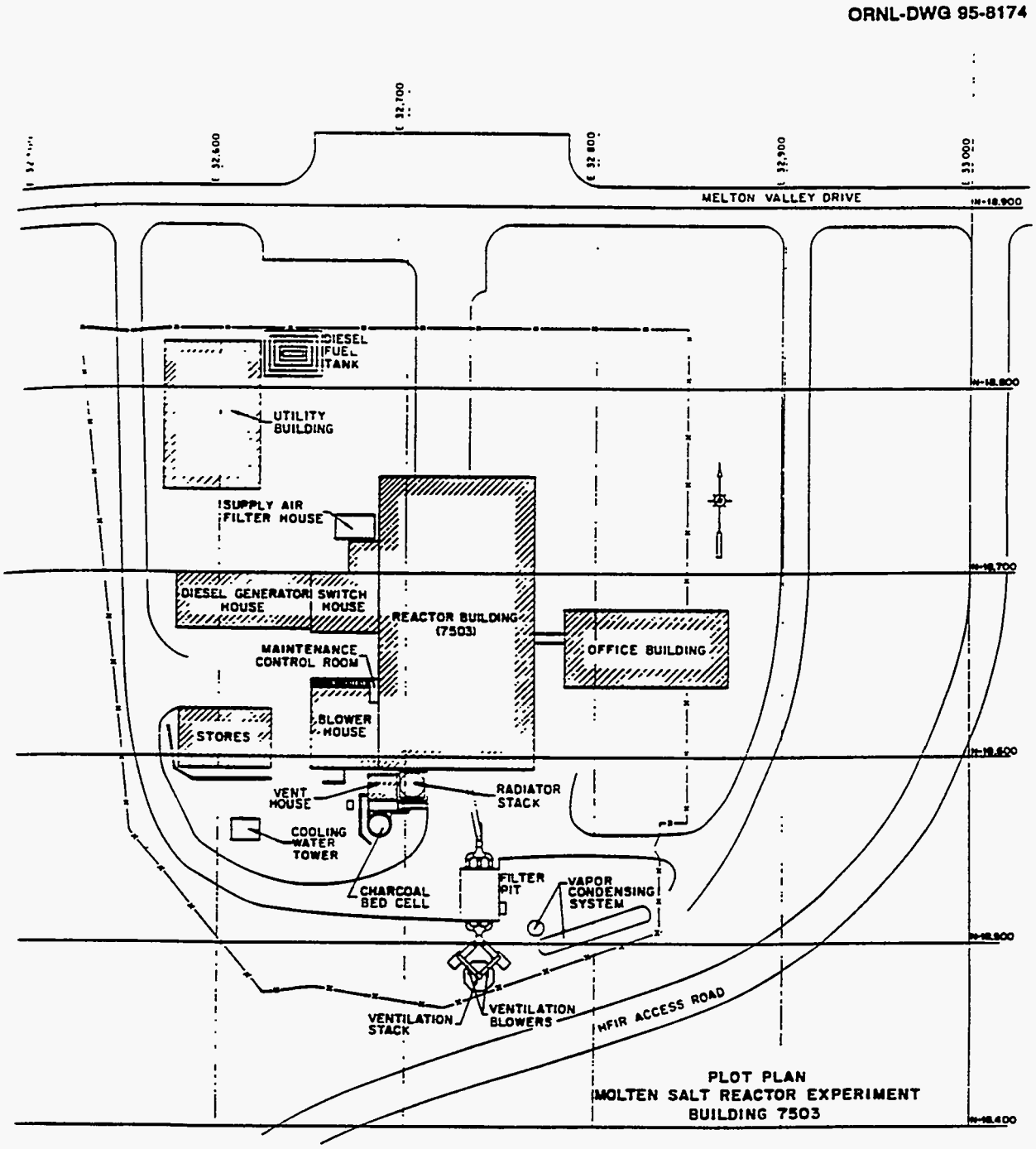

Fig. 1.1. Diagram of the Molten Salt Reactor Experiment site.

2. ASSOCIATED DOCUMENTS

2.1 TASK-SPECIFIC WORK PACKAGES

Task-specific work packages (WPs) will be prepared to address all aspects of the task to be performed. A WP may include the following:

- a basic description of the work to be completed;
- documentation of a Nuclear Criticality Safety Assessment (when required);
- a Safety Work Permit (SWP), work instructions, **or** a Task-Specific Health and Safety Plan (TSHASP);
- a Radiological Work Permit (RWP);
- other task-related permits, as needed; and
- appropriate standard operating procedures (SOPs) to safely and successfully complete the desired task.

The package will be initiated by the facility staff and routed to representatives of the appropriate disciplines [e.g., Office of Radiation Protection (ORP)] for completion and sign-off. The package is routed to the MSRE ES&H Manager and, when appropriate, the Office of Safety and Health Protection (OSHP) representative for review and approval of specific permits. The package details the scope of work, identifies the work environment, the hazards, and the controls that must be followed to safely complete the desired task.

2.2 TASK-SPECIFIC HEALTH AND SAFETY PLAN (TSHASP)

When a task falls under the scope of 29 CFR 1910.120 and, therefore, under the ORNL HAZWOPER Program, a TSHASP will be included in the WP. The ORNL HAZWOPER Coordinator has defined criteria for determining when a task is specifically under the HAZWOPER Program. Additional criteria for HAZWOPER control include (1) hazards associated with the task, (2) duration of the task, and (3) level of effort to accomplish the task.

TSHASP development shall be a cooperative effort involving the MSRE ES&H Manager, the Site Safety and Health Officers (SSHOs), the MSRE Radiation Control Technicians (RCTs), and the workers who will perform the work (see Sect. 3 for a description of site roles). The TSHASP will serve as an extension to this PHASP and shall address all task-specific information including, but not limited to, the work location, standard operating instructions for the work effort, the anticipated hazards to health and safety, and the prescribed methods for controlling the task-specific hazards through controls and safe work practices. The TSHASP may include new data that have been received subsequent to the publication of this PHASP.

The TSHASPs will be reviewed and approved by the MSRE ES&H Manager, the MSRE Facility Manager, and a representative of the ORNL Safety and Health Evaluation and Support Team (SHEST). ORNL personnel listed in the *ORNL HAZWOPER Program Manual* (ORNL/M-2716) will

review and comment on TSHASPs. This review process ensures that all TSHASPs comply with regulations and procedures of the various ORNL ES&H disciplines.

The format of the TSHASP is presented in Attachment A.

2.3 PROJECT DOCUMENTATION

Project documentation shall be maintained at the facility by facility staff and/or the MSRE Document Coordinator for the duration of the project. Upon completion of the project, all appropriate documentation will be retained as historical records and forwarded to the appropriate Document Management Center. Required project documentation may include, but is not limited to, the following:

- Project Management Plan.
- The PHASP.
- Project logbooks.
- Site instrumentation monitoring and calibration logs.
- Task-specific RWPs.
- Nuclear criticality approvals.
- TSHASPs.
- TSHASP briefing records.
- Accident and illness reports.
- Inspection reports.
- Worker training records.

2.3.1 Project Logbook

A project health and safety (H&S) logbook shall be maintained for tasks at the MSRE. This logbook is for the purpose of documenting and summarizing all pertinent task activities and HAZWOPER activities. Items to be recorded in the logbook shall include, but are not limited to, the following: task operations, instrumentation monitoring, site entrants, accidents or injuries, and attendance at pre-entry and daily health and safety briefings.

2.3.2 Corrective Actions

Corrective actions are those measures taken to rectify any facility or task deficiency that was observed from self assessments and surveillance. Corrective actions may be proposed by any person performing work or involved in support of the project at any time.

2.3.2.1 Field activities

Most corrective actions will be of short duration, such as failure to date and sign a monitoring form or properly document errors. Corrective action will be initiated by bringing the discrepancy to the attention of the appropriate personnel. For H&S concerns, corrections will be accomplished at the time of the disclosure under supervision of the SSHO, RCT, or ES&H Manager. Any actions that violate safety and health protocol [such as the use of ineffective PPE, entering the Support Zone from the Contamination Reduction Zone (CRZ) without frisking, or violating nuclear criticality safety requirements] will be considered short-term events. Suspension of work until corrective action can be taken will be evaluated at that time, and, depending upon the severity of the event, appropriate actions will be taken. After corrective action, work will resume under the direction of the SSHO, OSHP representative, RCT, or ES&H Manager. The event, personnel involved, and decisions made will be documented in the MSRE H&S logbook.

2.3.2.2 Occurrence reporting

Department of Energy (DOE) Order 232.1A, *Occurrence Reporting and Processing of Operations Information*, became effective on February 22, 1993. The Occurrence Reporting System (ORS) may be initiated any time an employee, contractor, or subcontractor reports problems, concerns, conditions, or events that have or could have adverse or negative impact on safety, the environment, health, quality, security, or site operations. The occurrence is to be reported to line management (in this case the Facility Manager) or the Laboratory Shift Superintendent (LSS), as appropriate. If the event involves a real-time occurrence that requires assistance from plant emergency services, on-site personnel should take action to mitigate the occurrence and immediately report the situation as described in Sect. 10.1.2.

2.3.2.3 Health and safety plan field changes and variances

Any planned change in task or deviation from the PHASP, WP (including work instructions), or TSHASP, or any change in established work procedures or SOPs that could impact employee health and safety, or is immediately dangerous to life, health, or the environment, requires a Health and Safety Plan Field Change Form (provided as Attachment B). The form must be completed and signed by the appropriate persons prior to implementation of the change. The change must be documented in the project H&S logbook or on the HASP Field Change Form attached to the original document. Task personnel must be informed of the change before performing further work on the task.

A variance is a routine change in any aspect of the written procedure that would not affect the health and safety of site workers. If a variance from the plan occurs, a description of the change and the reason for it must be recorded in the project H&S logbook at the time of occurrence. All personnel involved in the work process will be informed of these changes.

For any deviation that could adversely affect the quality of data being generated, the Field Change Form shall require the approval of the Facility Manager and the Project Manager in addition to the signatures listed on the form (see Attachment B). Changes must be explained to all site personnel. The Field Change Form records the deviation, the substituted method or rationale for the change, and an explanation of how data quality, and/or personnel health and safety, will be affected. It will become a part of the project record and available for review at any time.

3. FACILITY ORGANIZATION

The MSRE facility is currently being managed as a part of the ORNL Environmental Restoration (ER) Program by Energy Systems through a contract with DOE. The roles and responsibilities for facility and project operations should remain the same throughout the duration of the project. Task-specific individuals may change as different work activities are conducted.

3.1 KEY PERSONNEL

Key health and safety personnel for the MSRE project are provided in Table 3.1 and key project personnel in Table 3.2. Emergency contacts are listed in Table 3.3.

Table 3.1. MSRE health and safety personnel

Responsibility	Name	Telephone
MSRE Project Manager	J. E. Rushton	576-7000
MSRE Facility Manager	R. L. Faulkner	574-9188
Facility Coordinators	G. A. Mays R. A. Kite T. C. Morelock	574-0268 574-8805 574-5558
MSRE ES&H Manager	S. N. Burman	576-7364
MSRE Radiological Protection Coordinator (ORP Coordinator)	J. E. Francis	574-6701
Safety and Health Evaluation and Support Team (SHEST) Representative	D. G. Rowland Pager number	576-6445 873-5537
ORNL Nuclear Criticality Safety Section	J. F. Mincey	574-4338
MSRE OSHP Representative	B. Miller	576-8218
MSRE Radiation Control Technicians (RCTs)	B. W. Ross S. D. Mathews J. F. Allred	241-2753 241-5354 241-5354
MSRE HAZWOPER Site Safety and Health Officers (SSHOs)	P. F. Tiner R. C. Gosslee	574-9613 576-7293

Table 3.2. MSRE project personnel

Responsibility	Name	Telephone
MSRE Project Manager	J. E. Rushton	576-7000
Assistant to MSRE Project Manager	S. G. Kimmett	574-1552
Criticality Safety Oversight	L. L. Gilpin	576-6351
Quality Assurance Manager	J. S. Ivey	576-3876
MSRE Facility Manager	R. L. Faulkner	574-9188
Facility Nuclear Criticality Coordinator	R. M. Szozda	241-2756
Facility Coordinators	G. A. Mays R. A. Kite T. C. Morelock	574-0268 574-8805 574-5558
Safety Analysis Engineer	C. L. Hedrick	574-1646
MSRE Technical Support Manager	B. D. Patton	576-0603
Reactive Gas Removal System Project Manager	R. L. Faulkner	574-9188
Uranium Deposit Removal Manager	K. L. Walker	574-7067
Fuel Salt Disposal Manager	F. J. Peretz	576-5516
MSRE Business Manager	E. G. Mai	576-3563
MSRE Waste Certification Officer	S. E. Childs	241-2807

Information contained in Table 3.3 must be included in all TSHASPs.

Table 3.3. Emergency contacts

Responsibility	Name	Telephone
EMERGENCY		**# 911**
Laboratory Shift Superintendent		**574-6606 Station 103 Radio No. 295**
ORNL Fire Department (Fire Shift Captain)		576-5678
ORNL Environmental Health Protection		574-6688
ORNL Environmental Management		576-6670
ORNL Medical		574-7431
Protective Services (Fire, Security Patrol)		574-6277
MSRE Facility Manager	R. L. Faulkner	574-9188
Facility Coordinators	G. A. Mays R. A. Kite T. C. Morelock	574-0268 574-8805 574-5558
MSRE ES&H Manager	S. N. Burman	576-7364
MSRE Radiological Protection Coordinator (ORP Coordinator)	J. E. Francis	574-6701
Radiation Protection (Off-Shift)		574-6700 Radio No. 152
ORNL SHEST Representative	D. G. Rowland	576-6445
ORNL Nuclear Criticality Safety Section	J. F. Mincey	574-4338
MSRE Waste Certification	S. E. Childs	241-2807
MSRE Emergency Response Team	R. A. Kite S. N. Burman D. E. Clark K. S. Thomas	574-8805 576-7364 574-6940 574-6940

3.2 CHAIN OF COMMAND

The SSHO is responsible for informing the MSRE ES&H Manager and the MSRE Facility Manager of any ES&H issues. The MSRE Facility Manager will contact the MSRE Project Manager who will make the appropriate decision as to whether the DOE representative should be contacted. A consultation will be initiated involving the SSHO, the MSRE ES&H Manager (or Facility Manager if the MSRE ES&H Manager is not available), and, if needed, the appropriate ORNL discipline(s): SHEST representative, Office of Radiation Protection, Officer of Safety and Health Protection, Waste Management, Nuclear Criticality Safety, or Environmental Compliance. For issues that cannot be resolved at this level, division managers of the appropriate disciplines (ES&H, Waste Management, Environmental Compliance, or Nuclear Criticality Safety) will be contacted for assistance. In all cases, resolutions should be agreeable to all involved parties. For nonemergency situations, when neither the MSRE ES&H Manager (or designee) or the Facility Manager can be contacted, the SSHO may first contact the appropriate discipline(s) directly. In an emergency contact the LSS. The TSHASP should reflect this chain of command, and site participants should understand exactly who should be contacted before site activities are initiated. This chain of command is illustrated in Fig. 3.1.

3.3 ROLES AND RESPONSIBILITIES

Roles and responsibilities of the following positions are detailed in the *MSRE Project Plan.*

- MSRE Project Manager
- ORNL D&D Program Representative
- ORNL Criticality Safety Oversight
- MSRE Facility Manager
- MSRE Safety Analysis Engineer
- MSRE Waste Certification Officer

The sections below contain descriptions of project roles and responsibilities for the following.

- MSRE ES&H Manager
- SSHO
- ORP Coordinator and RCT
- SHEST representative
- OSHP
- task personnel

These roles and responsibilities are not limited to those listed below. Key task personnel and H&S personnel shall be identified in each work project TSHASP.

All individuals working at or visiting the MSRE facility must adhere to all MSRE, DOE, Federal, State, Energy Systems, and ORNL procedures, directives, orders, and regulations and must abide by directions and instructions given by facility management and health and safety individuals.

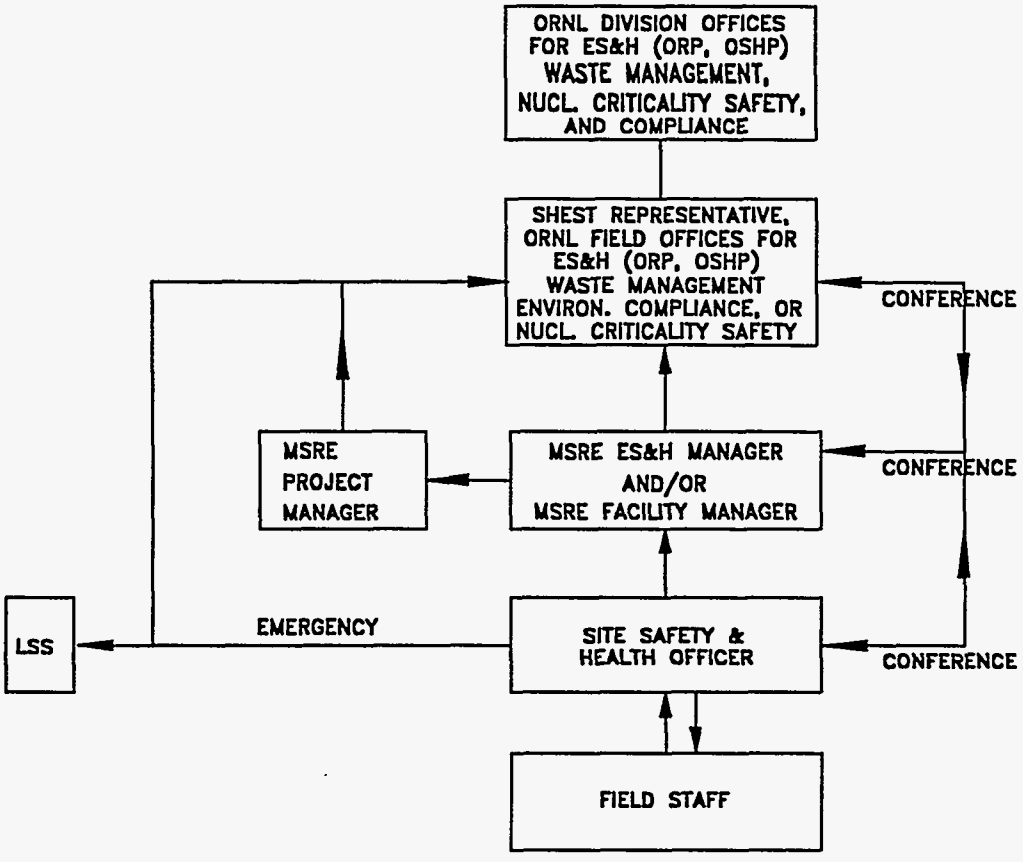

Fig. 3.1. MSRE chain of command for reporting health and safety issues (situation dependent). The SSHO, IH representative, or any task worker first contacts the MSRE ES&H Manager and/or the MSRE Facility Manager. Then, a conference is initiated involving the SSHO, the MSRE ES&H Manager and/or the MSRE Facility Manager, and, if needed, the appropriate disciplines(s): Safety and Health Evaluation and Support Team (SHEST) Representative, Office of Radiation Protection (ORP), Office of Safety and Health Protection (OSHP), Waste Management, Environmental Compliance, or Nuclear Criticality Safety. In an emergency, contact the LSS. For nonemergency situations when neither the MSRE ES&H Manager (or designee) nor the Facility Manager is available, the SSHO should contact the appropriate disciplines(s) directly. The SSHO should contact the LSS when stop work conditions occur due to an unexpected hazard.

3.3.1 Cessation of Work (Stop-Work Authority)

According to MSRE project policy, all employees, contractors, subcontractors, and visitors have stop-work authority. All individuals involved in any aspect of this project will have the authority and responsibility to stop work for any perceived threat to the safety and health of the workers, other personnel, or the environment. A concern must be brought to the attention of the on-site H&S representative(s) or task leader. For health and safety concerns, the respective SSHO, RCT, or OSHP representative will evaluate the situation and, based on results from specific instrumentation to detect hazardous environments or his/her professional judgement, will rectify the situation in question. This correction may be as simple as upgrading PPE or extending zones or as complex as implementing engineering or administrative controls. If the H&S representative cannot resolve the problem, work will be halted until conditions can be corrected. The H&S representative may need to confer with other related experts and personnel working on the task to arrive at a consensus on how to address the concern.

In the case of an emergency situation, anyone can cause a halt to activities and instruct all other site workers to pull back to the designated area or support zone. At such time, the SSHO, RCT, OSHP representative, or task leader will evaluate the situation and notify the ES&H Manager and the Facility Manager and the respective emergency discipline.

The Facility Manager will notify the LSS and the Project Manager. The Facility staff will be responsible for relaying information about any stop-work decision through the chain of command for reporting H&S issues (Fig. 3.1).

For health and safety matters, the ES&H Manager, SSHO, RCT/ORP Coordinator, or OSHP representative is authorized to order the commencement of work activities once the subject of concern has been resolved to the satisfaction of all health and safety personnel consulted and the LSS (if the LSS was involved in the shutdown). However, if an auxiliary organization (e.g., OSHP) orders cessation of work, only that organization can permit resumption of work.

3.3.2 MSRE Environmental Safety and Health Manager

The MSRE ES&H Manager shall be a regular MSRE project employee (not a temporary, part-time, or subcontract employee) responsible for the coordination and oversight of all project environmental safety and health issues. The ES&H Manager shall be responsible for the coordination of all task activities with the Facility Manager, SSHOs, OSHP representative, and other task personnel. The ES&H Manager is required to have fulfilled the training and medical monitoring requirements for Exclusion Zone (EZ) access. Responsibilities of the ES&H Manager may include, but are not limited to, the following:

- Providing/coordinating health and safety oversight for the project's safety-related activities.
- Coordinating industrial hygiene, health physics, and related support activities.
- Identifying known and anticipated hazards associated with the task order.
- Evaluating the impact of the potential hazards on the workers, public, and property.
- Identifying and recommending control measures.

- Supporting facility investigations and characterizations.
- Providing safety briefings for visitors.
- Managing accident investigations.
- Ensuring applicable reporting and record-keeping measures are maintained.
- Establishing project environmental requirements.
- Preparing or concurring on environmental contaminant/hazard characterization, material disposition, and waste management plans.
- Assisting the Project Manager to incorporate environmental requirements into the MSRE baseline, scope, and schedule.
- Conducting project environmental compliance oversight with regulations promulgated under Federal Facilities Compliance Act (FFCA); Resource Conservation and Recovery Act (RCRA); Toxic Substances Control Act (TSCA); Clean Water Act (CWA); CERCLA; Emergency Planning and Community Right-to-Know Act (EPCRA); National Environmental Policy Act (NEPA); Clean Air Act (CAA); the National Emission Standards for Hazardous Air Pollutants (NESHAP); and state equivalent regulations.
- Reviewing relevant documents and requirements from federal and state regulations and identifying requirements that are applicable to the MSRE Remediation Project.
- Ensuring that the MSRE Remediation Project is fully prepared to comply with anticipated regulatory response times and technical/procedural constraints.
- Providing regulatory compliance information to the environmental compliance organization.
- Interfacing with Jacobs Engineering, Tennessee Department of Environment and Conservation (TDEC), U.S. Environmental Protection Agency (EPA), and DOE on environmental issues.
- Fostering a proactive and productive relationship with the regulatory agencies.
- Working with the Project Manager to effect changes to improve compliance practices as needed.
- Assisting the MSRE Remediation Project Team with the appropriate aspects of waste management.
- Participating as a member of the project configuration control board (PCCB).
- Assisting the SSHOs, RCTs, and OSHP representatives in establishing work zones and in selecting the level of PPE required to ensure that all anticipated activities can be safely performed.

- Confirming with the MSRE Training Coordinator that the project is in compliance with the requirements of 29 CFR 1910.1200 for hazard communication training on all hazardous materials brought into the site for use in site operations.

- Developing the TSHASPs in a cooperative effort with the RCT, the Project Manager, the SHEST representative, Nuclear Criticality Safety, and other authorities.

- Approve work packages (after H&S evaluation), open permits, and confer with other H&S disciplines on completion of permits.

3.3.3 Site Safety and Health Officer

The SSHO shall be designated by the ES&H Manager to perform actual task health and safety supervision of all activities deemed to fall under the requirements of the site HAZWOPER program. More than one SSHO may be used during a project if project operations are ongoing at more than one location within the facility. The SSHOs are required to have fulfilled the training requirements and medical monitoring requirements for EZ access, to have a minimum of 2 years health and safety experience through work activities or education, and to have previously performed or been trained as a supervisor for hazardous waste sites. The responsibilities of the SSHO shall include, but are not limited to, the following:

- Overseeing the selection, inspection, storage, and maintenance of personal protective clothing and equipment to be used in conjunction with the RCT.

- Establishing and maintaining work zones to prevent the potential spread of contamination during work and decontamination activities in accordance with the RCT.

- Controlling entry and exit of all personnel and observers into the CRZ and EZ.

- Participating in the preparation and implementation of TSHASPs.

- Conducting periodic inspections (self assessments) to ensure the compliance of all facility entrants with health and safety measures outlined in the PHASP, the TSHASP, and other appropriate documents.

- Confirming each worker's suitability for HAZWOPER work based on a physician's recommendation, HAZWOPER physical (as required), and required training in accordance with 29 CFR 1910.120. Also verifying with the MSRE Training Coordinator that each worker has the appropriate training to perform the tasks.

- Ensuring that any injury or illness related to work performance is reported to the Facility Manager, MSRE ES&H Manager, and, if necessary, medical.

- Ensuring that monitoring of ambient site conditions is conducted for potential chemical and radiological exposures; ensuring that workers are monitored for symptoms of exposure or for conditions related to task hazards, including physical stresses such as temperature extremes, as required.

- Ensuring that pre-entry and daily health and safety briefings are conducted. These briefings include, but are not limited to, subjects such as hazard communications; information concerning

the facility emergency action plan and emergency response actions and responsibilities; and the locations of fire alarms, extinguishers, telephones, and primary and secondary assembly points.

- Conducting S&H briefings if site conditions change.

- Establishing and posting at the work area an emergency action plan, telephone numbers, and appropriate radio communication information.

3.3.4 Radiological Protection Coordinator and the Radiation Control Technician

All health physics monitoring and oversight services shall be provided through the ORNL ORP. RCTs providing support at the MSRE will be provided by, subcontracted through, or approved by the ORP. An ORP Coordinator or RCT with working knowledge of the MSRE will be designated by the ORP to provide on-site support for each task. The responsibilities of the RCT shall include, but are not limited to, the following:

- Reviewing the PHASP and all TSHASPs and WPs prior to mobilization of personnel and equipment and the commencement of project activities and granting written approval of the plan(s) (by signature) on the basis of compliance with 10 CFR 835 and the adequate address of health physics concerns.

- Attending pre-entry and daily health and safety briefings and presenting radiation protection information to all site workers during the briefings.

- Being present during task operations that require HP coverage.

- Monitoring for the detection of elevated rad levels during task activities and assuring that personnel and equipment are surveyed for contamination before leaving Radiological Areas.

- Completing RWPs to the extent possible prior to issuing task WPs for approvals.

- Completing RWPs before the task commences.

- Assuring that equipment leaving the area has been appropriately contained and tagged (i.e., radiation contamination tags) if needed.

- Monitoring and documenting radiological hazards at the site.

- Determining by task the estimated or possible exposure that might be received. For potentially high exposure, completing an as-low-as-reasonably-achievable (ALARA) review in accordance with Radiological Review Requirements listed in RPP-310.

- Implementing and overseeing site operations to ensure that work is conducted in accordance with 10 CFR 835 (*Occupational Radiation Protection)*, ORNL Radiation Protection procedures, MSRE SOPs, and practices applicable to radiation protection.

- Assisting the ES&H Manager, SSHOs, or OSHP representative in the selection of the appropriated PPE and respiratory protective equipment for use during each project task.

- Assisting the ES&H Manager or SSHOs in establishing zones for work project activities.

- Fulfilling responsibilities of SSHO, if needed.
- Meeting requirements of SSHO.

3.3.5 Safety and Health Evaluation and Support Team (SHEST) Representative

The SHEST representative is responsible for reviewing this PHASP for compliance with the requirements of 29 CFR 1910.120. The SHEST representative may also be asked to review and comment on TSHASPs. At his/her discretion, the SHEST representative may provide oversight to the project and consult with the MSRE ES&H team on HAZWOPER-related matters. Responsibilities of the SHEST representative shall include, but are not limited to, the following:

- Reviewing the PHASP and TSHASPs prior to mobilization of personnel and equipment and the commencement of project activities related to 29 CFR 1910.120.
- Assisting the SSHOs or ES&H Manager and the RCT in the selection of PPE and respiratory protection, as needed.
- Recommending approval or disapproval of each SSHO to the ES&H Manager as being able to perform as a SSHO at the site, based upon the requirements listed in Sect. 3.3.3 of this PHASP and the ORNL HAZWOPER Program.
- Determining in special circumstances whether equivalent training status as allowed by 29 CFR 1910.120 can be granted and documenting the same in writing, as detailed in Sect. 5.1.11 of this PHASP. This is done in conjunction with the Center for Continuing Education (CCE).

The OSHP has charged SHEST with the responsibility for the anticipation, identification, evaluation, and control of on-site hazards associated with construction activities and service subcontractors. SHEST is integrated into the project planning during engineering design and provides initial project-specific environmental, safety, and health requirements. As part of the site characterization, SHEST coordinates sampling of suspect materials likely to be involved in project activities. SHEST reviews the Division I (environmental health and safety sections) of the project design specifications and signs acceptance prior to the bid process. After a project has completed the bid process, SHEST, and MSRE ES&H representatives are responsible for review and approval of contractor project documentation including, but not limited to, the site HASP, safety and health program, project-specific hazard analysis, critical lift plan (as applicable), hoisting and rigging plan (as applicable), and operator certifications for construction activities. Thereafter, SHEST provides project oversight and support throughout the project work activities including changes incurred with additions/deletions of work scope and/or site conditions. Figure 3.2 illustrates contractor routing for MSRE and how this process interfaces with MSRE health and safety personnel.

3.3.6 Office of Safety and Health Protection

The OSHP at ORNL shall be responsible for consulting and advising on non-HAZWOPER tasks with respect to industrial hygiene and industrial safety concerns. Facility activities will be conducted in accordance with ORNL procedures; therefore, OSHP may be called upon to perform site assessments or personnel monitoring of ORNL employees [dependent on work project activities (e.g., confined space entry)]. In addition, OSHP may be required to assist the SSHOs or ES&H Manager and the RCTs in the selection of appropriate PPE and respiratory protection.

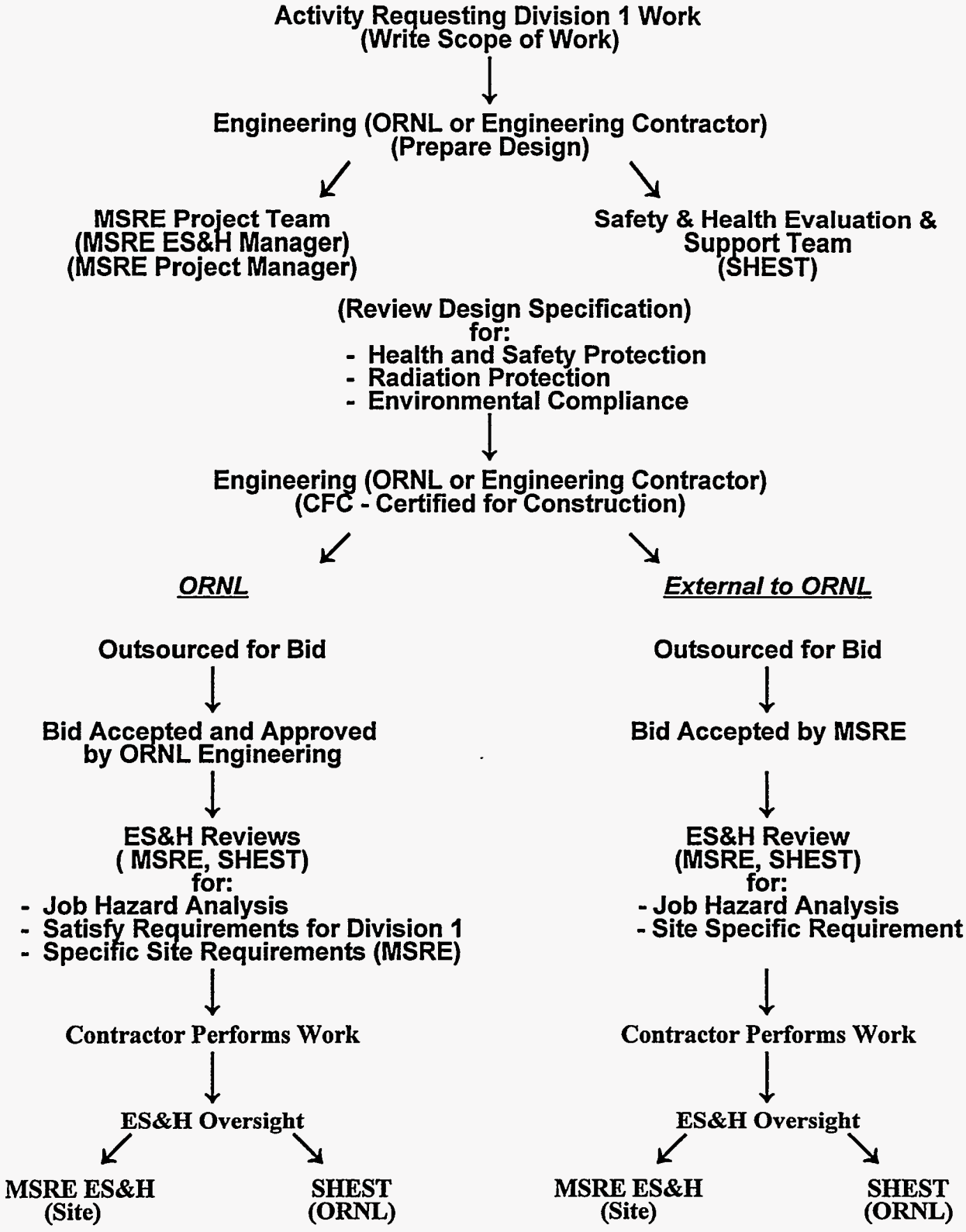

Fig. 3.2. Contractor routing for MSRE.

3.3.7 Task Personnel

The responsibilities of all personnel involved in task operations include, but are not limited to, the following:

- Taking all reasonable precautions to prevent injury to themselves and their fellow employees; using *all of their senses* and information collected from monitoring instruments to alert them of potentially harmful situations.

- Performing only those tasks that they believe can be done safely, and immediately reporting any accidents and/or unsafe conditions to the task leader or P&E supervisor, SSHO, ES&H Manager and, for radiological concerns, the RCT.

- Notifying the SSHOs of any existing medical conditions (e.g., allergies, diabetes) that require special consideration. ORNL Health Division approval and/or a physician's recommendation may be required before an individual with a medical condition may be assigned specific tasks.

- Avoiding unnecessary or deliberate contact with any potentially contaminated substances (i.e., walking through pools) and avoiding unnecessary placement of equipment and tools on potentially or suspected contaminated surfaces.

- Avoiding the transfer of contaminated materials or equipment.

- Being familiar with the physical characteristics of the site, including

  — Locations of available fire alarm boxes, fire extinguishers, telephones, and assembly points;

  — Areas of known or suspected contaminations or "hot zones;"

  — Facility access requirements; and

  — Nearest facility resources (e.g., rest rooms and break rooms).

- Maintaining for proper disposal all wastes generated during project operations.

- Reporting all injuries, regardless how minor, to the task leader or P&E supervisor, ES&H Manager, and SSHO.

- Reporting in person to the ORNL Health Division when any illness or injury related to work activities is incurred. (The ES&H Manager or SSHO must be notified.)

- Abiding by a buddy system, with each worker being responsible for keeping track of his or her partner in the event of an incident or emergency situation.

- Reporting to the RCT for frisking prior to egress from the CRZ or EZ as directed by the SSHOs or RCT.

- Becoming familiar with the procedures required by the WP and TSHASP.

- Conducting all tasks in accordance with the WP, TSHASP, RWP, and SWP for each task, as required.

- Reporting to the ES&H Manager or SSHO, the RCT, or their direct supervisor any information regarding facility operations or conditions that may have an impact on the health and safety of the project. The worker has the right to bring work to a halt and inform the proper representatives when he/she feels conditions warrant attention.

- Completing all training required to work at the MSRE facility and to perform varied tasks in many different locations and areas.

4. PROJECT HAZARD ANALYSIS

The MSRE program consist of four phases of remediation: (1) interim corrective measures, (2) reactive gas removal (RGR), (3) uranium deposit removal, and (4) disposition of the fuel and the fuel salts. Each phase will consist of numerous tasks or work efforts. As described in Sect. 2.1, each of these tasks will have a task-specific WP containing either (1) an RWP and a HAZWOPER TSHASP (for tasks that fall under the direction of 29 CFR 1910.120), (2) an RWP and a SWP (for tasks that do not fall under the direction of 29 CFR 1910.120), or (3) work instructions. All versions of the WP will contain a scope of work, required permits, and any generated SOPs for the task. All the expected hazards and their controls will be identified in the specific WP.

An overall description of the major efforts for each phase of the MSRE program is presented in this section along with related health and safety concerns and controls. Additional task-related hazards and controls specific to a particular effort will be covered in the task-specific WPs.

4.1 INTERIM CORRECTIVE MEASURES

The interim corrective measures phase of the project has been completed. This phase of the project included those areas and tasks that were needed to

1. investigate and mitigate the immediate safety concerns related to the possibility of a nuclear criticality accident,
2. partition or isolate the route of UF_6 off-gas through the piping system, and
3. install new pressure transducers in the piping system to obtain a more accurate measurement of gas pressure within the system and to monitor for any subsequent pressure build-up.

Since the MSRE was a liquid fuel reactor, gases were among the byproducts of the chemical/nuclear reactions. At one step in the production of energy, the reactive gases were contained on charcoal traps located in a series of pipes in the charcoal bed cell (Fig. 4.1, area No. 1). During energy production, the charcoal bed cell proper was filled with water. The water served to absorb any heat that was given off through the pipe walls as a byproduct of the fission reaction process. If a breach in integrity of the pipe walls allowed contact with the surrounding water remaining in the charcoal bed cell, potential for a nuclear criticality accident would exist. As part of the interim corrective measures, the water from around the charcoal filled cylinders was drained to eliminate this concern. Thus, the criticality issue from surrounding water has been resolved. This effort was accomplished in the fall of 1994. Also, in early 1994, samples taken from the off-gas system indicated the migration of UF_6. This information resulted in the initiation of a more intensive monitoring effort and tracking of system pressure.

The MSRE piping system that originates at the three fuel storage tanks and eventually terminates in the charcoal bed cell was partitioned. A segment of this system with a "T" configuration separates off and runs through a sample enricher device (Fig. 4.1, area No. 2). This was the best and safest location to segregate the system. Existing valves were closed and a purge and trapping mechanism was added to control a pressure build-up in the system, if one should occur.

Old, unreliable pressure transducers were replaced so that pressure(s) within the system could be monitored more adequately. Four pressure transducers were installed throughout the piping complex. Three transducers, one for each storage tank, were affixed to existing lines originating from

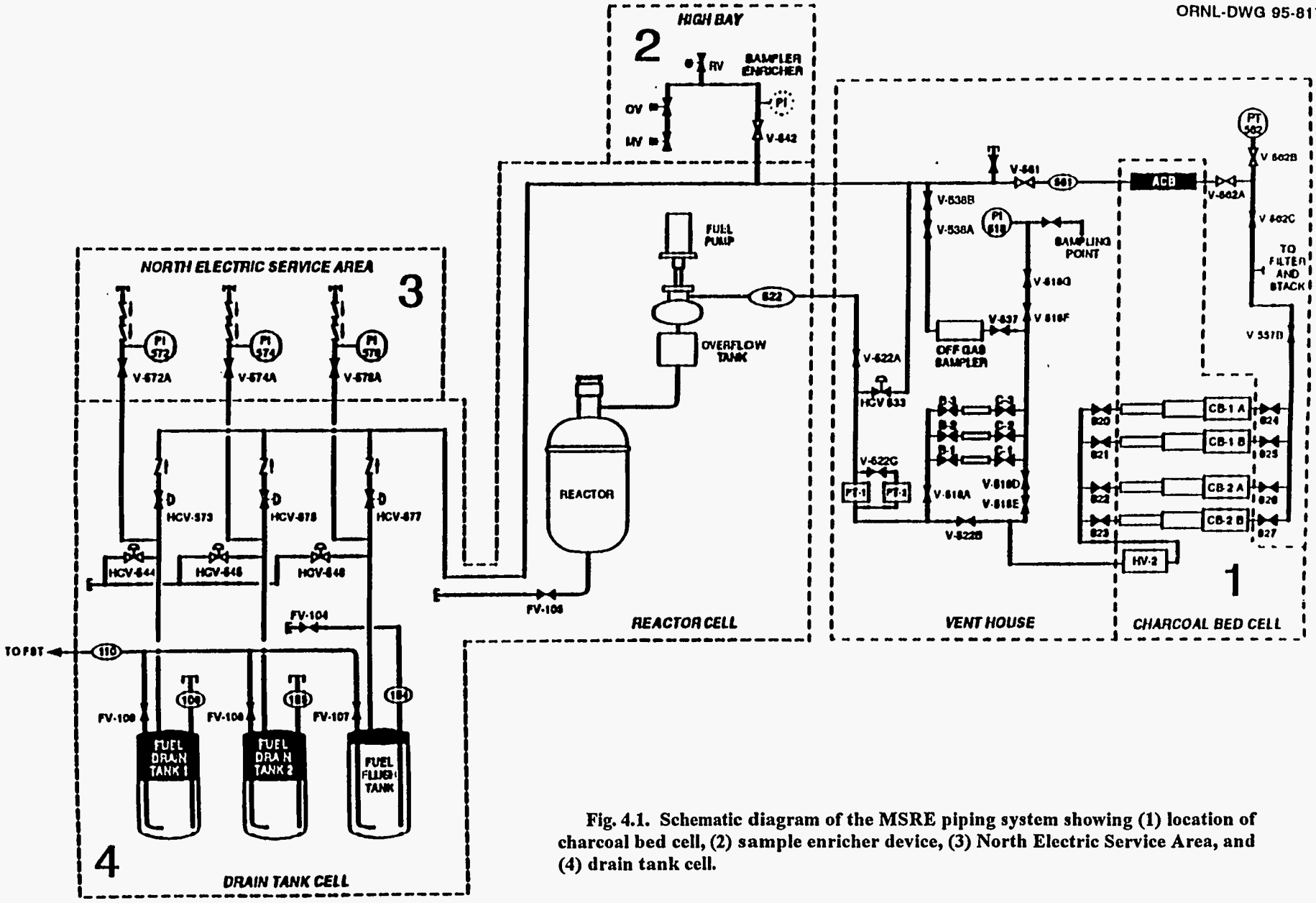

Fig. 4.1. Schematic diagram of the MSRE piping system showing (1) location of charcoal bed cell, (2) sample enricher device, (3) North Electric Service Area, and (4) drain tank cell.

each tank. These lines were accessed in the North Electrical Service Area (Fig. 4.1, area No. 3). With these transducers installed, accurate pressure data can be obtained.

Other surveillance and maintenance activities that prepared the facility for removal activities were also contained in the interim corrective measures phase of the project.

4.1.1 Health and Safety Concerns

Health and safety concerns associated with these efforts were numerous including physical hazards such as limited space, electrical hazards, illumination concerns, and tripping and falling. Other concerns included exposure to lead, asbestos, temperature extremes, CO_2, UF_6, and other radionuclides.

4.1.2 Controls

Administrative and/or engineering controls were established for each task during the interim corrective measures phase of the project. Examples of controls that were instituted include enclosures, training and simulated mock-ups, permits and plans, and PPE.

4.2 REACTIVE GAS REMOVAL

It is now speculated that over 25% of the uranium stored in the storage drain tanks has been converted to UF_6 and has migrated throughout the MSRE system. Also, fluorine has been released from the salts to form F_2, which is present throughout the lines. A purge and trapping system is in place for the separation and collection of uranium and fluorine and other gases. (This operation will take place in area No. 2, Fig. 4.1.) A shielded cylinder filled with sodium fluoride (NaF) and one filled with alumina serve as chemical traps for the gases. These cylinders are attached to the process lines, valved, and equipped with disconnects for the exchanging of unloaded cylinders. The other end of the piping system is capped. Due to the possibility of exposure, a sealed glove box with a constant vacuum, maintained through HEPA filters, is in place over the fittings for the collection cylinders. Technicians access the valves in the glove box and disconnect and reattach new cylinders through glove ports. When the cylinders are saturated, the valves are closed and the cylinders disconnected, capped, and lowered through an opening in the bottom of the glove box into an individual stainless cask. The cylinders are transported to the Radiochemical Development Facility (RDF), Building 3019, for storage and future processing of the products.

4.2.1 Health and Safety Concerns

Nuclear criticality safety and safety and health considerations associated with the reactive gas removal efforts include possible exposure to UF_6, uranium, fluorine, and chlorine trifluoride; pressure hazards; and possible temperature extremes.

4.2.2 Controls

Administrative and engineering controls are in place to ensure the safe completion of these tasks. Examples of controls include glove box enclosures, ventilation systems, glove-in/glove-out techniques, special fittings for attaching the appropriate trapping vessels, stainless casks for transportation, and various plans and permits.

4.3 URANIUM DEPOSIT REMOVAL

The third phase of remediation involves removal of the remaining UF_6 gas located throughout the system and removal of accumulated uranium deposit contained within the charcoal-filled pipes within the auxiliary charcoal bed (ACB) (Fig. 4.1, area No. 1). The ACB, which contains the uranium, is located within the charcoal bed cell, outside the MSRE facility. Through gamma scanning, the extent of uranium will be determined within each of the charcoal bed cell pipes. A structure will be constructed for use as a ventilated containment enclosure. The structure will be outfitted with lighting, cameras, and a HEPA filtration/ventilation system. A large steel plate with an access opening will be positioned over the top of the ACB. A mobile manipulator with two mounted cameras will be remotely guided into place. A robotics device will be guided alongside the ACB. A "hot tap" has been utilized to puncture the charcoal-filled cylinder just below the uranium deposit. A vacuuming device will be attached to this opening and sealed with "O" rings to prevent any release of gases or other material to the environment. The uranium-laden charcoal will be vacuumed into specially designed collection vessels. These containers will be removed to another facility for repackaging before transport to Building 3019 for storage and future extraction.

4.3.1 Health and Safety Concerns

The major health and safety and nuclear criticality safety concerns for this phase of the project are radiological. High levels of radioactivity are expected to be encountered when the deposit-removal activity begins. The actual removal effort will be conducted robotically. Personal H&S issues may come into effect if decontamination of the facility is required.

4.3.2 Controls

This work will all be conducted remotely. Remotely operated machinery will be utilized to breach the system and will be controlled from a control room a safe distance away. A containment enclosure will house the robotics manipulator and will provide protection for site personnel, as well as protecting the environment.

4.4 FUEL SALT REMOVAL

The removal of the fuel salts from the fuel drain tanks (Fig. 4.1, area No. 4) and throughout the system will be considered. The salts and associated fuel constituents that were used in the operations of the MSRE are LiF, BeF_2, ZrF_4, PuF_3, and UF_4. These components must be taken into account during all phases of the MSRE project, not just during the fuel salt removal phase. Some strategies for dispensing with the fuel salts include vacuuming, heating the salts up to a high temperature and extracting, securing in a less harmful form, or simply leaving in place for future considerations.

4.4.1 Health and Safety Concerns

Health and safety concerns with this phase of the project should be limited. Like the uranium deposit removal phase, nuclear criticality safety/radiological exposure concerns will be of greatest importance.

4.4.2 Controls

The actual extraction techniques have not been developed at this time. Based on the results of the uranium deposit removal phase, much of the same technology applied for that effort may be utilized for this phase of the project.

4.5 POTENTIAL SITE PHYSICAL HAZARDS

4.5.1 Noise

Hazards. The operation of large or heavy equipment such as machinery can create areas where noise levels exceed 85 decibels on the A-weighted scale (dBA). Exposure to excessive noise levels may lead to temporary or permanent hearing loss.

Controls. Hearing protection shall be worn by task personnel where noise levels are suspected or shown by noise level meter monitoring to exceed 85 dBA. In the event that a new noise hazard, such as a new piece of equipment, is brought on-site, the SSHO or OSHP representative will test the equipment or area for possible hazards. Areas where noise levels are greater than 85 dBA will be posted as "Noise Hazard Areas—Hearing Protection Required." Work supervisors or task leaders will ensure compliance with posted warnings.

4.5.2 Eye Protection

Hazards. The eye may be the organ most vulnerable to occupational injuries. Demands placed on the eyes such as prolonged viewing can cause fatigue to the eyes and possible injury as a result of this fatigue. The eye is susceptible to hazardous chemical burns from vapors, splash injuries, and flying objects from grinding/milling operations. The eye is subject to physical cuts, abrasions to the cornea, and blunt blows to the eye itself, which can cause an increase in intraocular pressure. Proper eye protection is essential to the well being of sight and the general mental state of the individual. All employees at MSRE should be cognizant of eye safety and use PPE when it is needed.

Controls. If an employee gets a small particle in the eye or a chemical splash or vapor burn to the eye(s), he/she should first try to cleanse the eye with water. Irrigate the eye at a nearby eye wash station for at least 15 minutes; then seek medical attention. The eye wash station at MSRE is treated with a chemical to prevent the growth of acanthamoebae. The station is tested monthly and is sent for pressure testing yearly.

Eye protection should match the hazard the worker is being asked to perform. Protection from excessive light rays (welding operations, laser use, general ultraviolet radiation) might require goggles, protection from chemicals might require glasses with side shields or a full face shield, and protection from scratches or debris might require clear shock-resistant lenses. All eye protection for occupational use must meet or exceed ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection.* This regulation specifies that all lenses must be at least 3 mm thick and capable of withstanding a specific impact from a known source.

Eye protection requirements will be evaluated on a task-by-task basis. The task to be performed will determine the type of eye protection needed to adequately protect the workers. The MSRE H&S

representatives will determine the specific protection and make recommendations. The specified eyewear will be documented in the work instructions, safety work permit, or the TSHASP.

4.5.3 Site Working Conditions

Hazards. Due to the nature of the site and the fact that the work will take place both within the facility and outdoors, there will be a large number of physical hazards primarily because of varying working conditions. These hazards may include, but are not limited to, work on elevated surfaces; debris generating activities (e.g., cutting, grinding); ergonomics (e.g., lifting/moving heavy objects); proximity to sharp edges (e.g., sheet metal); irregular walking/working surfaces; limited work space (e.g., low overheads; protrusions of piping, wiring, etc. into walking/working areas); and personnel encounters with objects and conditions that may cause slips, trips, falls, or cuts.

Controls. Personnel should be aware of task hazards and site conditions. PPE and other hazard controls for task/site operations will be evaluated on a task-specific basis. For most activities, minimum PPE will include safety glasses with side shields or goggles, work clothing, gloves, and hard-toed footwear. Task-specific administrative and/or engineering controls will be utilized whenever feasible to reduce hazards associated with a task (e.g., pre-job briefing, fall restraint/protection).

4.5.4 Overhead Power Lines

Hazards. Overhead power lines pose a hazard for the operation of equipment when there is the possibility of contact.

Controls. A 10-ft minimum clearance shall be maintained from all lines 110 volts or greater. The 10-ft distance can increase as line voltage increases (e.g., 10 ft plus 0.4 in. for each 1 kV over 50 kV). If the appropriate clearance cannot be maintained, other options shall be considered such as de-energizing and grounding the power lines.

4.5.5 Electrical Hazards

Due to restarting systems and equipment that have been in shutdown mode for the past 40 years, numerous electrical hazards may exist throughout the MSRE facility. Electricians working at the facility routinely work with currents of 120V, 208V, and 480V. They are not exposed to electrical currents equal to or greater than 600V. Personnel should always remain cognizant of the potential for electrocution or shock when conducting any activities. Common electrical hazards include old frayed power/electrical lines, overhead power lines (see Sect. 4.5.4), transformers, circuit boxes, electrical generators, and lightning. Other electrical hazards associated with MSRE activities may include undetected live wires and deteriorating wiring insulation.

Hazards. Additional electrical hazards may include, but are not limited to, the following:

- power outage or loss of power;
- standing water or puddles in the immediate area where work operations and power sources exist;
- conducting outside activities during electrical storms;

- operating booms, masts, or cranes within a 10-ft radius of overhead power lines;
- excavating in the immediate area of underground power lines;
- improper selection of tools for a work effort located near electrical power sources (tools should be nonconductive and/or grounded).

Controls. Various controls may be implemented in order to decrease or eliminate electrical hazards to personnel. Some control measures to consider are

- consulting blue prints, drawings, site maps, and/or penetration permits to locate potential power sources (underground power lines, overhead power lines, conduits, etc.) and performing an area walkover prior to commencing work activities;
- implementing lock-out/tag-out procedures or ground-fault-circuit interrupters prior to commencing work activities;
- assuring that all equipment that poses an electrical hazard is equipped with a ground-fault-circuit interrupter;
- recognizing hazardous work conditions (puddles or standing water) prior to commencing work activities;
- properly using PPE (rubber boots, gloves, etc.) as indicated in the TSHASP;
- ceasing outdoor activities prior to severe weather conditions (thunderstorms/lightning storms);
- utilizing nonconducting materials and tools when working in the vicinity of electrical power sources or equipment.

4.5.6 Temperature Extremes

Heat Stress. Working in protective clothing can greatly increase the likelihood of heat fatigue, heat exhaustion, and heat stroke, the latter being a life-threatening condition. If employees are dressed out in protective clothing and temperatures at the work site are above 80° F, the wet bulb globe thermometer (WBGT) may be monitored to assess the potential for heat stress. Sufficient cool water is available at drinking fountains located throughout the MSRE facility. The SSHO will be responsible for briefing workers on the signs of heat stress when temperature conditions require it. This may be done during the daily S&H briefing. Work/rest schedules will be implemented, when necessary, within the guidelines of the American Conference of Governmental Industrial Hygienists WBGT Threshold Limit Values and the National Institute for Occupational Safety and Health (NIOSH 1986).

Heat stress will be addressed on a day-by-day basis due to changing weather patterns. When a potential heat stress situation is encountered, various factors such as humidity, air movement, and physical condition and acclimation of task personnel will be evaluated.

- **Heat Exhaustion**

  — **Symptoms:** Extreme fatigue, cramps, dizziness, headache, nausea, profuse sweating, pale clammy skin, core body temperature >38°C (100.4°F).

  — **Treatment:** Immediately remove victim from the work area. Allow victim to rest, cool off, and drink plenty of cool water. If the symptoms do not subside after a reasonable rest period, employees shall notify the SSHO and seek medical assistance.

- **Heat Stroke**

  — **Symptoms:** Body temperatures often are between 107-110°F. Initial symptoms often include headache, dizziness, nausea, oppression, and dryness of the skin and mouth. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly.

  — **Treatment:** Immediately evacuate the victim to a cool and shady area. Remove all outer clothing and lay the victim on his or her back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels to the head. Sponge off the bare skin with cool water. Seek medical attention immediately.

Cold Stress. The MSRE facility is heated with steam heat. Steam is supplied from the main plant through a 6-in. mainline to a reducing valve station on the east side of the building. The ORNL P&E Department performs repairs and modifications to the steam lines. However, facility maintenance, excavation activities, and various other activities may be conducted outside or in unheated parts of the facility during cold weather. Such activities may present hypothermia and/or frostbite hazards. Any time work is being performed under these conditions the situation will be addressed during the daily H&S briefing. If considered necessary, a work/rest schedule will be implemented to provide workers the opportunity to recover in a heated environment in order to minimize the hazards due to cold.

The body gains heat through muscle activity and food and loses heat through respiration and sweating. During cold temperatures the body's first physiological defense is to conserve heat through constriction of blood vessels of the skin and by shivering (shivering increases muscle activity). Cold first affects the skin by cooling the surface blood in the skin capillaries. This cooled blood reaches the brain and affects the hypothalamus, which regulates the body temperature. The body responds by shivering, using energy and causing muscle fatigue. Exhaustion sets in and serious injuries and disorders can result from the cold. Heat loss from convection (the passing of cold air over the body) is probably the greatest and most deceptive factor in the loss of body heat. The windchill index is utilized to predict the cooling effect on the body from the environmental temperature and wind velocity. The windchill index is just a tool to help predict the impact the cold can have on a person when working outside. Refer to the windchill index chart in the American Conference of Governmental Industrial Hygienists (ACGIH) Handbook when recommending workload and duration of exposures.

4.5.7 Confined Space Entry

A confined space is defined as a space that (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (i.e., the entrant is required to contort the body or use the hands as an aid to entry or exit of the space); and (3) is not designed for continuous employee occupancy.

A permit-required confined space (permit space) is defined as a confined space that has one or more of the following characteristics: (1) contains or has a potential to contain a hazardous atmosphere; (2) contains a material that has the potential for engulfing an entrant; (3) has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; or (4) contains any other recognized serious safety or health hazard.

If confined space entry is necessary during MSRE operations, the requirements of 29 CFR 1910.146 shall be fulfilled. The provisions and requirements of the OSHP procedures for confined space entry shall also be followed. A representative from OSHP shall be contacted prior to any confined space entry, and OSHP shall conduct all required atmospheric testing in accordance with established ORNL procedures and MSRE requirements. In some areas within the MSRE complex, monitoring for CO_2 is required prior to entering a confined space. The OSHP representative, SSHO, ES&H Manager, or the Facility Manager must be consulted prior to entering a suspect area.

4.6 POTENTIAL SITE CHEMICAL HAZARDS

Many chemical hazards with various origins or functions (e.g., acids, solvents, herbicides, pesticides, sensitizers, toxic agents, process contaminants, chemicals used in facility and task operations) may be present at the MSRE facility. No regulated substance is stored or used at the facility in quantities in excess of its threshold quantity, and no known reproductive toxin such as a teratogen or mutagen is present at the facility. Chemicals that have been identified at the MSRE facility as known or suspected site contaminants are listed in Table 4.1. The table also contains physical and chemical properties, toxicity, health effects, and symptoms of exposure. Specific action levels and guidelines for site chemicals will be addressed in the TSHASP.

The potential for possible chemical contamination will be assessed by a review of the site characterization information and anticipated work activities by the SSHO. A detailed evaluation of the chemical contamination present at each task will be included in the TSHASP. Chemical hazards will be minimized through the use of engineering and work-practice controls, as mandated by the SSHO. Details of control methods to be used in site operations to reduce the potential for personnel exposure shall be included in the TSHASP or WP.

Threshold Limit Values (TLVs) are established by ACGIH. These are professional recommendations rather than legal standards. TLVs refer to airborne concentrations of substances that a worker can be exposed to for an 8-hour period. TLVs are designed to be used by individuals trained in industrial hygiene/industrial safety.

Material Safety Data Sheets (MSDSs) for any chemicals brought on-site for site operations must be provided by the manufacturer prior to the start of field activities. Some MSDSs may be obtained through the ORNL MSDS Database System. The MSDSs shall be available on-site during all operations.

Table 4.1. Characteristics of suspected chemical contaminants at the MSRE

Contaminant	TLV/PEL[a]	STEL/ IDLH[b]	Target organs/ miscellaneous information[c]	Signs and symptoms	Physical and chemical properties
Ammonia (NH_3)	PEL: 35 ppm; TLV-TWA: 25 ppm	STEL: 35 ppm; IDLH: 500 ppm	Lungs, eyes, skin; inhalation can result in acute respiratory system damage at concentrations of 1000 ppm; contact can cause severe eye irritation and chemical burns	Irritation and tearing of eyes, coughing, difficulty breathing, headache and nausea	Colorless gas with sharp, strong odor readily detectable at 20 ppm
Ammonium fluoride (NH_4F)	TLV/PEL: 2.5 mg(F)/m^3	Not listed	Airway, lungs, skin, eyes; extremely destructive to tissue of mucous membranes and upper respiratory tract, eyes, and skin; inhalation may be fatal	Burning sensation, coughing, wheezing, shortness of breath, laryngitis, headache, nausea and vomiting	White crystalline solid
Beryllium fluoride	TLV: 0.002 mg/m^3 (Be), 2.5 mg/m^3 (F)	STEL: 0.005 mg/m^3 (30 min)	Skin, mouth, stomach, eyes, respiratory system; suspect human carcinogen	Irritation to mouth, eyes, lungs	Amorphous, colorless to grey pieces; odor not known
Carbon dioxide (CO_2)	TLV/PEL: 5,000 ppm	STEL: 30,000 ppm; IDLH: 50,000 ppm	Lungs, skin, cardiovascular system; inhalation of high concentrations may be fatal	Increased breathing rate, headache, dizziness, shortness of breath	Colorless and odorless gas (can be solid or liquid)
Cesium fluoride	PEL: 2.5 mg/m^3 (F); TLV: same	Not listed	Respiratory system, skin, eyes; destructive to tissue of mucous membranes, upper respiratory tract, eyes, and skin; inhalation may be fatal	Corrosive; causes burns to skin, eyes, upper respiratory tract	White, chunky powder
Chlorine trifluoride (ClF_3)	TLV/PEL: 0.1 ppm	IDLH: 20 ppm	Airway, lungs, skin, eyes; corrosive and extremely irritating, chemical pneumonitis and pulmonary edema are possible and may be fatal	Coughing, wheezing, respiratory distress; irritation of nose, throat, mouth; burning and tearing of eyes	Greenish yellow, almost colorless liquid or gas, with sweet irritating odor

Table 4.1 (continued)

Contaminant	TLV/PEL[a]	STEL/ IDLH[b]	Target organs/ miscellaneous information[c]	Signs and symptoms	Physical and chemical properties
Fluorine (F_2)	PEL: 0.1 ppm; TLV: 1 ppm	IDLH: 25 ppm; STEL: 2 ppm	Upper and lower respiratory system, eyes, skin	Irritating to eyes and respiratory tract; can cause thermal burns to skin	Pale yellow gas; sharp pungent, irritating odor; odor normally detectable below 1 ppm; reacts violently in water
Hydrofluoric acid	PEL: 2.6 mg/m^3 (F); TLV: 2.6 mg/m^3 (F)	STEL: 5.2 mg/m^3 (F)	Nose, throat, respiratory system, stomach, eyes, skin	Severe burns to exposed areas of skin, eyes, respiratory tract	Colorless liquid; fumes in air; sharp, pungent odor
Lead (dust or fumes)	PEL: 50 $\mu g/m^3$ for 8 hours		GI tract, CNS, kidney, blood, mucous membranes	Weakness, gingival lead line around teeth, abdominal pain, irritation of eyes	Soft, grey solid
Lithium fluoride	TLV: 2.5 mg/m^3 (F)	Not listed	Eyes, respiratory system, skin	Irritation to eyes, skin, mucous membranes, upper respiratory tract	White, crystalline chunks
Thallium	TEL/PEL: 0.1 mg/m^3 (skin)	15 mg/m^3	Skin, eyes, CNS, lungs, liver, kidneys, GI tract, body hair	Absorbed through skin	Appearance and odor vary depending upon the specific soluble compound; properties vary accordingly
Uranium hexafluoride (UF_6)	TLV: 0.2 mg/m^3 (U); TLV: 2.5 mg/m^3 (fluorides)	Not listed	Respiratory tract, kidneys, skin, eyes, digestive tract	Severe burns to respiratory tract, GI tract, eyes	Solid, white, deliquescent solid; sharp, penetrating odor associated with hydrofluoric acid; poison
Uranium powder	PEL: 0.2 mg/m^3; TLV 0.2 mg/m^3	STEL: 0.6 mg/m^3	Liver, kidneys, skin, eyes, respiratory tract	Irritation to eyes and skin	Silvery-white powder; odorless
Uranium tetrafluoride (UF_4)	TLV: 0.2 mg/m^3	IDLH: 30 mg/m^3	Lungs, kidneys, GI tract, hemopoietic system	Acute symptoms: dermatitis, moderately severe injury to the eyes	Monoclinic, green crystals
Zirconium tetrafluoride	TLV: 2.5 mg/m^3 (F); 5 mg/m^3 (Zr)		Upper respiratory tract, mucous membranes, eyes, skin	Burning sensation, coughing, wheezing, shortness of breath, headache, nausea, vomiting	White powder
Zinc bromide solution	NE	NE	Skin, eyes, nose, throat	Ingestion causes burns to mouth and stomach	In solution at MSRE

Table 4.1 (continued)

Contaminant	TLV/PEL[a]	STEL/ IDLH[b]	Target organs/ miscellaneous information[c]	Signs and symptoms	Physical and chemical properties
Zinc fluoride (in solution form)	2.5 mg/m^3 (F)	NE	Skin, respiratory tract, GI tract	Severe irritation to skin, respiratory tract, GI tract	In solution at MSRE

[a]TLV - Threshold limit value, TWA - Time-weighted average, PEL - Permissible exposure limit, TEL - Total exposure limit, NE - not established. Values given in this column are continually updated as new information becomes available. Consult current literature before establishing site action levels.

[b]STEL - Short-term exposure limit, IDLH - Immediately dangerous to life and health, NE - not established. Values given in this column are continually updated as new information becomes available. Consult current literature before establishing site action levels.

[c]CNS - Central nervous system, GI - gastrointestinal tract.

Source: ACGIH 1995, NIOSH 1994, MSDS sheets, and MSRE historical information.

4.6.1 Lead

The status of lead as an occupational hazard has changed in recent years. The International Agency for Research on Cancer (IARC) has determined from animal studies that there were sufficient data to indicate lead as an animal carcinogen and that there were sufficient inconclusive data to state that lead was a contributor as a human carcinogen. Lead is now considered a carcinogen, and both TLV and OSHA PELS have changed to reflect these studies.

Lead was used extensively throughout the MSRE facility for shielding. Instrument panels, compartments, vaults, and areas around highly contaminated vessels and piping were lined with lead bricks. As part of the ORNL OSHP Lead Program, a Lead Plan must be completed and approved by the Lead Program Coordinator prior to any extensive lead removal. This plan will describe what condition the lead is in, how the lead will be removed, and what expected dust or fumes will be generated during this process. Required PPE and individual training will also be addressed. MSRE will utilize trained dedicated individuals from the Lead Worker Program for large lead remediation activities.

4.6.2 Cryogens

Cryogens (extremely cold liquids) such as liquid nitrogen are used to supercool lines and chemicals to achieve a desired effect. Many operations at MSRE, and in the research laboratory (in Building 4500S) supporting MSRE research activity, utilize cryogens to reduce temperatures for experimental purposes. When such chemicals are used, extreme caution must be exercised to avoid burning or freezing of human tissue. Proper gloves and face shields shall be worn when handling these chemicals. To avoid spills and/or misuse of containers, all containers, tanks, and transporting vessels must be labeled as extremely cold hazards.

4.6.3 Fluorine

One of the major contaminants during all MSRE remediation efforts will be fluorine. Fluorinated beryllium, lithium, and zirconium were the salts involved in the matrix that transported the uranium through the reactor. When the system was placed in shutdown, the fuel salt was drained

in approximately equal volumes into the fuel drain tanks and the flush salt was drained into the flush salt tank. The fuel and flush salts were allowed to cool and solidify in the tanks. The presence of the numerous radioactive fission products in the fuel salt mixture resulted in the release of halogen gas through the process of radiolysis. In the drain tanks, the release of fluorine gas and subsequent increasing buildup of pressure was a concern. Uranium fluoride gas and fluorine migrated throughout the MSRE off-gas piping system. Uranium tetrafluoride was able to find its way into the ACB through a broken boundary valve. (This valve was closed in 1995.) The ACB is filled with charcoal and was used to filter the noble gases during the operation of MSRE. The detection of UF_6 in the ACB was a serious concern. The properties of carbon and fluorine gas are incompatible and, under proper conditions, could lead to a deflagration. Measures are being taken to alleviate the potential of a deflagration, but the deposit of uranium remains and is the target of the second phase of the project, Uranium Deposit Removal.

Exposures to fluorine during any phase of the project could be caused by a leak or rupture of a primary containment line, a deflagration that releases fluorine gas into the environment, or human error. Fluorine is the most reactive nonmetal. It will react vigorously with most oxidizable substances at room temperature and reacts rapidly with water to produce ozone and hydrofluoric acid.

Fluorine gas is a severe eye, mucous membrane, and skin irritant. It is corrosive and extremely irritating to the upper and lower respiratory tract. Contact to the eyes will be irritating and can cause blindness. Skin contact will result in dermal burns.

4.6.4 Hydrogen Fluoride

Hydrogen fluoride is a gas that becomes a liquid at lower temperatures. It could be generated at the MSRE facility by the interaction of fluorine gas and air. Hydrogen fluoride is very soluble in water and most organic compounds. Workplace exposures to HF occur primarily via the respiratory tract. Redness of the skin and some burning and irritation of the nose and eyes occurs at concentrations ≥3 ppm.

4.6.5 Chlorine Trifluoride

Chlorine trifluoride is one of the most reactive components of the class of compounds known as halogen fluorides. With the exception of fluorine, chlorine trifluoride may be one of the most reactive chemicals known. Chlorine trifluoride is a nearly colorless gas with an irritating odor similar to chlorine or mustard and with an extremely low odor threshold (~35 ppb). Chlorine trifluoride is thermally stable and nonflammable, but it is hypergolic and will initiate the combustion of many materials with which it comes in contact.

Reactions with chlorine trifluoride are extremely difficult to control and usually lead to a wide variety of reaction products. Chlorine trifluoride is used in the reclamation of uranium from irradiated fuels. This is accomplished by reacting the fuel with ClF_3 forming the corresponding fluorides. The gaseous uranium hexafluoride is then recovered by distillation.

From the beginning of Reactive Gas Removal, it became apparent that the MSRE off-gas piping system was blocked in several places by nonvolatile plugs. It is believed that these plugs consist of UO_2F_2 (or related compounds such as UOF_4) created by hydrolysis of UF_6 by inleaking moisture, or UF_5 (or related compounds such as UF_3 or UF_4) formed by radiolysis of solid UF_6. To remove

the plugs it is desirable to dissolve the deposit by converting the plugs to a gaseous form, UF_6. This will be accomplished with the addition of chlorine trifluoride into the MSRE off-gas piping via the Reactive Gas Removal System.

4.7 POTENTIAL SITE RADIOLOGICAL HAZARDS

Radiological conditions will be assessed by a review of site characterization information and anticipated work activities by the RCT. On-site contamination/radiation monitoring will be performed by the RCT or an approved representative. A detailed evaluation of the radiological conditions present during each task will be included in the TSHASP or the RWP. Radiological hazards will be minimized to ALARA levels by the use of time, distance, and shielding, as well as the use of PPE and on-site frisking, as mandated by the RCT. Maximum contamination guides for release of equipment are contained in Table 4.2. Personal clothing will not be worn in contaminated areas (underwear and socks excluded). Personnel will be provided the level of PPE deemed appropriate by the RCT and the SSHO. Details of control methods, in addition to those listed above, to be used in site operations to reduce the potential for personnel exposure shall be included in the site TSHASP. See Table 4.3 for detailed information on suspected or known radionuclide contaminants at the MSRE.

Criticality safety will be comprehensively addressed and receive an objective review. All identifiable risks will be reduced to acceptably low levels and management authorization of the operation will be documented. (Training requirements are given in Sect. 5.1.6.)

4.7.1 Fissionable Material

The primary radioactive material hazard present in the MSRE facilities is associated with the fuel salts. This hazard includes an estimate of up to 28,200 Ci of mixed fission products. The majority of this material is in the fuel salts within the two drain tanks, a lesser amount is in the flush tank, and a smaller amount is in undrainable pockets within the MSRE off-gas system. Some of the uranium from the fuel salts has migrated into the off-gas system in the form of UF_6 and reacted with the charcoal in the ACB to form UF_4. Approximately 95 Ci of uranium is believed to be deposited on the charcoal matrix of the ACB.

Fissionable materials in the uranium fuel salt include approximately 21.7 kg of ^{233}U, 915 g of ^{235}U, and 709 g of ^{239}Pu in the two drain tanks and the fuel flush tank. The amount of fissionable material believed to have migrated to the ACB is estimated to be 2.2 kg of ^{233}U and 67 g of ^{235}U.

4.7.1.1 Reactive gas removal

For the Reactive Gas Removal System (RGRS), two traps will be used to remove UF_6 and F_2 from the MSRE process gas. One trap will be filled with NaF pellets for trapping UF_6, and the second filled with Al_2O_3 for the filtering of F_2. The gas passes through the matrix and the filter media traps the components within the cylinders. The traps are encased within stainless steel overpacks. These overpacks are slightly larger then the traps themselves. Both trap and overpack are housed within a shielded carrier. The shielded carrier is constructed from an 11-in. by 27-in. stainless steel block. The shielded carrier provides about 3 in. of steel shielding around the trap and overpack. Once the traps are filled the entire containment system, trap, overpack, and shielded carrier is moved to a Fissile Control Storage Area at the MSRE facility. This area is locked, posted, and under observation with an internal camera system for remote viewing. When the material is to be transported to

Building 3019, all activities (loading, securing, notification, etc.) will follow the approved MSRE Transportation Plan.

Table 4.2. Surface radioactivity values

Nuclide[a]	Removable (dpm/100 cm^2)[b]	Total (fixed + removable) (dpm/100 cm^2)[c]	Maximum total (fixed + removable) (dpm/100 cm^2)
U-natural, ^{235}U, ^{238}U, and associated decay products	1,000 alpha	5,000 alpha	15,000 alpha
Transuranics, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	100[d]	300
Th-natural, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000	3,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above. Includes mixed fission products containing ^{90}Sr.	1,000 beta-gamma	5,000 beta-gamma	15,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO, and metal tritide aerosols	1,000	1,000	—

[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 cm^2 of surface area should be determined by smearing the area with dry filter or absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the smear with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be smeared, and the activity per unit area should be based on the actual surface area. Except for transuranics, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa, and alpha emitters, it is not necessary to use smearing techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

[c]The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than the Maximum Total column in this Table 4.2.

[d]There is currently no DOE Order or Federal Regulation providing guidance for the release of transuranic contaminated material and equipment to uncontrolled areas. Until 10 CFR 834 is finalized, ORNL will adopt the guidance in Regulatory Guide 1.86 as directed by the DOE Site Office (R. O. Hultgren to M. W. Rosenthal, "Unrestricted Release Limits for Transuranic Contaminated Equipment and Property," June 8, 1992). It is generally conceded that radiation survey instruments are incapable of detecting 100 dpm/100 cm^2 in the scanning mode. Monitoring of equipment potentially contaminated with transuranics will be done in the scanning mode for the maximum limit and then the scaling mode will be used in areas identified as suspect in the scanning mode to ensure that the average limit is not exceeded.

Table 4.3. Characteristics of suspected radionuclide contaminants at the MSRE

Contaminant	DAC[a] D[b] (μCi/mL)	DAC[a] W[b] (μCi/mL)	DAC[a] Y[b] (μCi/mL)	Critical target organs[c]
MANMADE RADIONUCLIDES				
Cesium-137	7×10^{-8}			Whole body
Plutonium-239/240		2×10^{-12}	6×10^{-12}	Bone, lung, gonad
Strontium-90	8×10^{-9}		2×10^{-9}	Whole body, bone, lung
Yttrium-90			3×10^{-7}	Bone, lung, whole body
Uranium-232	9×10^{-11}	2×10^{-10}	3×10^{-12}	
Uranium-233	5×10^{-10}	3×10^{-10}	2×10^{-11}	Bone, lung, whole body
NATURALLY OCCURRING RADIONUCLIDES				
Uranium-234	5×10^{-10}	3×10^{-10}	2×10^{-11}	Whole body, bone, lung
Uranium-235			2×10^{-11}	Bone, lung, whole body

[a]Derived air concentrations (DACs) for occupational exposure are based on either a stochastic (committed effective dose equivalent) of 5 rem/year or a nonstochastic (organ specific) dose limit of 15 rem/year to the lens of the eye and 50 rem/year to any other organ, tissue, or extremity of the body, whichever is more limiting.

[b]The DACs include three lung retention classes: D - daily, W - weekly, and Y - yearly. This classification refers to the approximate length of retention in the pulmonary region. Thus, the range of half-times is less than 10 days for class D, from 10 to 100 days for class W, and greater than 100 days for class Y.

[c]Critical target organs based on exposure-to-dose conversion factors for inhalation.

Source for DACs: 10 CFR 835 December 14, 1993. *Occupational Radiation Protection; Final Rule.*
Source for critical target organs: Eckerman, K. F., et al. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. EPA, Office of Radiation Programs, Washington, D.C.

4.7.1.2 Uranium deposit removal

For the Uranium Deposit Removal Project (UDR), the uranium-laden charcoal will be vacuumed into a collection canister. This canister will be the primary containment for the ACB filter media. Attached to this stainless steel canister is a stainless steel cyclone separator. The canister is fabricated from 4-in. schedule 10 stainless steel pipe with an ellipsoidal end cap at the bottom and a custom reducer at the top. The maximum diameter of the cyclone separator is 6-in. The cyclone separator and filter media containers have a favorable geometry for ^{233}U. Transporting the material from MSRE to a repackaging "hot cell" at the designated interim storage facility at Building 3019, will be in a shielded carrier with a minimum of 4-in. of lead shielding. Interface equipment will allow for safe transfer of the payload. A transportation plan will be written and approved for the safe transporting of this fissile material.

4.8 OTHER POTENTIAL SITE HAZARDS

4.8.1 Illumination

Field activities at the MSRE normally will be conducted during daylight hours, and a minimum of 5 footcandles will be required to conduct operations. (A footcandle is a unit of illumination equal to one lumen per square foot when measured at a surface that is everywhere one foot from a source of one candle power.) Field measurements for illumination will be taken if conditions appear suspect. A conservative guideline may be that field work commence 15 minutes after sunrise and conclude 15 minutes prior to sunset. Adherence to the minimum 5-footcandles requirement will be based on the SSHO's best professional judgment.

Most of the MSRE work will be performed inside the MSRE, Building 7503. Situations and circumstances will be evaluated for illumination on an individual basis. At times, due to location within the facility, supplemental lighting will be required. Two portable dual halogen bulbed tree-lights are available to increase illumination of the work area, when lighting is questionable. In these situations, the SSHO or OSHP representative will evaluate conditions and possibly refer to illumination instrumentation to determine if additional lighting is required.

In the event of a power outage or loss of power, battery powered evacuation lights are situated at strategic locations throughout buildings 7503 and 7509. These lights are designed to activate when electrical power is lost. Routine testing of the lights is performed during monthly H&S walkdowns of the facility. Any nonresponsive lights are reported to the ORNL Fire Protection Department.

4.8.2 Laser (thermodetector)

A hand-held thermodetector is utilized periodically at MSRE. The device, classified as a Class 2 laser, is used to characterize temperature within the closed piping system throughout MSRE. Harm to the unprotected eye from lasers is a phenomenon known as the focusing effect. Light from a laser entering the eye is concentrated 1.0×10^6 times onto the retina. The laser's light beam is concentrated to a fixed point or spot on the retina causing that area to be burned. A reflected laser beam can cause as much damage to the eye as a direct exposure. The primary physical trauma associated with a laser lesion is usually thermal in nature The low power laser devices (such as the MSRE thermodetector) are not powerful enough to injure the eye with an acute exposure.

Lasers should be secured when not in operation. Personnel operating this detector should know and understand the potential for eye trauma, the proper protective eyewear, and other safety implications concerning these devices. Warning labels are affixed to the thermodetector stating: Caution, laser radiation, do not stare into beam, 0.9 mW He-Ne, and Class 2 Laser product.

4.8.3 Ergonomics

The interaction of personnel with their working environment at this site may also present potential hazards such as the incorrect lifting of heavy loads, prolonged operation of vibrating equipment, improper body positioning, and negotiation of physical obstacles when accessing confined spaces. Office work can also present hazards such as stress, incorrect positions for performing work, and incorrect use of equipment. All of the aforementioned conditions are potential factors in site operations. Personnel should always position themselves properly, lift from the legs when lifting equipment or heavy objects, and rely on the buddy system for assistance in lifting loads

that are too heavy for one person. Back strain, the most common ergonomic hazard at a job site, may be avoided if site workers ask for assistance when they need it.

During the review phase of the WP, the possibility of an ergonomic impact will be evaluated by the H&S disciplines. Proper controls will be put into place at the beginning of work. If any worker feels discomfort resulting from performing duties on-site, the worker should bring this information to the attention of the SSHO or OSHP representative.

4.8.4 Hot Work

Hazards. Hot work (welding, burning, etc.) can be hazardous as an ignition source and as a source of release for airborne contamination or products of combustion.

Controls:

- All hot work will be done within the specification of the ORNL permits (SWP, Hot Work Permit). The Project Manager or construction manager is responsible for generating the SWP and Hot Work Permit.

- A 10-lb cylinder of dry chemical fire extinguishing agents will be kept in the immediate area of hot work.

- To the extent possible, remove combustible material from work area.

- A dedicated fire watch will be maintained during and for 30 minutes after all hot work activities.

- A Hot Work Permit must be obtained and maintained on-site while work is in progress.

- When welding, cutting, or grinding stainless steel, or similar material (e.g., Monel Metal), the work area or station must be properly ventilated, and/or (consistent with regulation 29 CFR 1926.353) PPE must be worn to protect the worker from metal fume fever.

- The following requirements apply to all welders and contractors performing welding, burning, and hot work (W/B/H) activities. These activities include all methods of welding, plasma-arc and torch cutting, and other torch open-flame operations for construction and maintenance activities.

  - Welders engaged in W/B/H activities at ORNL shall be suitably protected to minimize the potential for burns resulting from clothing ignition caused by sparks, slag, and trapped molten metal in their work garments. At a minimum, W/B/H activities at ORNL require the use of flame-resistant clothing.

  - ORNL welders who perform W/B/H activities shall wear company-issued flame-resistant clothing as standard work clothing. Whenever flame resistant clothing does not provide adequate protection or when heavy sparks and slag are expected, additional protection shall be used. The need for additional protective equipment shall be determined by a job hazard evaluation.

- Flame-resistant clothing for other crafts and activities is being evaluated. Welders other than ORNL employees performing W/B/H activities shall wear flame-resistant clothing that meets the requirements of National Fire Protection Association (NFPA) 701 standard for flame resistance.

- Welders performing W/B/H operations where anti-contamination clothing is required shall wear flame-resistant clothing for all layers. Disposable flame-resistant coveralls may be used. Exceptions may be designated only by ORP or OSHP professionals. Based upon an evaluation of job hazards, yellow tape currently used for sealing the zipper, cuffs, and around the hood of protective clothing will continue to be used in radiation contamination areas per existing procedures.

- Personnel performing work near W/B/H operations (such as fire watch personnel) shall have clothing requirements evaluated on a case-by-case basis by a job hazard evaluation. If fire watch or other personnel are exposed to the same hazards as the employee performing W/B/H work by position or proximity, they shall wear similar clothing or clothing that provides equivalent protection.

- Flame-resistant clothing or equivalent protection may be utilized by other personnel based upon a job hazard evaluation.

- Other PPE for W/B/H operations such as respirators will continue to be used as required by a job hazard evaluation.

- It should be noted that cotton clothing treated with flame-resistant materials may lose its protective characteristics with repeated laundering and shall only be laundered according to manufacturer's requirements. Additionally, heat stress should be evaluated during a job hazard evaluation for all W/B/H operations since the flame-resistant clothing may cause a slight increase in warmth for the wearer. Appropriate work/rest regimes or other controls may be required.

The P&E welding shop has established a remote welding station in Building 7516. A considerable amount of welding is conducted "on site" to increase productivity. This station complies with all fire protection standards and OSHA regulations for welding operations. Any changes to the station or increase in operational capacity of the station will require a revision to the current permit. The permit for the MSRE welding station is No. 68.

The MSRE P&E Supervisor is responsible for requesting and maintaining valid Hot Work Permits. All void and expired Hot Work Permits shall be returned to the ORNL Fire Protection Department. Hot Work Permits are evaluated by the appropriate H&S representatives and issued for specific work on a task-by-task basis. Task evaluations are needed for welding activities at the MSRE complex because of the confined spaces and the use of corrosive gases at the facility.

Intense lighting sources such as welding operations must be evaluated to prevent damage to the retina of the eye. Welding emits ultraviolet, visible, and infrared radiation. Proper eyewear must be worn by the individual performing the welding and anyone observing welding operations. Specification for tint of lens for welding eyewear is specified in ANSI Z87.1, *Eye and Face Protection.*

4.8.5 Flammable Materials

Hazards. Flammable materials pose fire/explosion hazards if ignition sources are present. MSDSs for all site materials will be maintained on-site by the SSHO.

Controls:

- All work environments suspected of containing flammable conditions will be evaluated by OSHP prior to personnel entering the area. If explosive levels equal to or exceeding 10% of the LEL are detected, entries to that area will be restricted and engineering efforts may be used to remedy the situation.

- Flammable liquids shall be stored in an Underwriters' Laboratory-approved safety container designed and labeled for that purpose. The approved safety container must be stored in approved flammable cabinets. MSRE has two cabinets designed for flammable liquids, one in Building 7516 and one outside Building 7503.

- Flammable wood products (wooden pallets and scrap building supplies) are stored prior to disposal outside Building 7516.

- Waste cardboard boxes are stored prior to disposal in an approved metal bin located west of Building 7503.

- Lubricating oils are stored in nonflammable cabinets. Used oils are stored for characterization and subsequent recycling in a waste oil storage area established by Waste Management at the southwest corner of Building 7503.

- No smoking or open flames shall be permitted within 50 ft of stored flammable materials.

Work being performed in a suspected explosive atmosphere must have stringent controls in place before any activities can be undertaken. If the environment is suspect for explosive conditions, the atmosphere must be characterized by the OSHP. Fire protection engineering will be asked to confer with OSHP in order to better rectify the situation. If conditions are conducive for an explosion, engineering controls must be established to remove the hazard, and a root cause investigation must be conducted to determine the cause of the hazardous conditions. Once the hazard has been eliminated, work can begin. Spark resistant tools and grounded electrical receptacles must be used to reduce the chances of a mishap.

4.8.6 Compressed Gas Cylinders

To reduce the potential for fire and deflagration, carbon dioxide gas is being pumped into the charcoal bed cell to displace the oxygen, thus, necessitating the use of compressed gas cylinders at the MSRE complex. (This process will be discontinued after the fluorine gas is removed from the ACB during the denaturing phase of UDR.) Other cylinder gases at the MSRE complex include fluorine, chlorine trifluoride, helium, hydrogen fluoride, and ammonia. These are extremely hazardous gases. (Refer to Table 4.1.) Extreme care must be exercised when transporting, opening, and disconnecting the regulator for these cylinders.

Hazards:

- Discharge of flying objects such as dust and dirt from the cylinder valve upon opening.
- Damaged cylinder or valve resulting in the cylinder becoming an airborne projectile.
- Displacement of oxygen in low-lying areas throughout the building.
- Corrosive and toxic gases.

Controls:

- Cylinders must be transported in an approved cylinder truck or dolly designated for cylinders.
- All cylinders when not in use must be capped.
- All cylinders must be appropriately labeled with the label specifying contents of the cylinder and whether the cylinder is full or empty.
- Cylinders shall be stored upright and properly secured with chains, bars, brackets, or other approved devices to prevent the cylinder from falling.
- Segments of compressor hose shall be secured so that they will not become separated.
- Safety glasses and gloves shall be worn by site personnel when handling and assembling compressed gas cylinders or systems. Some cylinders may require additional PPE. Each application will be reviewed by the ES&H Manager prior to use.
- No smoking or open flames will be permitted within 50 ft of stored compressed gas cylinders.
- Hoses will not be located where they may be run over by vehicular traffic.
- Cylinders shall be stored at least 20 ft from highly combustible materials.
- Damaged cylinders and cylinders with unknown contents shall not be moved under any circumstances by untrained personnel. The immediate area around the cylinders shall be roped off, personnel shall be evacuated, and H&S personnel shall be notified at once.
- Proper PPE, ventilation requirements, and proximity to an eyewash station must be established when manipulating hazardous gas cylinders (HF, F_2, ClF_3, NH_3).

4.8.7 Asbestos

Hazards. Based on historical and process knowledge of the MSRE facility, asbestos may frequently be encountered during activities. Asbestos-containing material may be encountered as debris left from discontinued operations that took place prior to the regulation of asbestos. Asbestos contained in buildings does not pose a threat to humans, **as long as the material is not deemed "friable" and is in an "undisturbed" condition.** The EPA officially defines friable asbestos-containing material as "any material containing more than 1% asbestos by weight, which when dry can be crumbled, crushed, pulverized or reduced to a powder under hand pressure."

The health risk to humans regarding asbestos exposure involves the introduction of asbestos fibers into the body. The main routes of entry are inhalation and ingestion. A variety of diseases and physiologic symptoms may result due to asbestos exposures, with the majority of the symptoms presenting themselves after a latency period. The most common ailment is asbestosis, which is a diffuse, nonmalignant scarring of the lungs. Mesothelioma and bronchogenic carcinoma are the malignant forms of cancer that often are associated with chronic asbestos exposures. Clinical symptoms associated with asbestos exposure may include any of the following: dyspnea, rales, finger clubbing, and restricted pulmonary function.

Controls. Although it is apparent that the human health risk is less at lower asbestos concentrations than at higher concentrations, any degree of exposure is assumed to present potentially adverse health effects to a susceptible individual. Asbestos hazards will be minimized through the use of engineering and work-practice controls as specified by the SSHO or ES&H Manager. Engineering controls might include double-enclosed tenting for asbestos removal operations and/or a positive-air-pressure ventilation system with HEPA filters. Safe work practices include wearing sufficient PPE and avoiding activities that generate airborne fibers such as sweeping. A detailed description of the specific control methods and PPE to be employed during site operations shall be documented in the TSHASP.

All sampling and remediation activities dealing with asbestos-containing material shall comply with 29 CFR 1910.1001 and EPA guidelines. All personnel participating in sampling or remediation efforts shall possess the proper training credentials as specified in 29 CFR 1910.1001. The SSHO in conjunction with the OSHP representative shall monitor all site activities dealing with asbestos-containing material. The ORNL Asbestos Coordinator should be contacted for guidance.

4.8.8 Beryllium

Beryllium has been classified by the International Agency for Research on Cancer (IARC) as a human carcinogen and has also been identified as being responsible for the development of chronic beryllium disease. Beryllium fluoride is a component of the fuel and flush salts stored in the MSRE. The fuel salt contains ~30.3 kg of beryllium and the flush salt about 34 kg. Analysis of smear samples collected in Building 7503 revealed the presence of beryllium in some areas of the sub-basement. These areas have been posted and locked to restrict entry. Beryllium has not been detected in any other areas of the building.

4.8.9 Machinery

MSRE maintains a satellite P&E shop located on the MSRE site in Building 7516. This shop contains numerous pieces of machinery used for cutting, grinding, and drilling of wood and metal to support MSRE remediation operations and to maintain an aging facility. This equipment is part of the monthly MSRE safety inventory list and is inspected and scrutinized for compliance on a regular basis. Some of the items that are checked on these tools are (1) proper guards and fences, (2) proper anchoring in place to prevent movement during operations, and (3) proper "push" tools for completing cutting actions for saws.

PPE is required and used when operating equipment in the shop. Different pieces of equipment have various hazards associated with them. Cognizant workers and detail to safety will prevent injury from this type of machinery.

4.8.10 Heavy Equipment

Hazards. The hazards associated with the operation of heavy equipment such as cranes are, in general, personnel injury, equipment damage, hydraulic leaks, or property damage.

Controls:

- All heavy equipment shall be used in the manner intended. Drivers will operate all equipment in accordance with the manufacturers' instructions and within the safe operating parameters defined by the manufacturer.
- Heavy equipment conducting hoisting and rigging (H&R) activities shall operate within the guidelines of the approved lift plan, if applicable.
- All heavy equipment shall have current annual inspection certifications before use.
- All heavy equipment shall be inspected daily by the operators and, as required, by certified inspectors before operations begin. The SSHO will be responsible for ensuring that inspections are performed, that lifting cables and slings have been inspected, and that the inspection tag is affixed to the device.
- All hydraulic equipment will be inspected for leaks or other problems.
- Applicable monthly, quarterly, and special inspections shall be completed prior to equipment operation.
- Where possible, heavy equipment in stationary operations should be barricaded (with hazard tape) at a sufficient distance for ground personnel to avoid moving cabs, counterweights, and booms. When ground personnel are working in the vicinity of heavy equipment, they should inform the flagman or equipment operator of their presence.

4.8.11 Hoisting and Rigging Operations

Operations that involve the use of cranes, forklifts, hoists, powered industrial trucks, and slings are subject to certain hazards that cannot be controlled by mechanical means. The possibility of serious accidents resulting in personal injury, death, or significant property damage exists whenever H&R activities take place. All operations involving hoisting and rigging operations shall be conducted in accordance with the provisions and requirements of all applicable sections of 29 CFR 1910 and 29 CFR 1926; additional guidance may be obtained from *DOE Hoisting & Rigging Manual* (DOE 1993). All MSRE operations involving hoisting and rigging operations shall be evaluated on a task-by-task basis by an OSHP representative specializing in hoisting and rigging. In addition, proposed lift plans for hoisting and rigging activities shall be submitted to the ORNL H&R Program Manager for review by the H&R Review Team. All applicable SOPs shall be maintained on-site for quick reference.

H&R activities shall be conducted only by qualified personnel as specified in the ORNL Hoisting and Rigging plan, if applicable, or possibly following guidance of the DOE Hoisting and Rigging Manual. Possible site operations may involve, but are not limited to, rigging activities or the use of any of the following types of equipment:

- Overhead and gantry cranes.
- Mobile cranes.
- Forklift trucks.
- Hoists.
- Hooks.
- Wire rope, slings and rigging accessories.
- Below-the-hook lifting devices.

4.8.12 Excavation/Penetration and Dismantling

Operations involving excavation or penetration are subject to various hazards (e.g., contact with hazardous or radioactive materials, electrical lines, cave-ins, etc.) These operations will require that an excavation/penetration permit be obtained before the work is initiated. The task will be carried out in conformance with the permit and in accordance with this HASP.

Operations at the site involving dismantling will be performed by contractor(s). Dismantling activities are subject to certain hazards (e.g., hazardous or radioactive material that may become airborne, nuisance dusts, falling debris). The contractor(s) performing the dismantling work will submit a Health and Safety Plan for the task to the MSRE ES&H Manager who will review it.

4.8.13 Generic Hazards

Housekeeping. A facility safety, health, and housekeeping walkdown inspection is performed weekly by the SSHO. A checklist is used to assess the adequacy of the facility on various items in 18 categories such as proper postings, waste management, current inspection labels, etc.

Egress. All buildings in the facility are provided with emergency lighting including lighted exit signs. Personnel are assigned to serve as wardens and searchers in the event of an emergency building evacuation.

Illness and Injury Reporting. The occurrence of a work-related illness or injury shall be reported to the task supervisor, the SSHO, and the ORNL Health Services.

4.8.14 Biological Hazards

The word "biohazard" (a combination of the words biological and hazard) refers to plants, animals, or their products that may present a potential risk to the health and well-being of humans. Biohazards can affect humans either directly through illness or indirectly through disruption of the environment. Biohazards can be transmitted to a person through inhalation, injection, ingestion, or absorption through the skin.

4.8.14.1 Indoor air quality

The quality of the air we breath is important for good health and productivity in the work place. Various factors such as chemical contaminants, carbon dioxide levels, and biological organisms influence the quality of breathing air. Examples of chemical contaminants used in office and work spaces include solvents used in chemical cements, adhesives for carpets, fire retardant fiber coatings,

and cleaning compounds. All these chemical contaminants can affect the quality of respirable air. Building air can become stale or spoiled in the work place. An increase of carbon dioxide (CO_2) from office equipment or inadequate air exchange can cause the local environment to become stale and can contribute to headaches and possibly cause dizziness for some workers.

Biological organisms such as molds, mildew, other fungi, and spores thrive in moist and stagnant environments. Air conditioner units and recirculators provide an ideal habitat for bacteria. The bacterium *Legionnella pnuemophila*, Legionnaires bacterium, has been found in air conditioners and cooling towers. The air conditioner unit in Building 7503 has been sampled and characterized for bacteria, spores, and fungi. There were fungi present. The entire unit was treated and recharacterized with results indicating that the contaminants had been eliminated.

If at anytime air quality is questionable, OSHP will be requested to sample and characterize the internal environment for air quality. Anyone at the facility can request investigation through the on-site health and safety representatives.

4.8.14.2 Flora and fauna

Work around MSRE requires working outdoors, maintaining the grounds, excavation, outfall sampling, cleaning roof drains, etc. Anyone working outdoors can potentially come in contact with stinging and biting insects (wasps, bees, mosquitoes), bird droppings, poisonous plants (poison ivy, poison oak), and venomous snakes and spiders. Proper identification of these hazards and avoidance whenever possible is the best prevention for these hazards. Also, various barrier creams have shown positive results in preventing contact dermatitis from plants. Sprays and repellents can be used for insect control. Care must be taken not to use barrier creams or repellents when working in an environment where airborne particulates could accumulate on the skin causing chemical burns to that area.

4.8.14.3 Blood borne pathogens

The occupants and visitors to MSRE must be aware of the potential health effects from handling, cleaning, or treating human body fluids such as blood, salvia, or excrement. Various diseases and conditions are transmitted via contact with these materials [e.g., hepatitis B and human immunodeficiency virus (HIV)]. All body fluids are assumed to be infectious, and all individuals must take adequate precautions to protect themselves from blood borne pathogens. When rendering first aid to an individual with a cut or someone who is bleeding, wear latex or vinyl gloves, if at all possible. If, in an emergency situation, gloves can not be worn, wash the exposed area of skin as soon as possible. When cleaning up bodily fluids, wear latex or vinyl gloves and dilute the fluids with a 1:100 dilution of Clorox bleach. Discard all towels or clothes in a plastic bag and label the bag as biological waste. The waste can be disposed of at ORNL Health Services.

4.9 RISK ASSESSMENT OF SITE OPERATIONS

A task description and an assessment of possible health risks to workers for each anticipated site operation shall be developed and included in the TSHASPs prior to their approval.

5. SITE ACCESS REQUIREMENTS

Primary access to the MSRE is controlled by means of a perimeter fence that encompasses the MSRE facility and support buildings. To obtain access to the MSRE building, the Facility Manager or Facility Coordinator(s) must be notified. A sign-in log is stationed inside the east doorway of Building 7509. The log must be completed prior to proceeding. MSRE personnel who have completed facility access requirements and need to enter over an extended period of time can use the portal badge reader to gain access to the facility. First time visitors to the MSRE facility must complete an "MSRE Access and Emergency Response Requirements" form. This form explains alarms and conditions that could occur at the facility. This form is a self-study detailing hazards that exist at the facility.

The minimum requirements for access to the MSRE facility are listed below. Health and safety training must comply with the requirements specified in 29 CFR 1910.120, DOE orders, and ORNL policies. All training requirements presented in this PHASP can be fulfilled only by training courses or modules that have been reviewed for equivalency by the Energy Systems training program.

- The MSRE Facility Manager and/or Facility Coordinator(s) will have final control over site access.

- The MSRE ES&H Manager will review all work packages during the review process and determine the H&S training requirements needed to perform the task. The MSRE ES&H Manager will then confer with the MSRE Training Coordinator to verify the level of training needed for workers, visitors, and observers, if needed.

- All personnel other than visitors to the facility are required to have General Employee Training (GET).

- All personnel who will be performing work at the MSRE facility are required to have the proper training to do the work. In some instances, 24 hours of health and safety training and a radiological worker training course may be required. If respirators are used, or intrusive activities (e.g., accessing the primary containment system) are performed, the workers must have 40 hours of health and safety training [HAZWOPER training, per 29 CFR 1910.120(e)], respirator training and fit test, and Radiological Worker II training.

- All visitors who are granted site access and have business in the Radiological Areas must be frisked by an RCT or use the hand and foot monitor when exiting the area. If the area visited and time at the site pose a radiological concern, project management must arrange for temporary pocket dosimetry. Additionally, visitors must abide by all requirements of the PHASP, applicable TSHASPs, and permits. Visitors must also comply with site requirements, project or task requirements, and ORNL and DOE guidelines.

- Access to specific HAZWOPER zones by visitors is controlled by the SSHO.

5.1 TRAINING

5.1.1 General Employee Training (GET)

All Energy Systems employees, prime contractors, students, interns, and subcontractors are required to complete GET and to also complete a GET refresher training session every 24 months. This requirement was established by Energy Systems for all personnel. GET training describes the primary function of the various Energy Systems sites and their responsibility to DOE. It covers the security system, emergency programs, various emergency signals, and appropriate actions that need to be taken by each individual. GET also covers general health and safety topics including the various radiation zones that can be found throughout each plant. GET explains the Hazardous Communication Program and how it affects the employee. For additional information on the GET contact the Center for Continuing Education.

5.1.2 40-Hour SARA/OSHA HAZWOPER Training

Personnel who work at designated HAZWOPER work areas must recognize and understand the potential hazards to health and safety associated with task activities. Individuals may not participate in or supervise any HAZWOPER work activity until they have been properly trained. Paragraph (e) of 29 CFR 1910.120 reflects a tiered approach to this training. The objectives of the HAZWOPER training program are to:

- educate workers about potential health and safety hazards they may encounter at the site;
- provide the knowledge and skill necessary to minimize risk to worker safety and health;
- provide thorough training in the proper use and potential limitation of safety and PPE; and
- ensure that workers can safely avoid or report potential emergencies.

The training program should include 40 hours of classroom instruction in a wide range of health and safety topics, demonstrations, and "hands-on" practices plus 3 days of supervised field experience at a hazardous site. An Energy Systems Supervised Field Experience Form will be completed for each HAZWOPER-trained individual to document compliance with the field experience requirement listed in the training section of 1910.129(3)(i). A copy of the Supervised Field Experience Form must be completed and maintained by the MSRE Training Coordinator to verify compliance with this regulation.

5.1.3 24-Hour SARA/OSHA HAZWOPER Training

SARA/OSHA 24-hour training includes a minimum of 24 hours of classroom training plus 1 day of supervised field experience at a hazardous waste site. The 24-hour training is required for workers or supervisors who are on-site regularly and will only enter areas that have been fully characterized, indicating that exposures are under the PELs and published radiological exposure limits. If task requirements specify respiratory protection equipment, 24-hour SARA/OSHA training will not suffice. An additional 16 hours classroom training and 2 days of field experience will be required to upgrade to the 40-hour training. For MSRE personnel, a copy of the certificate or verification of completion of this training is maintained by the MSRE Training Coordinator.

5.1.4 8-Hour SARA/OSHA HAZWOPER Supervisor Training

An additional 8 hours of HAZWOPER supervisory training will be required for individuals who act as SSHO during HAZWOPER work activities. This training is in addition to the 40-hour training

required for the SSHO. The supervisor training elaborates on roles and responsibilities under the health and safety program, the PPE program, the medical surveillance program, and the emergency response plan.

5.1.5 ORNL Radiological Worker Training

Radiological worker training is designed to meet the requirements stipulated in 10 CFR 835. A radiological worker is defined as an occupational worker whose job assignment involves exposure to radiation while working on, with, or in proximity to radiation-producing machines or radioactive materials and is likely to be exposed above 100 mrem per year (including external and internal sources). This also includes personnel who work in or have access to Contamination Areas, regardless of their dose. The basic objectives of this training is to provide answers to the following questions:

- What is radiation and where does it originate from?
- How harmful is it to the individual?
- How can it be controlled and who is responsible for it's control?
- How can an individual minimize his/her exposure?

The MSRE project requires that facility workers performing work in radiological areas complete Radiological Worker II training. This training covers the use of PPE for protection against a radiological concern. Instruction includes the proper type of PPE and how to don and doff the protective articles. A certificate of completion is awarded upon satisfactory completion of the course, clothing demonstration, instrument laboratory, and examination. Retraining and recertification are required every two years. Visitors who need to access Radiological Areas and need to don PPE may do so without meeting the requirement for Radiological Worker training if they are escorted by the RCT.

5.1.6 Nuclear Criticality Safety Training

Nuclear criticality safety (NCS) training is required for individuals working with fissile material, supervisors who oversee their work, and others who are around areas containing fissionable material. The MSRE facility contains fissile material and certain areas of the MSRE have been designated a "Fissile Control Area."

There are three levels of fissile training:

- Level 0 for individuals not involved in the handling of fissile material.
- Level 1 for workers and handlers of fissile material.
- Level 2 for those directly involved in the operations and those whose responsibilities involve supervising the handlers or workers.

Level 0 includes a 4-hour training session covering recognition of alarms and appropriate action to take in response to an accident. Levels 1 and 2 include a 16-hour training session covering more details on hazard recognition and the safe operation and handling of fissile material.

The NCS training requirement can be waived for visitors and guests who will be escorted by an individual with Level 1 or Level 2 NCS training. Visitors and guests who plan to independently visit a controlled area must have NCS training.

5.1.7 Asbestos Training

If asbestos abatement or repair is needed within the MSRE facility, personnel involved with the work must comply with all applicable OSHA, EPA, and Asbestos Hazard Emergency Response Act (AHERA) regulations. Based on these regulations, applicable ORNL procedures will depend upon the level of effort required for the operation. The following ORNL OSHP procedures deal with asbestos:

- OSHP-012 "Asbestos Oversight Management Program
- ESS-IH-201 "Inst. Asbestos Management Program"

The level of effort with regard to asbestos and the condition of the suspect material will dictate what degree of training will be required when working around or handling asbestos and other man-made fibers. The 1- to 2-hour Asbestos Awareness Training includes video tapes that explain and identify hazards dealing with asbestos-containing material. This training is required of personnel working around but not coming in contact with asbestos material.

Additional laws and regulations that need to be considered when dealing with asbestos include: EPA Worker Protection Rule; NESHAP; AHERA; and Department of Transportation regulations.

If any suspected asbestos-containing material must be sampled or a determination made concerning amount of suspected asbestos material or the potential degree of hazard posed by this material, a qualified Asbestos Inspector and a qualified Asbestos Management Planner must make these calls. This involves additional training for each discipline. The qualifications for these disciplines can be found in AHERA, Final Rule, 40 CFR 763, Subpart E.

5.1.8 HAZWOPER Site Safety and Health Officer Training

This training course (or an equivalent SSHO training course) is recommended to ensure that all individuals serving as SSHOs are following the same guidelines, recommendations, and orders. The training program ensures consistency among those acting as SSHOs. Qualifications of all personnel requesting to be SSHOs must be reviewed by the ORNL SHEST representative. The ORNL SHEST representative shall review the applicant's educational background, field experiences, types of sites worked, and types of instrumentation utilized during the course of his/her career. Based on this information, the ORNL SHEST representative will assign the applicant a level of competence, either SSHO Level 1, 2, or 3. After approval, the individual must attend 8-hr SARA/OSHA HAZWOPER Supervisor Training. Based upon experience and educational background, this requirement may be temporarily waived by the ORNL SHEST representative until a class becomes available for participation. Once this training has been acquired, all requirements to serve as a SSHO have been fulfilled. Further information on requirements and criteria for SSHOs is available from the ORNL HAZWOPER Program.

5.1.9 Worker/Visitor Training Requirements

The requirements for worker training for tasks conducted under this PHASP shall be determined by the anticipated role of the worker and the tasks that he or she is required to perform. Minimum training requirements for entry into a site for routine or occasional workers; controlled access area, CRZ, or EZ workers (Levels A, B, C, and D+ workers); on-site supervisors; and nonworkers or site visitors are listed in Table 5.1. The regulatory basis for the requirements presented in Table 5.1 is

located in 29 CFR 1910.120. The presentation of this information was adapted from the U.S. DOE document OSHA Training Requirements for Hazardous Waste Operations (DOE 1991).

Table 5.1. Site training requirements

Operation/ personnel	Site health & safety briefing	24-h	40-h	8-hr super-visor	8-hr refresher[a]	Rad worker II	Nuclear criticality safety training
Routine/occasional worker	X	X[b]	X		X	X	
Routine/occasional worker (Level D)	X	X			X	X	See Sect. 5.1.6
On-site supervisor	X	X[c]	X	X	X	X	
Nonworker/visitor[d,e]							
Level A or B PPE[f]	X		X		X	X[g]	
Level C PPE	X		X		X	X[g]	See Sect. 5.1.6
Level D or No PPE	X						

[a]Annual requirement; however, personnel not receiving refresher training within 3 years of initial training or last refresher course (at a minimum) should repeat the initial course.

[b]24-h training is adequate for workers *only* for entry into areas where Level D PPE is sufficient. For routine workers, area must also have been monitored and fully characterized.

[c]Supervisors of on-site workers who require only the 24-h course need only take the 24-h initial and 8-h supervisor courses.

[d]If the area visited and time at the site pose a radiological concern, as determined by the RCT, visitors should be issued and instructed on the use of required PPE, receive a site-specific safety briefing, be escorted by trained personnel, and wear a personal dosimeter.

[e]Nonworkers are DOE employees and DOE contractors not directly involved with hazardous waste or MSRE operations (e.g., management, audit, and oversight personnel). Visitors include those covered and not covered by OSHA.

[f]PPE - Personal Protective Equipment

[g]Radiological Worker II required in radiological areas.

Other worker training requirements, as stated above, will be project- and task-specific, and may include, but are not limited to, courses on the following subjects: respiratory protection, radiological worker, confined space entrant/attendant, asbestos, specific carcinogens, and operation of specific equipment. Training requirements shall be dictated by 29 CFR 1910.120(e), 29 CFR 1926, and any other regulatory standards that would be applicable to site operations. The SSHO and the MSRE Training Coordinator will be responsible for verifying task-specific training for workers on certain equipment.

5.1.10 Waiver of Training or Medical Requirements

Specific training or medical requirements (e.g., bioassay program) may be waived for visitors requiring access to certain zones if specific hazards (such as airborne radioactivity) do not exist. Waivers will be enacted on a case-by-case basis and shall be granted and approved by the MSRE ORP Coordinator.

No ones safety and health will be compromised for site access. All site hazards shall be evaluated and controls in place (if needed) before access is granted.

5.1.11 Training Documentation

Acceptable forms of documentation of worker training will be up-to-date certificates of training for all completed courses that are required for site access and operations. An ORNL Special Access Training card and an up-to-date respiratory fit-test card will serve as acceptable forms of training documentation, as applicable. Training records will be maintained by the MSRE Training Coordinator.

5.1.12 Equivalent Training

In special circumstances, according to the provisions of 29 CFR 1910.120 (e)(9), equivalent training such as hazardous waste site work experience, academic training, and/or other forms of certification or training may be considered acceptable for compliance with the training requirements of 29 CFR 1910.120(e)(1) through (e)(4). The determination of whether equivalent training status is granted shall be determined and documented in writing by the SHEST representative and the Center for Continuing Education.

5.2 PRE-ENTRY HEALTH AND SAFETY BRIEFING

Task personnel are required to attend a pre-entry health and safety briefing prior to entering the work area. This pre-entry health and safety briefing shall be conducted by the task leader. The SSHO or MSRE ES&H Manager and the RCT or representatives who have been designated by the SSHO and the ORP shall contribute issues relevant to H&S of the workers. The pre-entry health and safety briefing shall highlight the health and safety information presented in the PHASP, TSHASP, current SWPs, and RWPs. This information may include, but is not limited to, the following:

- Reporting chain of command.
- Site or task location access requirements.
- Site hazards and symptoms of exposure.
- Site physical and mechanical hazards and recognition of hazards.
- Personnel and equipment decontamination requirements.
- Location of the primary and secondary emergency assembly points.
- Emergency procedures.
- Spill response procedures.
- Location of the site emergency action plan.

- Location of "clean" areas or break areas and rest room facilities.
- Location of nearest communication equipment (telephone, fire alarm pull boxes).
- Location of emergency telephone numbers.
- Evacuation routes.
- Other information contained in the PHASP or the TSHASP.

5.2.1 Documentation of Briefings

Attendance at the pre-entry health and safety briefings for HAZWOPER-designated tasks will be documented by the signature of all personnel present at the briefing in the MSRE H&S logbook. MSRE attendance sheets will also be used as documentation of receiving this briefing.

5.2.2 Daily Safety and Health Briefings

Daily S&H briefings shall be held by the task leader, MSRE ES&H Manager, SSHO, RCT, and/or the ORP Coordinator to summarize planned activities, to identify new hazards, or to clarify any task or project-related issues. All site personnel anticipated for the day's activities will be required to attend. Daily S&H briefings may include, but are not limited to, the following subjects:

- Worker safety issues.
- Task-specific PPE and respiratory requirements.
- Requirements for RWPs and/or SWPs.
- SOPs and any approved deviations to the prescribed procedures.
- Previous "lessons learned."

5.3 PERSONAL PROTECTION REQUIREMENTS

5.3.1 Personal Protective Equipment

The SSHO and RCT shall specify the PPE required for specific activities, tasks, and access into specific work zones. This specification shall be based on possible site contaminants, OSHA requirements, Radiation Protection guidelines, and chemical and radiological hazards information. The SSHO and/or the RCT will assist all site personnel in donning and doffing. PPE required to perform a specific task will be denoted in either the RWP, SWP, TSHASP, or work instructions.

5.3.2 PPE Upgrade/Downgrade Authority

There are various circumstances where it may be necessary to upgrade or downgrade PPE levels. Some examples are listed below.

Reasons to upgrade:

- Known or suspected presence of dermal hazards.
- Occurrence or likely occurrence of gas or vapor emission.

- Change in work task that will increase contact or potential contact with hazardous or radioactive materials.

- Request of the individual performing the task.

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally thought.
- Change in site conditions that decreases the hazard.
- Change in work task that will reduce contact with hazardous materials.

These are only guidelines and not rules for upgrading or downgrading PPE. The decision to change PPE levels will be made based on facility and job site conditions. Persons with the following site roles shall have the authority to order the upgrade or downgrade of PPE levels during ongoing site activities: ES&H Manager, SSHO, RCT, ORP Coordinator, and OSHP representative. At a minimum, the upgrade or downgrade of PPE levels must have the approval of both health and safety and RCTs. The consensus to upgrade or downgrade PPE levels and the basis for the decision shall be recorded on all applicable project documentation including the H&S logbook, SWPs, and RWPs. The SSHO shall ensure that this documentation is completed.

All site personnel shall be made aware of the upgrade or downgrade and shall be provided updated procedures for donning and doffing and decontamination activities.

5.3.3 Respiratory Protection

All respiratory equipment shall be approved by the National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA). All personnel required to use respiratory protection shall have an up-to-date quantitative respirator fit test and will wear only those respirators approved by the quantitative fit test. In addition, site personnel will abide by a single-use per day respiratory policy depending on contamination levels encountered. When the face-to-face-piece seal of the respirator has been broken (e.g., for lunch and other breaks), the respirator will be scanned for radiological contamination and, if nothing is detected, the respirator will be placed in its protective bag and sealed for reuse. No site personnel will be issued a respirator without a valid respirator card. Respirators will only be issued by qualified issuing personnel. The ES&H Manager or SSHO will verify qualifications of issuers.

Personnel at the MSRE Facility will comply with the ORNL respiratory protection program, which meets the requirements of 29 CFR 1910.134, as described in OSHP-006.

5.4 MEDICAL SURVEILLANCE

5.4.1 HAZWOPER Physicals

According to the requirements of 29 CFR 1910.120, site personnel who meet the criteria listed below must have a physical examination conducted by a physician who is board certified in occupational medicine in order to determine and document the qualification of the worker to perform work at hazardous waste operations (EPA 1990). Criteria for inclusion in the medical surveillance program are listed below:

- Employees who are, or may be, exposed to PELs of hazardous substances or health hazards for 30 or more days a year;
- Employees who wear a respirator for 30 or more days a year;
- Members of organized HAZMAT teams; and
- Employees who are injured as a result of overexposure during a site emergency or show symptoms of illness that may have resulted from exposure to hazardous substances.

At the MSRE, all individuals involved with breaching of the primary containment system and subject to potential exposure will be required to be placed on the HAZWOPER medical surveillance program.

The MSRE H&S Manager will provide a list of individuals needing to be considered for the medical surveillance program to the SHEST representative. The SHEST representative, in conjunction with the ORNL Health Division, will determine which workers, meeting the criteria listed above, will be required to participate in the hazardous waste worker medical surveillance program. Physicals shall be documented through a written approval by the examining physician.

5.4.2 Medical Monitoring

MSRE workers and project personnel who have the potential of receiving an exposure may need to be placed on the bioassay program. The MSRE Radiation Protection Supervision will determine which individuals need to be placed on this program.

Radionuclides identified at the MSRE facility that require bioassay include ^{232}U and ^{233}U. The frequency of bioassay measurements for workers in radiological areas has been set by Energy Systems.

6. FREQUENCY AND TYPES OF MONITORING

6.1 EXPOSURE MONITORING

6.1.1 Area Monitoring

While operations are being conducted at the facility, periodic real-time assessment of potentially hazardous chemical and radiological concentrations using direct reading instruments will be performed by the OSHP representative and/or the RCT, as required. While work is being performed in the EZ/HAZWOPER designated site, monitoring will be performed as often as conditions require. Prior to the commencement of any task activities, background concentrations and levels near the area will be monitored and recorded in the H&S logbook or on the SWP and RWP. Background readings shall be taken into account before action levels are established by the RCT, OSHP representative, and the SSHO. Monitoring of air concentrations for any confined space entries will be conducted in accordance with ORNL procedures by a representative from OSHP. Details of monitoring (equipment needed and intervals) will be contained in the TSHASP.

6.1.2 Dosimetry

All site entrants shall be regulated by the ORNL Radiation Dosimetry program and shall comply with all provisions of the requirements of ORNL Radiation Protection. Entrants into Radiological Areas may be required to wear both beta-gamma (blue) and neutron (red) TLD's, as well as direct-read (pocket) dosimeters (as specified by the RCT). The RCT, based on the characterization of the site, will inform the Internal Dosimetry Program of the radionuclides of concern. This will determine the type and frequency of the bioassays. The radionuclides of concern for this project are listed in Table 4.3.

6.1.3 Criticality Accident Alarm System

The MSRE facility is equipped with an alarm system to detect the presence of high levels of radiation within the facility. The system will alarm ***after*** a nuclear criticality accident. This system is connected to the ORNL Waste Operations Control Center (WOCC). Upon receiving the signal of the alarm, the respective disciplines will be notified by the WOCC.

Upon hearing this alarm (a constant Edwards horn), all MSRE personnel at the facility should proceed to the designated assembly point at the east end of Building 7509 (Room 13) or to the assembly point in Building 7516 (Sect. 10.2.2.1) and await further instruction via the ORNL public address system.

6.1.4 Ventilation Alarm

The MSRE complex is equipped with a ventilation system that is connected to the ventilation stack located at the south end of the complex. If a nuclear criticality accident occurs, contaminants will be evacuated by way of the ventilation system up the stack. The stack is equipped with multiple filters to filter out any contaminants prior to discharge to the environment. A sensor alarm located in the stack will notify the building occupants of a stack vacuum failure. The alarm will be heard throughout the MSRE complex and will be monitored by the LSS. The alarm has a distinct bell sound, like a doorbell. Upon hearing this alarm, all occupants will evacuate the facility, proceed to

the assembly point at the east end of Building 7509 (Room 13) or the assembly point in Building 7516 and await further instructions from the LSS office.

6.2 MONITORING EQUIPMENT/ACTION LEVELS

Various types of monitoring equipment may be required to conduct worker exposure monitoring during MSRE operations. The SSHO shall ensure that adequate monitoring equipment is available prior to the start of work. The ES&H Manager shall ensure that the instruments are used only by persons with training and experience in the care, operation, calibration, and limitations of the equipment. Persons performing monitoring shall be approved by ORNL Radiation Protection (for radiation instrumentation) and ORNL OSHP (for industrial hygiene instrumentation). Work involving potential exposure to hazardous materials shall not be performed unless properly maintained and calibrated monitoring instruments are available for use.

Instrumentation such as the following may be used to identify the presence of and/or to quantify the potential health hazards in existence at the site:

- **Combustible Gas/Oxygen Meter:** To measure combustible gases and oxygen content in confined spaces, trenches, and other areas that may have limited ventilation. All instruments used should be fully automatic, self adjusting, and shall have the capability of detecting oxygen, hydrogen sulfide, and carbon monoxide concentrations. The instrument shall be precalibrated with standard gases of known concentrations prior to field use. The prescribed action limits for the instrument shall be as follows:

LEL	≥ 10.0 % (5.0 % LEL for confined spaces)
O_2	≤ 19.5 % or ≥ 22%
H_2S	5.0 ppm
CO	12.5 ppm

- **High-Flow Air Sampling Pumps**: To sample and evaluate the air quality on-site. These instruments shall be calibrated before and after each use.

- **Personnel Air Sampling Pumps:** To collect personal samples if airborne contaminants are encountered. These instruments shall be calibrated before and after each use by the ORNL OSHP instrumentation specialist or qualified designee.

- **Total Organic Vapor Monitors:** Photoionization detector (PID) or flame ionization detector (FID) to survey the surrounding environment for possible organic contamination. The instrument is not chemical-specific; therefore, it can only indicate the presence of volatile organics that are detectable in the range of the instrument. Action level for this monitor measured within the breathing zone for 1 min duration is 5 ppm unless the specific chemical TLV is known. In the event the action level is reached, the area will be evacuated and the ES&H Manager shall be notified. The ES&H Manager will, in turn, notify the proper ES&H discipline (e.g., OSHP).

- **Colorimetric Detector Tubes**: For field identification of specific chemical contamination presence and for providing a rough estimate of the concentration level. These instruments shall be leak-checked prior to each use. Action level is 1/2 PEL.

- **Noise Monitoring Equipment**: To identify "problem" noise areas and equipment. These instruments shall be calibrated prior to, and after, use. Action level is 85 dBA.

- **Wet Bulb Globe Thermometer (WBGT)**: May be used to detect possible heat stress conditions. These instruments will be calibrated according to the manufacturer's specifications. The WBGT should be used at temperatures >70°F. Action levels follow ACGIH guidelines.

- **Portable Gas Chromatograph (GC)**: May be used to help evaluate and isolate potential volatile components measured in the breathing zone by the PID or FID. The action level for this instrument is chemical dependent.

- **Personal Thermoluminescent Detection (TLD) Badges and Direct-Read Pocket Dosimeters**: Issued to each employee through ORNL Radiation Protection programs to monitor worker beta/gamma exposures.

- **Portable Alpha and Beta-Gamma Survey Meters**: To survey for radioactive contamination on personnel and equipment. These instruments shall be source-checked daily prior to and after use. Action levels are surface radioactivity limits listed in Table 4.2.

- **Neutron Dose Rate Instrument:** To survey for neutron radiation dose rates. These instruments shall be source-checked according to ORP procedures and calibrated at least annually.

- **Beta/Gamma Exposure Rate Instrument:** An ion chamber used to survey for beta and/or gamma radiation in order to determine exposure rates. These instruments shall be source-checked daily prior to and after use and calibrated at least annually.

- **CO_2 Monitor:** To continuously monitor and display the CO_2 content measured in parts per million to the nearest 50 ppm. Action level is 2500 ppm.

- **Direct-Reading Pocket Dosimeters:** Issued to employees through ORNL Radiation Protection programs in order to monitor worker exposures to gamma radiation. Direct reading pocket dosimeters allow employees to monitor their exposure to gamma radiation throughout the work period.

- **Neutron TLD Badge:** Issued to employees through ORNL Radiation Protection programs in order to monitor worker neutron exposure.

- **Air Sampling Equipment**: To identify and quantify airborne radioactivity or specific chemical contaminants through laboratory analysis of samples. In addition to the high-flow and personnel air sampling pumps, two portable alpha low-volume samplers will be utilized at the glove box and hold-up tanks. These instruments shall be function-checked weekly and performance tested monthly during routine use and prior to nonroutine use. These instruments are currently calibrated annually.

All types of instrumentation used in field operations must be specified in each TSHASP.

6.3 CALIBRATION REQUIREMENTS

6.3.1 Calibration of Monitoring and Detection Instruments

All monitoring and detection instruments used during field operations shall be calibrated within the proper time frame and in accordance with the manufacturer's recommendations, guidelines, and specifications described in the manufacturer's SOPs. All instrumentation operation and calibration shall be conducted in accordance with ORNL Radiation Protection and OSHP procedures, where applicable and available.

6.3.2 Calibration of Fixed Alarm Systems

The calibration of MSRE fixed alarm systems will be performed on a predetermined schedule as part of the MSRE Surveillance and Maintenance Program. The discipline(s) responsible for maintaining a particular instrument system(s) will be responsible for providing calibration services.

6.4 MONITORING RESPONSE GUIDELINES

During site operations, the decisions to upgrade or downgrade PPE levels; to re-establish site EZs, CRZs, and/or Support Zones; or to cease work activities may be made on the basis of site monitoring results. These changes can only be authorized by site authorities including the ES&H Manager, the SSHO, the RCT, and ORNL OSHP. These response guidelines are dependant upon the type of work being conducted, the suspected contaminants, and the health effects and toxicity of the contaminants. Conditions vary from task to task, therefore, monitoring response will vary due to the site conditions. Guidelines shall be established for real-time site assessments in each TSHASP.

Due to the hazardous nature of the contaminants at MSRE and the array of hazardous chemicals used to treat blockages throughout the system, response to a release of material is a serious event. All alarms and signals are considered "actual" for a release until otherwise proven false. No matter where the potential release occurs, all MSRE personnel will shelter-in-place. The MSRE alarm recorder will indicate where a breach in the system has occurred. This will be verified by the WOCC and the LSS by phone to the MSRE Facility Manager. The Facility Manager, Operations Manager, ES&H Manager, and an MSRE RCT will attempt to determine the extent of the release visually, without breaching containment. The OSHP representative will be notified and will provide appropriate instrumentation to determine the extent of a chemical release. An OSHP representative and an RCT will don appropriate PPE and enter the area to ascertain if a release has occurred, monitoring as they go. The MSRE Emergency Response Team will be mobilized. The Hazardous Waste Operations Group will be notified through the LSS and will establish decontamination stations and serve as the MSRE Emergency Response Team's backup. The MSRE Emergency Response Team will enter the area to contain and stem the leak. The Emergency Response Team will not enter the area until they have received notification from the Hazardous Waste Operations Group that the group is situated and ready to support the entry team.

7. SITE ZONES AND CONTROL MEASURES

Where there is a potential for employee exposure to hazardous chemicals or radiation, or the accidental spread of hazardous substances throughout the building or the environment, zones will be established to separate certain operations and to control the flow of personnel and equipment. The establishment of these zones or areas will also ensure that personnel are properly protected against hazards at the work site, that work activities and contamination are confined to the appropriate area, and that personnel can be evacuated and accounted for in the event of an emergency.

Site zones and control measures may be either Radiological Areas, HAZWOPER-designated zones, or both. The decision to established Radiological Areas or HAZWOPER zones will be made by the RCT, the SSHO, and/or the ES&H Manager. The determination will be based on the hazards present, duration of the task to be performed, potential for exposure, location, and/or environmental impact.

7.1 WORK ZONES

HAZWOPER determined work zones (EPA 1991, NIOSH et al. 1985) will be cordoned off with HAZWOPER (orange and black) tape and/or HAZWOPER signs that will be placed to facilitate recognition of the zones. Typical HAZWOPER work zones include the EZ, the CRZ, and the Support Zone. The placement of these zones will be determined by the SSHO, and, if radiological areas are involved, by the RCT. The posting of work zones may be modified to accommodate ORNL ORP procedures. In some cases, based on site conditions, the three separate zones may not be necessary (e.g., confined spaces). In such cases, the site will be posted as a HAZWOPER site and access will be controlled.

The ES&H Manager and/or SSHOs (for HAZWOPER tasks), and the RCT (for radiological concerns), shall establish these zones (to the best of their ability) based on the contamination present and the specific work to be performed. The SSHOs will modify these zones to meet the constraints of the facility. The SSHOs will also control access to each of the zones.

These zones will be isolated from the rest of the facility by use of tape, rope, and/or warning signs. No person will enter the EZ or CRZ without proof of sufficient training and appropriate medical clearance as required by this PHASP, OSHA 1910.120(e), and the TSHASP. A daily log of all persons entering and leaving the CRZ will be maintained by the SSHO or designee in the H&S logbook.

7.1.1 Exclusion Zone

For HAZWOPER-designated work, the EZ is the area where contamination does or could occur and the greatest potential for exposure exists. To separate the EZ from the rest of the job site, the outer boundary of the EZ (also known as the "hotline") shall be designated by the SSHO, with concurrence from the RCT, and be clearly marked. All persons who enter the EZ will have the prescribed level of protective clothing and training and be placed on the medical monitoring program (for bioassay), as determined by the SSHO and ORP Coordinator, depending on the zone. An entry and exit checkpoint will be visually defined at the periphery of the EZ to regulate the flow of personnel and equipment into and out of the zone.

7.1.2 Contamination Reduction Zone

As the transition area between the contaminated area and the clean area, the CRZ is the area in which decontamination takes place, if needed. This zone is designed to reduce the probability that the Support Zone will become contaminated or affected by other site hazards. Access requirements for personnel entering the CRZ are the same as those described for entrance to the EZ. Upon leaving the CRZ and before entering the Support Zone, each person will be monitored by the RCT or a designated representative properly trained to evaluate hazards. Equipment will also be surveyed for radiological contamination by the RCT, or a designee, before exiting the CRZ into the Support Zone.

7.1.3 Support Zone

The Support Zone is defined as the uncontaminated area where workers or visitors should not be exposed to hazardous conditions. The zone will be marked with appropriate signs.

Because the Support Zone is free from contamination, personnel working within this zone may wear normal work clothes. Access to and from the area is not restricted for authorized personnel. Such personnel, however, will receive instruction in the proper evacuation procedures in the event of an emergency.

7.2 SITE COMMUNICATIONS

Several means of communication may be available for use during site operations. The location and type of communication shall be addressed in the pre-entry health and safety briefing, and shall be specified in the TSHASP.

7.2.1 Two-Way Radios

Some personnel, such as the SSHO, the RCT, the ORP Coordinator, the Facility Manager, and the OSHP representative, may have two-way radios for use in plant-wide communications. Radio numbers of key personnel will be listed in the PHASP and the TSHASP. Other site personnel who will have access to two-way radios should be identified during the pre-entry health and safety briefings. Radio and headset checks will be performed prior to entering a work area.

7.2.2 Plant Telephone System

The ORNL plant telephone system now requires that all seven digits of the telephone number be dialed when communicating within the plant (e.g., 574-XXXX, 576-XXXX, 241-XXXX).

7.2.3 The Buddy System and Hand Signals

The "buddy system" as described in 29 CFR 1910.120(a)(3) shall be used during work operations and activities conducted in the MSRE facility. Hand signals shall be used as the means of communication when distance, noise levels, or respirators prevent verbal communications. Basic hand signals and their meanings during operations are listed below.

- Thumbs up — "Okay" or "I Understand."
- Thumbs down — "No," "Negative," or "I Do Not Understand."

- Grasping buddy's wrist — "Evacuate!" or "Leave The Site Now!"
- Hands on top of the head — "I Need Assistance" or "Help!"
- Hand on the throat — "I Am Choking" or "I Can't Breathe!"

7.3 SANITATION

7.3.1 Housekeeping

The site shall be maintained in an orderly manner, free of congested construction debris and unnecessary combustible material. All uncontaminated waste shall be handled according to the task waste management plan. Disposable contaminated PPE will be scanned and bagged by the RCT and placed in the proper containment system as per ORNL procedure for disposal. An accumulation area will be designated to temporarily store various generated waste for removal by Energy Systems Waste Management.

7.3.2 Potable Water

Cool drinking water is available from water fountains located between Building 7503 and Building 7509 and in Building 7503. Water cooler and fountain orifices shall be cleaned on a regular basis by ORNL housekeeping.

7.3.3 Consumption of Food and Tobacco Products

Eating, drinking, chewing gum, and use of tobacco products at the MSRE Facility are confined to designated areas only. These areas will be designated by the MSRE Facility Manager. Designated areas shall be surveyed regularly for radiological contamination by the RCT.

No consumption of food, liquid, or use of tobacco products will be allowed in the CRZ or EZ of a HAZWOPER-designated area or in Radiological Areas.

7.3.4 Washing and Toilet Facilities

Two washing/toilet facilities, one for males and the other for females, are permanently in place within Building 7503. Each room contains shower stalls, toilets, and sinks. The facilities are large enough to handle occupants of Buildings 7503 and 7509. The facility is maintained by housekeeping personnel.

8. DECONTAMINATION PROCEDURES

Radiological Areas and hazardous chemicals pose primary concerns in controlling the spread of contamination within the facility. It is of utmost importance that task personnel, visitors, equipment, and the environment be protected from the spread of contaminants. The strict use of contamination control methods should be employed on all tasks conducted in the MSRE facility. Whenever engineering controls are not feasible, PPE shall be used to reduce employee exposure levels and maintain the levels ALARA. All engineering controls and safe work practices must be documented in the TSHASP and WPs.

8.1 PERSONNEL DECONTAMINATION

Decontamination, the process of removing, containing, or neutralizing contaminants, is critical to safety and health at the facility. Decontamination protects workers from hazardous substances that can eventually permeate protective clothing, respiratory equipment, and tools. Decontamination protects task personnel by minimizing the spread of hazardous substances into clean areas within the facility and protects the community by preventing the migration of contaminants from the worksite.

Protective clothing and respirators help prevent the wearer from becoming contaminated or inhaling hazardous substances, and good work practices help minimize contamination on PPE, tools, and equipment. But even with safeguards, contamination may occur. To prevent and minimize the severity of such incidences, the HAZWOPER regulations in 29 CFR 1910.120(k) and ORNL RPP-540 will be referred to in matters of contamination control.

The RCT will determine the extent of radiological contamination present using direct reading radiological instruments and background information gathered from historical and process knowledge. Prior to beginning a task, the area in which a task is to be conducted will be screened by the on-site RCT, and a hazard determination for radiological concerns will be completed. With this information, the dose assessment levels will be determined for the radionuclides of concern. These levels will establish the trigger for possible decontamination purposes. If trigger levels are needed for completion of the task, they will be recorded on the task RWP prior to WP sign-off and, therefore, prior to beginning work.

The appropriate level of PPE for radiological contaminants will be determined by the on-site RCT. Most articles of PPE are designed to be disposable. When egressing a Radiological Area, doffing procedures will be posted at the border of the Radiological Area and the Buffer area for rad or at the border of the EZ and the CRZ for HAZWOPER operations or an RCT or SSHO will be at the step-off pad to instruct individuals if they need help. All disposable PPE will be placed in the appropriate containers for scanning and proper disposal by the RCT. Individuals exiting the posted areas will either frisk themselves (permitted only if the individual has completed Radiological Worker II training) or be frisked by the RCT. If any contamination is detected and the RCT is not already present, he/she must be notified at once. The RCT will then refrisk the individual in question to evaluate the level and extent of contamination and direct the individual on the proper decontamination techniques. The individual will be periodically monitored to determine the success of the decontamination effort. If contamination cannot be removed to acceptable levels, the affected person will be transported to a health care facility designated by the incident commander after consultation with ORNL Health Services Center.

For specific details on personnel decontamination, RPP SOP 02-540-01 on handling radiologically contaminated personnel may be used as a guide.

8.2 EQUIPMENT DECONTAMINATION

A laydown area will be designated in the Radiological Area or the CRZ close to the egress point into the Clean or Support Zone. This area will contain a sheet of plastic or blotter paper large enough to protect the flooring from transferable contamination. The RCT, wearing the appropriate PPE, will survey all equipment, tools, sample containers, and other articles leaving the Radiological Area or the CRZ and entering the Clean Area/Support Zone. If any contamination is detected on any article, an attempt will be made to decontaminate the article. The piece in question will be decontaminated with a cloth wipe and a cleaning agent as directed by RCT. The article will be resurveyed to determine the progress of the effort. This process will be continued until the piece is free of contamination or the article is disposed of properly by authority of the RCT. Once the article has been decontaminated and determined to be free of contamination, the piece can be removed to the Clean Area/Support Zone.

Maximum ORNL limits for items given radiation and contamination clearance are presented in Table 4.2.

9. STANDARD OPERATING PROCEDURES

All SOPs used for any task or effort connected with the MSRE project shall be written in accordance with established procedures. Task-specific SOPs shall be developed, reviewed and approved by appropriate MSRE project personnel, included in the WP and the TSHASPs, as necessary, and maintained at the job site. Specific SOPs will be referenced and, when applicable, included in the WP.

9.1 WORK SMART STANDARDS FOR ENVIRONMENT, SAFETY, AND HEALTH

DOE, Energy Systems, and Lockheed Martin Energy Research Corp. (Energy Research) initiated the Work Smart Standards (WSS) Process to develop standards that are necessary, sufficient, and feasible to implement for protecting the environment and the health and safety of workers and the public. Sets of WSS are being developed and approved for particular activities, projects, facilities, and operations. The WSS will be implemented through integrated safety management systems using DOE P 450.4, *Safety Management System Policy,* which reinforces safety responsibility and accountability at all levels.

In selecting standards, the identification team considered standards in order of preference:

1. Federal and State laws and regulations.
2. Local ordinances.
3. Industry consensus standards.
4. DOE Orders and standards.

In citing applicable Federal or State regulations as WSS, a balance was sought in specifying the level of detail within the functional areas of health and safety and environment.

The WSS were reviewed for applicability to the tasks and objectives of the MSRE remediation efforts. WSS that apply to the conditions at the MSRE are included in the list of reference MSRE WSS. As hazards are identified those pertinent requirements and standards needed to protect the environment and the workers from that hazard will be added to the MSRE WSS matrix. Once the applicable Energy Research WSS are approved, the WSS utilized at MSRE will be compared with the Energy Research regulations. Where appropriate, Energy Research WSS will be adopted at MSRE. If no appropriate Energy Research WSS is available, an appropriate Energy Systems WSS will be adopted. Table 9.1 identifies (1) reference WSS that pertain to health and safety at MSRE and (2) sections of this document where more information on these WSS can be found.

9.2 BASIS FOR INTERIM OPERATION (BIO)

The purpose of the BIO is to establish an interim safety basis for the MSRE facility activities by demonstrating safety to workers and the general public. The BIO demonstrates that risks are identified, understood, and addressed through defense-in-depth safety philosophy that results in necessary and sufficient engineering features (both active and passive), design criteria, safety management programs, and specific operational controls and limitations that are implemented at the MSRE facility.

Table 9.1 Reference work smart standards (WSS) for health and safety hazards at MSRE

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Fire			
Electrical	Fire hazards associated with electrical equipment or work	•29 CFR 1910 •29 CFR 1926 •NFPA 70	4.5.5
Flammable material and compressed gasses	Applies to liquids, gases, solids—use and storage	•29 CFR 1910 •29 CFR 1926	4.8.5 4.8.6
Radiant heat, closed systems	Activities that use radiant heaters (includes office heaters) and steam heating systems	•29 CFR 1910 •29 CFR 1926	4.5.6
Spark-producing tools near flammables	Activities in a flammable or explosive atmosphere	•29 CFR 1910 •29 CFR 1926	4.8.5
Storage of combustibles	Identify items like pallets, boxes of material, lubricating oils, etc.	•29 CFR 1910 •IA - Fire prevention or response elements may be modified, reduced, or eliminated when justified by an evaluation that demonstrates an equivalent level of protection or an acceptably low risk to personnel and the environment. Such modification, reduction, or elimination of protection shall be approved by the DOE-ORO authority having jurisdiction (AHJ) for fire protection matter	4.8.5 7.3.1
Welding, torch, cutting, brazing		•29 CFR 1910 •29 CFR 1926 •NFPA 51B	4.5.2 4.8.4 4.5.3 4.8.9
Fire prevention		•29 CFR 1910 •29 CFR 1926 •40 CFR 264 •IA - Fire prevention or response elements may be modified, reduced, or eliminated when justified by an evaluation that demonstrates an equivalent level of protection or an acceptably low risk to personnel and the environment. Such modification, reduction or elimination of protection shall be approved by the DOE-ORO authority having jurisdiction (AHJ) for fire protection matter	10.2.4 4.8.4 4.8.5 4.8.6 10.1.1

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Fire rescue/response		•29 CFR 1910 •IA - Fire prevention or response elements may be modified, reduced, or eliminated when justified by an evaluation that demonstrates an equivalent level of protection or an acceptably low risk to personnel and the environment. Such modification, reduction, or elimination of protection shall be approved by the DOE-ORO authority having jurisdiction (AHJ) for fire protection matter. •NFPA 299 •TCA-68-140 •ORC 47:4731	10.2
Electrical			
Exposed to <600 V	120 V, 208 V, 480 V	•29 CFR 1910 •29 CFR 1926 •NFPA 70 •ANSI C2 •NFPA 70E	4.5.5 4.8.12
Exposed to >600 V	Activities involving work on the power distribution system (either aerial or subterranean) such as line work, phasing, conductor repair, etc.	•29 CFR 1910 •29 CFR 1926 •NFPA 70 •ANSI C2 •NFPA 70E	4.5.5
Temporary lighting		•29 CFR 1910 •29 CFR 1926	4.8.1
Substations/ transformers		•29 CFR 1910 •29 CFR 1926 •NFPA 70 •ANSI C2 •NFPA 70E	4.5.5
Nonionizing Radiation			
Laser	Laser wands used for presentations are **not** identified	•29 CFR 1926 •ANSI Z 136.1 (1993) •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELs)]	4.8.12

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Ultraviolet radiation	Activities where work will be conducted out-of-doors or near ultraviolet sources	•ANSI Z 49.1 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELS, and NIOSH RELs)]	4.5.2 4.8.4
Intense light source	Activities at or near intense light (e.g., welding, torch cutting, hot or molten materials)	•ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELs)]	4.5.2 4.8.4
Ionizing Radiation			
Radiation exposure	Activities that involve radioactive materials or radiation generators, that may result in internal and/or external radiation exposures (sources, medical X-ray equipment)	•10 CFR 835 •DOE N 441.1, Sect. 6.d, 6 •DOE N 441.1, Sect. 6.e (IA - Maintenance of the applicable NRC license for sealed sources will be acceptable)	4.7 Table 4.3 4.2 4.3 4.4
Radiation contamination	Activities that could cause airborne contamination and/or removable surface contamination that could result in internal uptake and/or contamination spread	•10 CFR 835 •DOE N 441.1, Sect. 6.d, 6 •DOE N 441.1, Sect. 6.e (IA - Maintenance of the applicable NRC license for sealed sources will be acceptable)	4.7 Table 4.3 4.2 4.3 4.4
Fissile material	Activities that involve fissile material(s) inspection, storage, configuration change, use or transportation	•10 CFR 830.120 •10 CFR 835 (accident dosimetry) •ANSI/ANS-8.1 •ANSI/ANS-8.3 •ANSI/ANS-8.5 •ANSI/ANS-8.7 •ANSI/ANS-8.10 •ANSI/ANS-8.15 •ANSI/ANS-8.17 •ANSI/ANS-8.19 •ANSI/ANS-8.20	4.7.1

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Environmental radiological program	Applicable to following A/H/I: •Generation, handling, or processing of radioactive materials; •Transfer of radioactive material; •Radioactive effluent discharges—air, surface water, groundwater, or a sanitary sewer; •Low-level waste— treatment, storage, or disposal; •Transuranic waste— treatment storage, or disposal; •Property containing residual radioactive material; •Release of property containing residual radioactive material	•IA - The contractor will use a tailored approach to environmental radiological management systems that addresses the following functions: (1) reduction/minimization, (2) characterization, (3) segregation, (4) acceptance criteria, (5) packaging, (6) treatment, (7) storage, (8) disposal, (9) environmental surveillance, (10) preoperational monitoring, (11) meteorological monitoring, and (12) reporting dose to the public. •IG - DOE Order 5820.2A & Draft 10 CFR 834	4.7 Table 4.2 Table 4.3 4.2 4.3 4.4 3.3.4 5.1.5 5.3 5.4.2 6 7 8 11
Generation, handling, or processing of radioactive materials		•10 CFR 20.1301 [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 1.a. Any temporary increase in dose limit to be approved by DOE ORO.] •10 CFR 20.1101(b) [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 2 only.] •10 CFR 20.1302 [IG - DOE Order 5400.5, Ch. II, Sects. 6.b(1), 6.b(2)(a) through 6.b(2)(d) provides consensus methods]	4.7 Table 4.2 Table 4.3 4.2 4.3 4.4 5.3 5.1.5 3.3.4
Transfer of radioactive material		•IA - Receiver must have a NRC or agreement state license to receive material. •10 CFR 20.1301 [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 1.a. Any temporary increase in dose limit to be approved by DOE ORO.] •10 CFR 20.1101(b) [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 2 only.] •10 CFR 20.1302 [IG - DOE Order 5400.5, Ch. II, Sects. 6.b(1), 6.b(2)(a) through 6.b(2)(d) provides consensus methods]	4.7 5.3 Table 4.3

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Transuranic waste: treatment, storage, or disposal		•IA - On-site disposal of transuranic waste is outside the EMEF work scope. •10 CFR 20.1301 [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 1.a. Any temporary increase in dose limit to be approved by DOE ORO.] •10 CFR 20.1101(b) [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 2 only.] •10 CFR 20.1302 [IG - DOE Order 5400.5, Ch. II, Sects. 6.b(1), 6.b(2)(a) through 6.b(2)(d) provides consensus methods.] •10 CFR 20 Appendix B, Tables 2 & 3. •10 CFR 20.2003 [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. III, Fig. III-1.] •DOE Order 5400.5, Ch. III, Fig. III-3 [IA - Radionuclide DCGs for air immersion only]	11.4 5.3 Table 4.3
Property containing residual radioactive material		•40 CFR 300 •10 CFR 20.1301 [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 1.a. Any temporary increase in dose limit to be approved by DOE ORO.] •10 CFR 20.1101(b) [IA - Criteria provide protection comparable to DOE Order 5400.5, Ch. II, Sect. 2 only.] •10 CFR 20.1302 [IG - DOE Order 5400.5, Ch. II, Sects. 6.b(1), 6.b(2)(a) through 6.b(2)(d) provides consensus methods]	4.7 Table 4.2 Table 4.3 6
Material Handling			
Compressed gas cylinders	Activities involving the handling and storage of cylinders (inert, flammable, toxic)	•29 CFR 1910 •29 CFR 1926	4.8.6

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Cranes and hoists, hoisting, rigging, and material handling	Activities where the use of gantry, overhead, monorail, and portable cranes will be used. Does not include personnel work platforms	•29 CFR 1910 •29 CFR 1926 •ANSI B30.2 •ANSI B30.5 •ANSI B30.10 •ANSI B30.11 •ANSI B30.16 •ANSI B30.20 •ANSI B30.21 •ANSI B56.6	4.8.10 4.8.11 4.5.5
Fork lift operation		•29 CFR 1910 •29 CFR 1926	4.8.10 4.8.11
Hazardous equipment and machinery	e.g., banding machines	•29 CFR 1910 •29 CFR 1926	4.8.9 4.5.5 4.8.3 4.8.10 4.5.1
Storage/handling of toxic materials		•29 CFR 1910 •29 CFR 1926	4.6
Transportation of hazardous waste on-site	Includes radioactive material	•29 CFR 1910 •29 CFR 1926	4.2 4.7.1.1 4.7.1.2 5.1.7
Transportation of hazardous waste		•40 CFR 261 & 263 •TN 1200-1-11-.04	4.6.2 4.8.6 5.1.7
Biological Factors			
Animals, insects		•29 CFR 1910 •29 CFR 1926	4.8.14.2
Indoor air	Bacteria, fumes, etc.	•ANSI/ASHRAE 62-1989	4.8.14.1
Mold and mildew, bird droppings		•29 CFR 1910 •29 CFR 1926	4.8.14.1 4.8.14.2
Poisonous plants	Such as poison ivy, etc.	•29 CFR 1910 •29 CFR 1926	4.8.14.2
Bloodborne pathogens	Activities where employees may be occupationally exposed to blood or potentially infectious materials	•29 CFR 1910	4.8.14.3
Thermal			
Cryogens	Activities where cooling materials such as liquid nitrogen are used or stored	•29 CFR 1910	4.6.2

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Hot/cold work environment		•29 CFR 1910 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELs)]	4.5.6
High temperature equipment/ materials	Activities where equipment/material that generates intense heat is used	•29 CFR 1910 •29 CFR 1926	4.8.4
Personnel			
Asbestos/man-made mineral fibers		•29 CFR 1910 •29 CFR 1926 •40 CFR 61, 257, 258, & 763 •TN 1200-1-7 •TN 1200-3	4.8.7
Asphyxiating gases	Activities that could release sufficient gases to (1) displace oxygen and result in an oxygen-deficient atmosphere (e.g., nitrogen, hydrogen, Freon, argon, or carbon dioxide) or (2) interfere with bodily use of oxygen (e.g., carbon monoxide)	•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELs)]	4.5.7 4.8.6 Table 4.1
Confined spaces	Activities conducted within "confined spaces" as identified by OSHA	•29 CFR 1910 •29 CFR 1926	4.5.7
Elevated work	Activities with potential for falls from elevated surfaces. Heights and configurations specified in OSHA	•29 CFR 1910 •29 CFR 1926	4.5.3
Eye damage	Debris-generating activities (e.g., grinding, cutting, cleaning with compressed air)	•29 CFR 1910 •29 CFR 1926	4.5.2
Hazardous materials/waste		•29 CFR 1910 •29 CFR 1926 •ANSI Z 358.1 •ANSI/ASHRAE 62-1989 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	11.4 4.6

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
High noise levels		•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.5.1
Lifting/carrying heavy objects	Activities where personnel move the heavy objects	•29 CFR 1910 •29 CFR 1926	4.8.3
Vibrating equipment	Activities where hand-held saws, decontamination scabbling, or hammering equipment is used	•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.8.3
Walking/working surfaces	Identify: (1) general surface hazards (e.g., irregular surfaces, floor grating, wet surfaces, scaffolds, or ladders); (2) low overheads and protrusions into walking and work areas (e.g., pipes, wiring, or air conditioners)	•29 CFR 1910 •29 CFR 1926	4.5.3
Excavation/ penetration		•29 CFR 1910 •29 CFR 1926	4.8.12
Demolition	Activities where machinery is used to demolish	•29 CFR 1910 •29 CFR 1926	4.8.12
Chemical			
Acids, solvents, toxic agents, and hazardous liquids	Includes sensitizers	•29 CFR 1910 •29 CFR 1926 •NFPA 45 (IA - for laboratories only) •ANSI Z 358.1 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	Table 4.1 4.6
Beryllium		•29 CFR 1910 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.8.8

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Carcinogens		•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.6 Table 4.1
Explosive and blasting agents	Storage and use for activities such as demolition	•29 CFR 1910 •29 CFR 1926 •TCA 68-105	4.8.12
Heavy metals	Lead, mercury, etc.	•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.6.1
Nuisance dusts	Activities that may generate or be exposed to dusts	•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.8.12 4.8.9
Pesticides, herbicides (non-FIFRA)		•29 CFR 1910 •29 CFR 1926 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.6
Toxicity in smoke or fumes	Activities that may generate smoke, fumes, etc., not associated with welding, cutting, or hot work (e.g., open burning of brush, exhaust emissions, HF releases)	•29 CFR 1910 •29 CFR 1926 •ANSI/ASHRAE 62-1989 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.6.1 4.2 4.6.3 4.6.4 4.6.5 4.8.6
Welding cutting, hot work fumes		•29 CFR 1910 •29 CFR 1926 •ANSI/ASHRAE 62-1989 •ANSI Z 49.1 •ACGIH, most current	4.8.4

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Reproductive	Activities that involve occupational exposure to chemical, physical, or biological agents of concern	•29 CFR 1910 •29 CFR 1926 •ANSI/ASHRAE 62-1989 •ACGIH, most current [IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA, WEELs, and NIOSH RELS)]	4.6
Mechanical			
Pressure systems	Used to identify systems and equipment containing stored pressure energy (e.g., air, steam, water, hydraulic)	•29 CFR 1910 •29 CFR 1926 •ASME B&PV Code •ANSI/ASME B31	4.1 4.2 4.8.6
Machinery and rotating parts	Aspects of pinch, crush, or hydraulic spray from the in-place operation of equipment (e.g., the working components of a brake, shear, lathe, drill press, drilling rigs, backhoes, bulldozers, or jacks)	•29 CFR 1910 •29 CFR 1926	4.8.9 4.8.10 4.8.11
Material grinding, cutting, drilling		•29 CFR 1910 •29 CFR 1926	4.5.3 4.8.9
Mobile equipment	Aspects of pinch, crush, or run over personnel from movement of the entire piece of equipment (e.g., drilling rigs, backhoes, or bulldozers)	•29 CFR 1910 •29 CFR 1926	4.8.9 4.8.10 4.8.11
Moving equipment	Aspects of pinch or crush personnel from movement of the major equipment components (e.g., bridge cranes or monorails)	•29 CFR 1910 •29 CFR 1926	4.8.9 4.8.10 4.8.11
Moving vehicles, carts, and bicycles	Activities where employees used vehicles, carts, bicycles inside facilities	•29 CFR 1910 •29 CFR 1926 •TCA 55-8-101	4.8.9 4.8.10 4.8.11
Powered platforms		•29 CFR 1910 •29 CFR 1926	4.8.10 4.8.11
Special hand tools	Air wrenches, special saws, power-actuated nail guns, etc.	•29 CFR 1910 •29 CFR 1926	4.5.5 4.8.5
Stored mechanical energy	Used to identify equipment under tension or temporarily elevated (e.g., compressed spring, blocked door)	•29 CFR 1910 •29 CFR 1926	4.8.11

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Other			
General office	Facilities, office equipment, workplace stress, etc.	29 CFR 1910	4.8.3
Generic (all work/all areas)			
Housekeeping		•29 CFR 1910 •29 CFR 1926	4.8.13 7.3.1
Egress		•29 CFR 1910 •29 CFR 1926 •NFPA 101 •NFPA 101A	4.8.13 3.3.7
Illumination		•29 CFR 1910 •29 CFR 1926	4.8.1
Sanitation		•29 CFR 1910 •29 CFR 1926	7.3 11.3
Weather-related exposure	Activities where employees could be exposed to high winds, lightning, hail, rain, snow, etc.	•29 CFR 1910 •29 CFR 1926	4.5.6 4.5.5
Injury and illness reporting		•29 CFR 1904	4.8.13 3.3.7 3.3.3
Air emissions		•TN 1200-3	11.1
Emission of hazardous air pollutant	Hazardous air pollutants for NESHAPs are asbestos, benzene, beryllium, coke over emissions, inorganic arsenic, mercury, radionuclides, vinyl chloride	•40 CFR 61 •TN 1200-3	11.1
Hazardous substances (CERCLA)	Hazardous substances are designated in 40 CFR 302.4	•40 CFR 302	11.1 11.2 11.4
Release or threatened release of hazardous substances		•40 CFR 300 •TN 1200-1-13	11.1 11.2 11.4
Extremely hazardous substances	Extremely hazardous substances are designated in 40 CFR Part 355, Appendix A	•40 CFR 355	11.1 11.2 11.4 4.6 4.8.6
Toxic chemicals	Toxic chemicals are listed in 40 CFR 372.65	•40 CFR 372	4.6
Hazardous chemicals	Hazardous chemicals are listed in 40 CFR 370.2	•40 CFR 370	4.6

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Waste generation		•40 CFR 260, 261, 262.11 •TN 1200-1-11	11.4
Hazardous waste generation		•40 CFR 260, 261, 262, 265, & 268 •TN 1200-1-11	11.4
Recycle or reuse of materials		•40 CFR 247 •40 CFR 261, 262, & 266 •40 CFR 761.1, 761.3, 761.20, & 761.30 •TN 1200-1-11-.09	11.4 4.8.5
Used oil		•40 CFR 261, 262, & 279 •40 CFR 761.3, 761.20, & 761.30 •TN 1200-1-1-11	11.4 4.8.5
Oil		•40 CFR 110 & 112	11.4 4.8.5
Solid waste disposal		•40 CFR 257 & 258 •TN 1200-1-7	11.4
Polychlorinated biphenyls		•40 CFR 761 •TN 1200-1-7 •40 CFR 116 & 117 •TN 1200-4 •40 CFR 302	11.4
Species of wildlife and plants that are federally listed as endangered, threatened, or of concern	Endangered and threatened wildlife and plants are listed in 50 CFR 17.11 and 17.12	•50 CFR 17 & 222	11.5
Sites, buildings, structures, or objects of historical significance	Consult appropriate Cultural Resource Coordinator	•36 CFR 60, 63, 65, 78, 79, & 800 •43 CFR 7 (IG - Programmatic Agreement for Management of Historical and Cultural Properties at the Oak Ridge Reservation)	11.5
Alteration to, damage to, or destruction of a facility eligible for listing on the National Register of Historic Places	Consult appropriate Cultural Resource Coordinator	•36 CFR 60, 63, & 800 (IG - Programmatic Agreement for Management of Historical and Cultural Properties at the Oak Ridge Reservation)	11.5
Human remains, structures, or artifacts that are at least 100 years old		•36 CFR 79, 296, & 800 (IG - Programmatic Agreement for Management of Historical and Cultural Properties at the Oak Ridge Reservation)	11.5

Table 9.1 (continued)

Activity/Hazard/ Issue	Supplemental criteria	Standards/Requirements	MSRE ES&H plan [a] (Sect. No.)
Point source discharges to surface water		•40 CFR 122 •TN 1200-4	11.2
Nonpoint source discharges (i.e., storm water runoff) to surface water		•40 CFR 122 & 232 •33 CFR 322 & 330 •TN 1200-4-10-.05	11.2
Discharges to surface water of toxic pollutants	Toxic pollutants are identified in 40 CFR 129.4	•40 CFR 122 & 129 •TN 1200-4-10-.05	11.2
General		•10 CFR 1021, NEPA	11.5

Note: Acronyms and abbreviations used in Table 9.1 are defined in Abbreviations, Page xiii.

[a] *Environmental Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL/ER-326/R1.

The safety analysis in the BIO consists of a preliminary hazards analysis (PHA) for the activities and hazards associated with the facility in its present shutdown condition. The intent of the PHA is to identify any areas where equipment, design, or procedural flaws might constitute safety vulnerabilities for the facility such that the addition of controls, restrictions, or compensatory measures may be required.

9.3 INTEGRATED SAFETY MANAGEMENT

The principles and functions of the Integrated Safety Management System are to be used to achieve systematic integration of environment, safety, and health protection into management and work practices at all levels of work. The direct involvement of the workers who will perform the work, beginning at the planning stage and continuing through final completion of activities, is critical to the successful development and implementation of an integrated safety management system.

The guiding principles of Integrated Safety Management include the following:

- Line management is directly responsible for the protection of the public, the worker, and the environment. To complement management, the DOE's Office of Environment, Safety, and Health provides safety policy, enforcement, and independent oversight functions.

- Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels.

- Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

- Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.

- Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.

- Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.

- The conditions and requirements that must be satisfied for operations to be initiated and conducted shall be clearly established and agreed-upon.

Integrated Safety Management is achieved by implementation of the following core functions, which are addressed in detail throughout this PHASP.

1. Define the scope of work—missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

2. Analyze the hazards—hazards associated with the work are identified, analyzed, and categorized.

3. Develop and implement hazard controls—applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.

4. Perform work within controls—readiness is confirmed and work is performed safely.

5. Provide feedback and continuous improvement—feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

10. EMERGENCY PREPAREDNESS AND CONTINGENCY PLANS

This section applies to any type of emergency, such as a fire, explosion, radiation release, radiological or chemical exposure, personal injury, or other types of emergencies that may be encountered by facility personnel at the MSRE facility. The information presented in this section was compiled from the Radiological Worker Training and the General Employee Training and should be in concert with the X-10 Site Emergency Plan, which defines emergency response requirements and responsibilities. MSRE also has a Local Emergency Manual developed specifically for the MSRE facility and the remediation project. All information in this section is discussed in greater detail in the Local Emergency Manual, which is conveniently located in a orange binder at the east entrance to Building 7509.

10.1 EMERGENCY CONTACTS AND NOTIFICATIONS

A listing of emergency contacts' telephone numbers and radio numbers shall be provided in each TSHASP and shall be posted during all facility operations in a designated location that is easily accessible to all site personnel. Primary emergency telephone numbers shall include, but are not limited to, the following:

Emergency Personnel	**Phone**	**Radio No.**
ORNL Emergency Response	911	295
Laboratory Shift Superintendent	574-6606	Station 103 or 295
Fire Department	574-5678	295
Medical (Health Services Center)	574-7431	295
Security	574-6646	295
Office of Safety and Health Protection	576-8218	
Office of Radiation Protection	574-6701	152
Environmental Compliance	574-8770	650
ER Program ES&H Manager	574-8268	686
SHEST	576-5064	231
Nuclear Criticality Safety	574-4338	

NOTE: These phone and radio numbers are subject to change and **must be verified** before posting or including in the TSHASP.

The LSS has responsibility for overall ORNL shift operations and acts as Site Emergency Director in the event of an emergency at Energy Systems facilities. The LSS evaluates emergency situations and directs remedial actions, taking into consideration risks versus benefits of specific emergency response actions, potential for exposure, possible biological consequences, and the anticipated number of persons potentially affected. The ECC is the ORNL site control center to which emergency situations can be reported and from which emergency response activities are coordinated and dispatched.

10.1.1 Site Personnel Responsibilities

The minimum requirements of an individual during an emergency situation are to know the following about his or her work area:

- The location of the facility Local Emergency Manual.
- The location of site emergency exit routes.
- The location of the facility assembly points.
- The location of the nearest fire alarm pull box and fire extinguisher. Fire extinguishers should only be used by personnel who know how to operate them safely, in addition to knowing the type of fire (e.g., electrical, petroleum product, wood) and the appropriate type of fire extinguisher to be used under the existing conditions.
- The location of other emergency equipment such as emergency self-contained breathing apparatus and eye wash station.
- The location of the nearest telephone or other means of communication such as radio or cellular telephone and emergency contact list.

10.1.2 Reporting An Emergency

Upon discovering an emergency situation, an individual must immediately take action to initiate emergency response activities. This involves first removing himself/herself from immediate danger and notifying the SSHO or the Facility Manager. The Facility Manager or the SSHO will notify the LSS and/or the laboratory ECC of the emergency situation so that the emergency response system can be activated.

10.1.2.1 Summoning assistance by telephone:

1. The plant telephone system can be used to initiate emergency response actions by dialing the numbers listed below. **CAUTION:** Dialing 911 from a cellular phone does not ring the LSS or ECC. The numbers below must be used to contact the LSS and/or ECC on a cellular phone.

SITE	OFFICE	NUMBER	RADIO
ORNL	LSS	574-6606	KIN 294/295
	ECC	574-6646	KIN 294/295

2. The Emergency Medical Services (EMS) network on the plant telephone system serves as a direct method to contact the ECC and is monitored during all shifts by the LSS and by the ORNL Health Services offices during day shift. The EMS network can be used as a method of communication and to summon emergency service units during emergencies at each facility by dialing 911.

3. Once the LSS office or the ECC has been contacted, the following information should be given over the telephone before the caller hangs up:

   a. A description of the type of emergency (to the caller's best knowledge).

   b. The location of the emergency (as specific as possible).

   c. The identity and location of the caller reporting the emergency.

   d. When personnel have been injured, tell whether an ambulance may be needed.

4. Before ending the conversation, the caller should listen for any instructions and answer any questions the LSS office may have. The LSS office should be the party that ends the communication.

10.1.3 Emergency Coordinator

In the event of an emergency situation, the Facility Manager will act as the facility emergency coordinator. Upon the arrival of ORNL emergency support staff (e.g., the Fire Department, the Health Division, Spill Response, or Nuclear Criticality Safety), the Facility Manager will relinquish authority to the incident commander of the ORNL support staff.

If the event occurs when a task is being performed, the SSHO (for HAZWOPER tasks) or the Facility Manager will act as the emergency coordinator for that area or task. The SSHO will ensure the cessation of work, communicating with the Operations Manager that all open systems have been secured, and instruct the workers on doffing specifications, if needed. The SSHO will further supervise the safe evacuation from the work area to the nearest assembly point and account for the safe arrival of each worker.

10.1.4 Emergency Actions for Facility or Task-Related Personnel

The immediate and appropriate actions required of an individual during an emergency situation are the following:

1. Summon help immediately by reporting the emergency to the LSS, SSHO, Facility Manager or Project Manager, or other authority.

2. Bring the emergency under control, if this can be done safely.

3. Sound the area, building, or facility evacuation alarm, as warranted.

4. Meet and orient emergency response units.

10.2 EMERGENCY ACTION PLANS

10.2.1 Emergency Alarm Systems at ORNL

It is the responsibility of any site personnel during an emergency situation to activate appropriate emergency alarm systems when applicable during an emergency, such as building evacuation and fire alarms, or when necessary, plant-wide alarms.

Personnel should be familiar with the correct actions to be taken in response to any plant, facility, or area alarm. To hear an audio tape of some of the alarms described below, dial the following number from the plant system telephone:

SITE	NUMBER
ORNL	574-4462

10.2.1.1 Standard alerting tone

The standard alerting tone is an alternating high-low tone that is followed by a Public Address (PA) system announcement and/or instructions.

10.2.1.2 Fire alarm

The fire alarm is a loud, continuous buzzer that functions as a local building evacuation alarm. Building or area occupants should immediately proceed along the designated evacuation routes to the local assembly points outside the building.

10.2.1.3 Radiation emergency alarm

The local radiation emergency alarm is a clarion horn which is similar to the sound of an air raid siren or a locomotive whistle. This alarm is the signal for immediate evacuation of an area. This alarm is often accompanied by flashing, rotating red or magenta beacon lights. At MSRE, building occupants should proceed to the closest shelter-in-place assembly point (see Sect. 10.2.2.1) and await further instructions.

10.2.1.4 Nuclear criticality alarm

The nuclear criticality alarm is a constant Edwards horn. All MSRE personnel should proceed to the designated shelter-in-place assembly point at the east end of Building 7509 or to the assembly point in Building 7516 and await further instructions.

10.2.1.5 Ventilation alarm

This alarm sounds like a distant doorbell and indicates a failure of the stack ventilation system. All building occupants should proceed to the designated shelter-in-place assembly point and await further instructions.

10.2.1.6 All clear signal

The all clear signal is an announcement given over the PA system that indicates that it is safe for personnel to return to work areas and resume normal activities.

10.2.2 Emergency Assembly Points

10.2.2.1 Shelter-in-place assembly points

The assembly point for shelter-in-place (all alarms except fire) for both buildings 7503 and 7509 is in Room 13 of Building 7509. Occupants of Building 7516 will assemble in that building. If an alarm specific to the high bay sounds (local radiation alarms), workers that were in the high bay must assemble in Room 17 of Building 7509. These individuals could be contaminated and must be isolated from uncontaminated occupants. The RCT will check these individuals and if no contamination is detected, they can join their coworkers in Room 13 of Building 7509.

10.2.2.2 Emergency fire assembly points

The emergency assembly point for the MSRE facility (Building 7503) is located in the north parking lot next to the turnstile. The assembly point for Building 7509 is located at the north end of the east parking lot next to the security fence. The location of the assembly points shall be included in the TSHASP and shall be addressed in the pre-entry health and safety briefing or in a periodic health and safety briefing as a reminder throughout the course of the project.

10.2.3 Evacuation Routes

Evacuation routes are established from locations within the facility HAZWOPER area. EZ evacuation routes shall be through the CRZ, if possible. The RCT shall designate the safest site operations evacuation route with the assistance of the SSHO. The location of the route and the recommended progression to the assembly point(s) shall be discussed in the pre-entry health and safety briefing. In the event of an evacuation, personnel responsibilities are as follows:

1. Personnel should be familiar with the safest and shortest evacuation route from each job site and area in which they perform work.

2. When an evacuation alarm is sounded, personnel should quickly but calmly proceed to the closest designated assembly point (north parking lot next to the turnstile for Building 7503 and north end of the east parking lot next to the security fence for Building 7509 or MSRE shelter-in-place area) to await further instructions from the LSS, the SSHO, or the incident commander.

3. If possible and practical, equipment should be shut down prior to exit from the area. If undue risk of exposure is present, personnel will not attempt to shut down equipment. During RGR operation, the "Scram Button" will close the valve communication with the MSRE off-gas system. "Scram Buttons" are located in the high bay next to the glovebox and in the shelter-in-place area.

4. Personnel should follow the instructions given over the ORNL PA System, by the SSHO, or by the emergency response team incident commander upon his or her arrival.

5. Personnel should remain at the assembly points until otherwise instructed.

10.2.4 Fire or Explosion

Fire suppression and response services shall be provided for MSRE activities by the ORNL Fire Department. The ORNL Fire Department can be summoned through the LSS or ECC offices as described in Sect. 10.1.2.

The MSRE facility has unique requirements for fire fighting. In some areas within the facility, the addition of water will increase the possibility of a nuclear criticality accident. Water can be used in areas equipped with overhead sprinkler systems. Other areas will need to be evaluated on a case by case basis. The ORNL Fire Department has a "Prefire Plan" that is developed to specify unique situations like MSRE. A copy of this plan is maintained at the facility and at the ORNL Fire Department. This plan explains the hazards associated with fighting a fire in various locations throughout the facility and the circumstances that determine when other fire fighting agents (CO_2, dry chemicals, etc.) will be used.

When reporting a fire at the MSRE facility, specify the location of the fire within the facility to the dispatcher so the Fire Department can respond with the appropriate equipment and agents to prevent the spread of the fire and prevent the possibility of a nuclear criticality accident.

Fire extinguishers at the MSRE facility can be found in the following locations.

Building	Location
7503	Basement, west double doors north wall
7503	Hallway outside observation room
7503	High bay, behind fence (southeast), RGRS
7503	Hallway outside lunchroom (east)
7503	High bay entrance (east wall)
7503	Hallway inside double exit door (northeast)
7503	High bay, north wall
7503	High bay, north annex (west wall)
7503	Service tunnel
7503	Basement, outside transmitter room
7503	Basement, north of heater room in hall
7503	Transmitter room
7503	Basement office area
7509	Main hallway, outside office 9
7555	North, next to door
7555	In switch gear room, north wall

Fire extinguishers with signs above them indicating they are "For Fires and For UF_6" have been placed in the high bay and outside the east high bay entrance. When cooled, UF_6 forms a solid; therefore, these extinguishers could be used for fighting fires or for cooling the MSRE system lines to plate out UF_6 to plug a leak if a break occurred.

Fire alarm pull boxes can be found at the following locations.

Building	Location
7503	Central hall, office area

7503	High bay entrance
7503	Across from transmitter room
7509	Breezeway, at the south door
7509	At east exit
7555	Outside south entrance

10.3 EMERGENCY MEDICAL SERVICES

10.3.1 Personnel Injuries

All injuries to project personnel, regardless how minor, must be reported to the SSHO. All injuries and the circumstances involved will be recorded in the H&S logbook by the SSHO. The completion of state worker compensation forms will be coordinated with the injured person, the person's supervisor, the SSHO, the ES&H Manager, and the Project Manager. At least one person, generally the SSHO, shall be designated to perform first aid and CPR in the event of emergency conditions during task operations.

10.3.2 Emergency Medical Services

All work related injuries will be treated by ORNL Health Division. Personnel with serious injuries requiring treatment beyond the capacity of ORNL Health Division services will be transported to the Methodist Medical Center of Oak Ridge, Tennessee, for further treatment and evaluation. Emergency radioactive decontamination or treatment of personnel exposure to radiation will be performed by REAC/TS.

10.3.3 Transportation

Emergency transportation of site personnel to receive medical attention or emergency decontamination (whether to the ORNL Health Division or to outside facilities) will be provided through the LSS office.

10.4 EMERGENCY RESPONSE

All emergency response activities shall be performed by personnel trained according the requirements of 29 CFR 1910.120 and ORNL procedures. The ORNL Emergency Response Team can be contacted through the LSS or ECC offices as described in Sect. 10.1.2.

10.5 LEAK PREVENTION

Leak prevention kits will be located adjacent to the enclosure boxes and at various locations throughout the facility. These kits will be equipped with devices for plugging, crimping, and securing leaking or broken lines. Operators and technicians will be trained by project personnel on how to recognize leaks or breaks in the system and on how to secure the leaks and prevent the possible spread of contamination.

11. MSRE ENVIRONMENTAL ACTIVITIES

11.1 MSRE AIR QUALITY

The MSRE containment ventilation system provides a continuous and controlled flow of air through all areas where possible contamination would be likely to occur (reactor high bay, north electric service area, drain tank cell, and charcoal bed cell). The general pattern of airflow is from less hazardous to potentially more hazardous areas, then to exhaust ducts where it passes through absolute filters and is monitored for radiological activity before it is released up the stack. Two large stack fans, located at the base of the 110-ft stack, maintain negative pressure throughout the facility and pull the air through the ventilation ducts and through the filter banks prior to being released up the stack.

The filter pit is divided into three cells or sections, and each section contains both roughing and acid resistant absolute filters. The minimum efficiency of the filters at the designated flow rate is 99.97% for particles greater then 3 microns in size.

The stack is free standing, 100-ft high. Four equally spaced pipe couplings are installed about 40 ft above the base for pitot tube flow measurements. The stack also houses radiological monitors for the detection of any contaminants before the air is released up the stack.

The MSRE stack is included in the ORNL NESHAP site permit for hazardous emissions. The MSRE remediation effort is a CERCLA driven project, and CERCLA does not require additional permits to cover this activity. The ORNL site adheres to 40 CFR 60 and 40 CFR 61. Subpart H of 40 CFR 60, *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities*, states that no facility (this includes MSRE) shall exceed those amounts that would cause any member of the public to receive in any year a total effective dose equivalent of 10 mrem. The MSRE stack is monitored by fixed detectors that measure alpha, beta/gamma, and radon levels as a part of the facility ventilation off-gas system. Sampling of the stack is on a fixed, routine bases and is conducted by the ORNL Office of Environmental Compliance and Documentation.

MSRE evaluates each activity and each prospective new chemical treatment plan for the potential of release to the local area and to the environment as a whole. All chemicals must be evaluated for compliance with State and Federal guidelines prior to their acceptance for use at MSRE. No chemical can be brought to or stored on the site (MSRE) in quantities greater than the chemicals "Reportable Quantity" as specified in 40 CFR 302, *EPA Designation, Reportable Quantities, and Notification Requirements For Hazardous Substances Under CERCLA.*

AHERA, 40 CFR 763, Subpart E requires that all personnel will be properly trained within each aspect of the job they are performing.

11.2 WATER QUALITY

MSRE has undertaken an in-depth evaluation of its facility water system, both potable and nonpotable sources. This evaluation was conducted in conjunction with the federally mandated Sink and Drain Survey. All sources that eventually contribute to an outfall that empties into a "Stream

of Tennessee" must be back traced to see what contributes to the water quality. All drains were dye tested and water lines were traced as closely as possible to determine the source. Inactive drains were plugged and noted on facility drawings. The Office of Environmental Compliance and Documentation collected all this survey information for compilation and response to the court order.

Storm water from Building 7503 is drained through roof drains that flow into a catch basin located west of Building 7503. The roof water combines with surface runoff water and contributes to the water sources for Outfall 282. Outfall 282 is located west of Building 7516 and empties into Melton Hill Branch. Rain water from Building 7509 empties into two roof drains that converge into one drain pipe that runs to a surface storm drain south of Building 7509. This drain finally contributes to Outfall 082, east of the MSRE facility. There are six surface storm drains located around the MSRE complex. Two south of Building 7509 located in the parking lot, one west of the charcoal bed cell, one between Building 7505 and Building 7555, and two on either side of Building 7516.

The sump room is located in the south end of the reactor high bay below the special equipment room at the lowest point of the building, ~30 ft below the main floor of the facility. The sump room receives uncontaminated water from various runoffs throughout the building via floor drains. Other drains from noncontaminated water sources empty into the sump room. The water is then pumped via two sump pumps to the catch basin located west of the charcoal bed cell.

11.2.1 Outfalls

There are three outfalls attributed to the MSRE complex; all receive water from various locations and systems around the site. All outfalls are monitored and sampled for constituents specified by the State of Tennessee's National Pollution Discharge Elimination System (NPDES) permits. MSRE is a Category 2 facility. The ORNL Office of Environmental Compliance and Documentation routinely samples the discharge water for those constituents specified in the permit.

Outfall 082. Outfall 082 is located east of the MSRE site. Building 7509 roof drains and air conditioner unit contribute to this outfall. The roof drains merge with the air conditioner unit discharge water and run south of Building 7509. Water from surface runoff combines with the building drainage and runs under the HFIR Road to the outfall.

Outfall 080. Outfall 080 is located to the extreme west of the charcoal bed cell. Surface runoff water plus water that is pumped from the pumps in the sump room of Building 7503 contribute to this outfall. The water from this outfall eventually winds around the Waste Management's storage facility and enters Melton Valley Branch further down stream. The discharge to the outfall is periodic as the sump pumps charge, so the water flow is pulsed.

Outfall 282. Outfall 282 is located west of Building 7516, across the Waste Management storage facilities access road. Roof runoff drains, the air compressor coolant water from Building 7555, and steam condensate lines from the MSRE facility as well as surface runoff from three surface drains contribute to the water source. This is the main outfall for the MSRE facility.

11.2.2 Chlorine

MSRE complies with the ORNL Site Chlorine Strategy, which states that no stream of Tennessee shall exceed a specific chlorine level. Each stream is sampled quarterly and results are

reported to DOE. A report for the entire complex is compiled and forwarded to the State. If there is a trend for consistently high chlorine levels (above specified limits) within a specific stream, the contributor(s) of the chlorine may be subject to fines, if the problem is not resolved. MSRE had elevated chlorine levels from multiple sampling efforts from two outfalls (282 and 082). Two dechlorinators were installed to remove the chlorine from the discharge water prior to its entering the streams.

A dechlorinator was installed at Outfall 282. A new headwall was constructed and the dechlorinator attached to the culvert so that all the discharge water is funneled through the dechlorinating tablets. The water has been resampled and the dechlorinating tablets are removing the chlorine from the water as it empties into the branch.

The water quality at Outfall 082 also had elevated chlorine content. The source of the water was traced to the air conditioning unit within Building 7509. The discharge water was sampled at the air conditioner, and the results equaled the levels at the outfall. The air conditioner discharge lines were also dye tested confirming the source of the chlorine at Outfall 082. An in-line dechlorinator was installed at the air conditioning unit within Building 7509. The discharge water was sampled at the storm drain and at the outfall and the chlorine contamination had been eliminated.

11.2.3 Water Temperature

The Office of Environmental Compliance also tests the streams around the site for elevated water temperature. Certain temperature parameters are established to maintain optimal aquatic life, and the streams around the site must be within these guidelines. Certain activities and routine maintenance of equipment that is water-cooled may have an affect on these perimeters. Activities should be scrutinized for impacting water temperature standards.

11.2.4 Construction Activities

Construction activities around the MSRE site must be evaluated for impact on site water quality. Possible construction site runoff during inclement weather will contribute to site water quality. Various controls must be utilized to reduce or eliminate the impact on water quality. These methods include, but are not limited to, hay bales, silt fences, or dikes.

11.3 MSRE SEPTIC SYSTEM

The Building 7503 sanitary waste system piping is directed to a septic tank located about 100 ft west of the reactor building, between Building 7555 and Building 7505. The drainage field is outside the perimeter fencing continuing westward from the septic tank.

11.4 WASTE MANAGEMENT

All wastes generated by the MSRE Remediation activities are handled and disposed of by the ORNL Waste Management Division. There have been five waste types generated at the MSRE from previous operations: solid low level waste (SLLW), RCRA, used oils, TSCA from disposal of polychlorinated biphenyls (PCBs), and resource recovery.

SLLW generated on-site typically has included items such as personnel protective equipment (e.g.,Tyvek suits, disposable gloves, and spent respirator cartridges), miscellaneous trash, contaminated equipment, HEPA filters, and alumina traps. All waste is segregated and packaged by MSRE technicians. The waste is then characterized for radiological contamination at the facility by the MSRE RCTs to meet the waste acceptance criteria for SLLW. These criteria can be found in the *Acceptance Criteria for Solid Low Level Waste Treatment, Storage, and Disposal Facilities*, WM-SWO 505. Waste management is responsible for final dispensation of this waste.

Resource recovery material refers to material that, when becoming waste, can be recycled or converted to a state that can be reused. Lead is an example of this material. The guideline for this waste follows 40 CFR 246 and ORNL Resource Lead Acceptance Policy pending approval from the ORNL Office of Environmental Compliance.

Limited RCRA wastes have been generated at MSRE. The waste so far has been nonrecyclable batteries and nonrecyclable lead. This waste is segregated and characterized to meet WM-SWO 404, *Waste Acceptance Criteria for Hazardous and Mixed Waste Treatment and Storage Facilities at ORNL.*

When suspect PCB-containing oils are discovered, the ORNL PCB Coordinator is notified. The suspected oil is sampled, characterized, and managed in accordance with TSCA and FFCA. If the oil exceeds regulatory limits, the Hazardous Waste Operation Group is called in to clean, decontaminate, and dispose of the contaminant. The regulatory driver for the sampling, cleanup, reporting, and management of this waste is 40 CFR 761.

Used oils are containerized and placed in an area away from possible impact from the elements. The oil is sampled and characterized and disposed of appropriately by the Waste Management Organization.

To date the MSRE Remediation activities have not encountered any low-level waste (LLW) or transuranic (TRU) waste. The MSRE has the potential to generate this type of waste. The activity that has the greatest probability of generating this waste will be the Fuel Salt Removal Project. This project is scheduled in the future, and this plan will be revised to address this waste prior to beginning that phase of the remediation project. If any LLW waste is encountered previous to this project beginning, it will be segregated and managed by ORNL Waste Management. ORNL Waste Management will be responsible for final disposition of this waste.

11.5 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

Section 121 of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under Federal or more stringent State environmental laws that are applicable or relevant and appropriate (ARARs) to the hazardous substances or particular circumstances at the site. Inherent in the interpretation of ARARs (40 CFR 300.5) is the assumption that protection of human health and the environment is ensured.

ARARs apply to those Federal and State regulations that are designed to protect the environment and do not generally apply to occupational safety regulations. EPA requires compliance with OSHA standards in 300.150 of the National Contingency Plan (NCP), but this compliance is not accomplished by way of the ARARs. Neither the regulations promulgated by OSHA, DOE

Orders, nor the Nuclear Regulatory Commission (NRC) regulatory requirements relating to occupational safety are addressed by ARARs. OSHA requirements are addressed in previous sections of this document.

Each phase of the MSRE Remediation Project is reviewed for NEPA values. ARARs are written and project documentation is reviewed to ensure that these values are addressed.

No endangered or threatened species or habitats, wetlands, or floodplains at the site were identified as potentially impacted by the remediation efforts. The MSRE has been determined to be a contributing structure to the ORNL Historic District (*Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*, Carver and Slager 1994) and may be eligible for inclusion in the National Register of Historic Places pursuant to 36 CFR 63. A permanent or long-term containment structure would have a physical impact on the MSRE or, at a minimum, on facility components contributing to its eligibility for inclusion in the National Register of Historic Places. Documentation required by Section 110 of the National Historic Preservation Act has been completed for the structure and accepted by the Tennessee State Historic Preservation Officer (SHPO) as fully in compliance with the memorandum of agreement executed by DOE-Oak Ridge Operations and the SHPO and accepted by the Advisory Council of Historic Preservation on May 6, 1994. No other location-specific ARARs, such as those relating to endangered or threatened species or habitats, wetlands, or floodplains, would be affected by the MSRE project.

12. REFERENCES

ACGIH. 1995. *Guide to Occupational Exposure Values–1995*, ISBN: 1-882417-12-7, American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, Ohio.

Carver, M., and M. Slager. January 1994. *Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee.* ORNL/M-3244, Oak Ridge National Laboratory.

Code of Federal Regulations (CFR). January 1, 1993. "Occupational Radiation Protection," 10 CFR 835.

Code of Federal Regulations (CFR). July 1, 1994. "Occupational Safety and Health Standards," 29 CFR 1910.

Code of Federal Regulations (CFR). July 1, 1994. "Safety and Health Regulations for Construction," 29 CFR 1926.

DOE. December 1991. *OSHA Training Requirements for Hazardous Waste Operations*, DOE/EH-0227P, U.S. Department of Energy, Office of Environment, Safety, and Health, Washington, D.C.

DOE. April 1993. *Hoisting and Rigging Manual*, DOE/ID-10500, Assistant Secretary for Environment, Safety and Health, Department of Energy, Washington, D.C.

DOE. December 1994, *U.S. Department of Energy Oak Ridge Operations Office, Site Integrated Program Plan for the Implementation of Defense Nuclear Facilities Safety Board Recommendation 94-1 for K-25 Site Deposit Removal Project and Oak Ridge National Laboratory Molten Salt Reactor Experiment Remediation Project, Oak Ridge, Tennessee, Volume 1: Remediation Strategy*, DOE/OR/01-1333&V1, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge K-15 Site, Oak Ridge, Tenn.

DOE Order 232.1A. July 21, 1997. *Occurrence Reporting and Processing of Operations Information*, U.S. Department of Energy.

DOE Order 5400.5. February 8, 1990. *Radiation Protection of the Public and the Environment.*

Eckerman, K. F., et al. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. EPA, Office of Radiation Programs, Washington, D.C.

EPA. 1990. *Occupational Medical Monitoring Program Guidelines for SARA Hazardous Waste Field Activity Personnel*, Environmental Protection Agency Publication 9285.3-04.

EPA. April 1991. *Establishing Work Zones at Uncontrolled Hazardous Waste Sites*, Office of Solid Waste and Emergency Response, Environmental Protection Agency.

NIOSH, et al. October 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, DHHS(NIOSH) Publication No. 85-115, National Institute for Occupational Safety and Health.

NIOSH. April 1986. *Criteria for a Recommended Standard, Occupational Exposure to Hot Environments, Revised Criteria 1986*, DHHS(NIOSH) Publication No. 86-113, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

NIOSH. June 1994. *NIOSH Pocket Guide to Chemical Hazards*, DHHS(NIOSH) Publication No. 94-116, National Institute for Occupational Safety and Health, Cincinnati, Ohio.

ORNL. April 1993. *ORNL HAZWOPER Program Manual*, ORNL/M-2716, Oak Ridge National Laboratory.

ORNL Nuclear Criticality Safety Procedures (available on-line).

ORNL Office of Safety and Health Protection Procedures (available on-line).

ORNL Radiation Protection Procedures (available on-line).

Appendix A

TASK-SPECIFIC HEALTH AND SAFETY PLAN (TSHASP)

HAZWOPER MSRE
TASK-SPECIFIC HEALTH AND SAFETY PLAN (TSHASP) FOR
_____ (name of task)

Work Package No. _____

Prepared by:

Purpose of the task:

Reviewed/Approved by:

_____

Radiological Protection Coordinator Date

_____

Safety and Health Evaluation and Support Team Date

_____

MSRE ES&H Manager Date

_____

Facility Manager Date

_____

Site Safety and Health Officer Date

This plan will be kept at the work site. The anticipated duration of the project is _____ day(s)/week(s) (circle one).

1.0 INTRODUCTION

This Task-Specific Health and Safety Plan (TSHASP) is for the performance of HAZWOPER-related activities [activities that fall under the scope of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER)]. The work will be conducted by the Oak Ridge National Laboratory (ORNL) Molten Salt Reactor Experiment (MSRE) personnel and associated ORNL support groups. The purpose of this document is to establish task-specific health and safety guidelines to be followed by all personnel involved in conducting work for this task. Work will be conducted in accordance with requirements as stipulated in DOE policies and Work Smart Standards (WSS). This TSHASP is equivalent to a site-specific Health and Safety Plan (HASP), which serves as an extension of the ORNL *HAZWOPER Program Manual* and the MSRE Project Health and Safety Plan (PHASP); combined they fulfill the requirements of 29 CFR 1910.120.

The levels of protection and the procedures specified in this TSHASP are based on the best information available from historical data and preliminary evaluations of the area and system. Therefore, these recommendations represent the minimum health and safety requirements to be observed by all personnel engaged in this task. Unforeseeable site conditions, changes in scope of work, or unexpected hazardous conditions not previously considered will warrant a reassessment of protection levels and controls stated in this evaluation. Requirements concerning revisions and modification to the TSHASP are discussed in Sect. 5.4 of this appendix.

2.0 TASK AND WORK SITE DESCRIPTION

2.1 TASK DESCRIPTION

Note: In this section list objectives for the task(s) and how they will be accomplished.

2.2 TASK AREA DESCRIPTION

Note: In this section provide a description of the work area (confined space, restricted accesses, elevated work). Also, include relevant historical data, sampling results, and/or area monitoring data for this location.

3.0 SITE ORGANIZATION AND COORDINATION

The work will be performed by MSRE project personnel and ORNL support disciplines. ORNL SHEST, OSHP, Radiation Protection, and Nuclear Criticality Safety will provide appropriate health and safety services including monitoring and oversight.

The following sections detail the organizational structure for this project.

3.1 SITE SAFETY AND HEALTH OFFICER (SSHO)

The SSHO serves as the primary on-site contact for safety and health during field activities; oversees the on-site execution of all work activities regarding safety and health procedures; and has the authority to stop all work if conditions are judged to be hazardous to site personnel or to the public/environment. The SSHO will remain at the work site at all times while workers are performing task activities. Other specific responsibilities are as follows:

1. Ensure that all task personnel meet the required level of training and meet medical requirements including respirator fit test (as required). Ensure that all task personnel attend a pre-entry briefing on project and potential related hazards and review the Work Package and TSHASP. Maintain copies of documentation of the above at the work site and ensure documentation is available for on-site review. Note: The ORNL Special Access Training Badge may be used as verification of training.
2. Require personnel to obtain immediate medical attention in the case of a work-related injury or illness.
3. Deny access to all or any portion of the work area, as warranted.
4. Order work to cease, the work area evacuated by all personnel, and safe working conditions re-established, as needed. Contact the Laboratory Shift Superintendent (LSS) when stop-work conditions exist due to suspected health and safety hazard(s).
5. Control access to the area by visitors and unauthorized personnel. Advise visitors and unauthorized personnel of their responsibilities. Ensure that visitors and unauthorized personnel meet access requirements before entry into any of the work zones.
6. Ensure the correct execution of the Work Package and TSHASP.
7. Ensure that the Work Package and TSHASP are revised and approved if there are changes in site conditions or tasks.
8. Advise emergency response personnel in an emergency.
9. Coordinate the establishment of site work zones, the required level of personnel protection, the monitoring program, and other controls with SHEST and Radiation Protection.

10. Coordinate and minimize the number of personnel and the amount of equipment in work zones.
11. Coordinate accident prevention by oversight of activities and awareness of all tasks and facility operations.
12. Ensure that needed work permits are obtained and made available on-site.
13. Ensure that the SHEST representative, and Radiation Protection are contacted prior to commencement of work to (1) notify of intent to begin work and (2) schedule monitoring support, as needed.
14. Conduct daily inspection of the work site.
15. Provide the SHEST representative with a list of personnel participating in work activities. The SHEST representative will determine if individuals on the list should be included in the hazardous waste worker medical surveillance program.
16. Ensures that appropriate fall protection measures are in place, if warranted.
17. Ensure that appropriate measures have been taken to prevent and contain spills.
18. Ensure that nuclear criticality safety requirements are in place.

3.2 TASK PERSONNEL

Task personnel responsibilities are as follows:

1. Take all reasonable precautions to prevent injury to himself/herself and to fellow team members; be alert to potentially harmful situations.
2. Perform only those tasks that can presumably be done safely and immediately report any accidents and/or unsafe conditions to the SSHO.
3. Notify the SSHO of any special personal medical conditions (i.e., allergies, diabetes, etc.).
4. Prevent spills and leaks to the extent possible. In the event spills or leaks occur, contain the spill, notify the SSHO or the RCT, and clean up immediately using safe cleanup measures as directed by the SSHO or RCT. Note: Do not engage in spill containment or cleanup if conditions are not safe and if the cleanup cannot be accomplished with supplies available at the site. Evacuate the area. All spills must be reported to the ORNL Environmental Compliance (4-8770).
5. Avoid splashing materials to the extent possible.
6. Practice good housekeeping by keeping the work area neat, clean, and orderly to the extent possible.
7. Report all injuries, no matter how minor.
8. Comply with the PHASP and TSHASP; post necessary directions at the work site.

3.3 RADIATION PROTECTION

ORNL Radiation Protection will be responsible for oversight and approval of personnel protection requirements related to radiation protection. A representative from the Office of Radiation Protection will review and approve the Work Package and TSHASP prior to commencement of task activities. ORNL Radiation Protection will be consulted prior to entry into any posted Radiological Area and will instruct participants on requirements for that area, including the need for a Radiological Work Permit, appropriate monitoring, dosimetry, and personal protective equipment. The Radiation Protection representative will be contacted for all radiological concerns at the facility.

3.4 SHEST

The ORNL SHEST representative may be consulted on matters of personnel protection related to industrial hygiene, industrial safety, and the requirements of 29 CFR 1910.120 (HAZWOPER). A SHEST representative will review and approve the TSHASP prior to commencement of task-related activities. The SHEST representative will provide guidance regarding potential safety hazards, personal protective equipment, industrial hygiene monitoring, and sampling requirements.

A complete organizational structure and description of responsibilities may be found in Sect. 3 of the ORNL *HAZWOPER Program Manual*.

4.0 PROJECT HAZARD EVALUATION

Place an X in each ☐ to indicate existing conditions or those that may be a result of task operations.

Task: (For a description of the task, see Sect. 2.0 of this TSHASP.)

4.1 PHYSICAL HAZARDS

☐	Heat stress	☐	CO_2 environment	☐	Noise
☐	Confined space	☐	Enclosed space	☐	Manual lifting
☐	Tripping/falling	☐	Ergonomic	☐	High pressure
☐	Oxygen deficient	☐	Vibration	☐	Explosive/ flammable

4.2 SAFETY/CONSTRUCTION HAZARDS

☐	Elevated work	☐	Welding/cutting	☐	Overhead hazards
☐	Hoisting/rigging	☐	Piping concerns		

4.3 CHEMICAL HAZARDS

☐	Volatile organic	☐	Inorganics	☐	Carcinogen
☐	Corrosive	☐	Metals (lead)	☐	Reproductive toxicant
☐	Mutagen	☐	Asbestos		
☐	OSHA specific				

4.4 IONIZING RADIOLOGICAL HAZARDS

☐	Internal exposure	☐	External exposure	☐	Criticality accident

4.5 NONIONIZING RADIOLOGICAL HAZARDS

☐ High voltage

Note: For the items checked in Sects. 4.1–4.5, provide additional information below.

4.6 DESCRIPTION OF HAZARDS AND CONTROLS

4.6.1 Physical Hazards

4.6.1.1 Temperature extremes

Applicable WSS: 29 CFR 1910; 29 CFR 1926; ACGIH TLVs
PHASP Sections: 4.5.5; 4.5.6; 4.8.4

How will this hazard be encountered?_____
_____

PPE required for the task? ☐ Yes ☐ No

Work load:
☐ Light
☐ Moderate
☐ Heavy

Precautions (specify):_____
_____
_____
Cooling/heating equipment needed:_____
_____
_____

4.6.1.2 Noise

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Section: 4.5.1

Specify the task that noise could impact:_____
_____

Noise extremes? ☐ Yes ☐ No

Sound level _____ dB(A)
Noise source(s):_____
_____
_____

If noise levels equal or exceed 85 dB(A) hearing protection will be worn.

Is hearing protection needed for this task? ☐ Yes ☐ No

Engineering controls: _____
_____
_____

Precautions (specify):_____

_____

4.6.1.3 Confined/enclosed spaces

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.3; 4.5.5; 4.5.7; 4.8.1; 4.8.6

Location of space: _____

CO_2 monitoring required? (Yes) _____ (No) _____

Is the area posted as a confined/enclosed space? (Yes) _____ (No) _____

Confined Space Entry Permit required? (Yes) _____ (No) _____

Confined Space Permit obtained? (Yes) _____ (No) _____

Lock-out/tag-out required? (Yes) _____ (No) _____

Identify equipment that is needed:

two-way radios	(Yes) _____	(No) _____
safety harness	(Yes) _____	(No) _____
hoist	(Yes) _____	(No) _____
safety line	(Yes) _____	(No) _____

other: _____

Attendant required? (Yes) _____ (No) _____

Note: ORNL Office of Safety and Health Protection (OSHP) must be contacted prior to entry into a confined space. Training requirements should be listed/verified in Sect. 10 of this TSHASP.

4.6.1.4 Ergonomic hazards

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.3; 4.8.3

Tasks: _____

Heavy lifting? (Yes)_____ (No) _____

Vibrating equipment?(Yes)_____ (No) _____

Tripping/falling? (Yes) _____ (No) _____

Controls/protective equipment:

_____

_____

_____
_____
_____

4.6.1.5 Fire/explosion

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.6; 4.8.4; 4.8.5; 4.8.6; 7.3.1

Tasks that could influence this hazard: _____

_____

Are flammable liquids present? ☐ Yes ☐ No

Are combustible gases expected? (Yes) _____ (No) _____

Concern(s):_____
Location:_____
Quantity:_____
Storage method (gasoline, cylinders, etc.): _____
_____
Describe flammable/explosive atmosphere:
_____
_____
Describe controls such as atmospheric testing, etc.:
_____
_____
For welding, cutting, or brazing, is Hot Work Permit required? ☐ Yes ☐ No

4.6.1.6 Hazardous atmosphere

Applicable WSS: 29 CFR 1910; 29 CFR 1926; ANSI/ASHRAE 62-1989
PHASP Sections: 4.2; 4.6.1; 4.6.3; 4.6.4; 4.6.5; 4.8.4; 4.8.6

Describe operations that may create hazardous atmospheres
(oxygen deficient or enriched, CO_2) (circle one):
_____
_____

Previous monitoring results:_____

Is atmospheric testing by OSHP required? (Yes) _____ (No) _____

What type of testing is required? _____

Instrumentation required:_____

4.6.2 Safety/Construction Hazards

4.6.2.1 Heavy equipment operation/hoisting and rigging

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.1; 4.5.3; 4.5.5; 4.8.3; 4.8.5; 4.8.9; 4.8.10; 4.8.11; 4.8.12

List heavy equipment to be used at the work site:

_____

_____

Does each piece of equipment have an Annual Inspection Certificate? (Yes)_____ (No)_____

Has each piece of equipment been inspected for both mechanical and safety concern prior to use? (Yes) _____ (No) _____

Have approved rigging, straps, cables, etc. been inspected? (Yes) _____ (No) _____

Additional (engineering):

_____

_____

_____

4.6.2.2 Hoisting/rigging

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.5; 4.8.10; 4.8.11

Load weight:_____

Equipment rated for load? ( ) Yes ( ) No

List equipment to be used (i.e., crane, forklift):_____

_____

_____

Lift plan required? ( ) Yes ( ) No

Lift requires review from the Hoisting and Rigging Committee? ( ) Yes ( ) No

Lift plan approved? ( ) Yes ( ) No

SSHO will ensure that the equipment annual inspection sticker is current, that all rigging used for the lift has been inspected by the ORNL Quality Department, and that plans or procedures for the lift are followed.

4.6.2.3 Electrical hazards

Applicable WSS: 29 CFR 1910; 29 CFR 1926; NFPA 70
PHASP Sections: 4.5.5; 4.8.1; 4.8.12

Is there any possibility of encountering an electrical hazard? ( ) Yes ( ) No

Location of hazard: _____

Electrical shock hazard? ☐ Yes ☐ No _____ Voltage _____ Current

Controls: _____
_____

Amount of voltage within electrical lines: _____
Height from equipment to hazard: _____

Required distance: _____

Grounding required: (Yes) _____ (No) _____

Lock-out required: (Yes) _____ (No) _____

Additional controls: _____
_____

4.6.2.4 Elevated work

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.3; 4.8.10; 4.8.11

Location of elevated work: _____

Working height: _____

List equipment to be used (i.e., ladder, scaffolding, powered lift): _____
_____
_____

List fall protection controls to be used: _____
_____
_____

4.6.3 Chemical Hazards

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.7; 4.6; 4.6.1; 4.6.2; 4.8.6; 4.8.8; 11.1;11.4

All hazardous chemicals related to the MSRE project (except those brought in for a specific purpose) are outlined in the PHASP. Those chemicals that could be encountered **during this task** are detailed below. See Sect. 6 of this TSHASP for OSHP monitoring/sampling requirements.

Substance: _____
How could it be encountered: _____
Use (for materials brought on site): _____
Location (where is it expected to be encountered): _____
TLV _____ PEL _____ IDLH _____ STEL _____
Route of exposure: _____
Target organs: _____
LEL _____ UEL _____ FP _____
Signs and symptoms of exposure: _____
_____
Health effects:
_____
_____
Additional comments and controls:
_____
_____

Substance: _____
How could it be encountered: _____
Use (for materials brought on site): _____
Location (where is it expected to be encountered): _____
TLV _____ PEL _____ IDLH _____ STEL _____
Route of exposure: _____
Target organs: _____
LEL _____ UEL _____ FP _____
Signs and symptoms of exposure: _____
_____
Health effects:
_____
_____
Additional comments and controls:
_____
_____

Substance: _____
How could it be encountered: _____
Use (for materials brought on site): _____
Location (where is it expected to be encountered): _____
TLV _____ PEL _____ IDLH _____ STEL _____
Route of exposure: _____
Target organs: _____

LEL _____ UEL _____ FP _____
Signs and symptoms of exposure: _____
_____
Health effects:
_____
_____
Additional comments and controls:
_____
_____

Substance: _____
How could it be encountered: _____
Use (for materials brought on site): _____
Location (where is it expected to be encountered): _____
TLV _____ PEL _____ IDLH _____ STEL _____
Route of exposure: _____
Target organs: _____
LEL _____ UEL _____ FP _____
Signs and symptoms of exposure: _____
_____
Health effects:
_____
_____
Additional comments and controls:
_____
_____

4.6.4 Ionizing Radiation

Applicable WSS: 10 CFR 835
PHASP Sections: 3.3.4; 4.2; 4.3; 4.4; 4.6; 4.6.2; 4.7; 4.7.1; 4.7.1.1; 4.7.1.2; 5.1.5; 5.1.6; 5.3; 5.4.2; 6; 7; 8; 11; 11.4

For ionizing radiological hazards identified in Sect. 4.4 of this TSHASP, provide the requested information. Available historical and site characterization data should be consulted to complete this section. An Office of Radiation Protection (ORP) representative may be contacted for assistance in completing this section. If a Radiological Work Plan (RWP) is generated for this task, Sect. 4.6.4, Ionizing Radiation, can be omitted. The RWP should be attached to this TSHASP and forwarded for review.

Location of task contamination data available (from prior scanning or history)?
(Yes) _____ (No) _____

Results: _____

Expected isotope(s) of concern: _____

How could these isotope(s) be encountered?_____

_____

Radiation type: Alpha/Beta/Gamma/Neutron

Radiological Work Permit in place? ☐ Yes ☐ No

Nuclear Criticality Safety documentation required? ☐ Yes ☐ No

Nuclear Criticality Safety documentation in place? ☐ Yes ☐ No

The radiological isotopes for the MSRE project have been identified from process knowledge and sampling results. The radiological hazards are outlined in Sect. 4.7 of the MSRE Project Health and Safety Plan (PHASP).

Dose rate: (maximum) _____ mR/h @ _____ meter(s)
(average) _____ mR/h

Worker dose limit: _____ mR/day

Worker dose projected for this task: _____

Contamination level: (fixed) dpm/100 cm^2
(removable) dpm/100 cm^2

Airborne contamination concentration
(if expected): _____ μCi/mi

Unrestricted airborne contamination
release potential? ☐ Yes ☐ No

Health Physics coverage: Continuous/Intermittent/Conditional

High volume sampling to be conducted? (Yes) _____ (No) _____
Low volume sampling to be conducted? (Yes) _____ (No) _____
Personal monitoring/sampling? (Yes) _____ (No) _____

Additional controls/requirements:

_____

_____

Instruments to be utilized and monitoring requirements are identified in Sect. 6 of this TSHASP.

4.6.5 Nonionizing Radiation

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.5.2; 4.5.5; 4.8.4; 4.8.12

Location: _____

High-voltage (>100kV) electrical transmission lines nearby? ☐ Yes ☐ No

Location, distance, and voltage:_____
_____
_____

4.6.6 Sanitation

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Sections: 4.8.13; 4.8.14.3; 7.3; 7.3.1; 11.3

Water fountains, break rooms, and washing and toilet facilities are discussed in Sect. 7.3 of the PHASP. The locations of these facilities will be conveyed to task workers at the pre-entry briefing.

Support Zone where eating, drinking, chewing, use of tobacco is permitted?

Location: _____

4.6.7 Illumination

Applicable WSS: 29 CFR 1910; 29 CFR 1926; ACGIH TLVs
PHASP Sections: 4.5.2; 4.5.5; 4.8.1; 4.8.4

Additional illumination needed? ☐ Yes ☐ No

Specify: _____

4.6.8 Lead

Applicable WSS: 29 CFR 1910; 29 CFR 1926
PHASP Section: 4.6.1

Will lead be encountered? (Yes) _____ (No) _____

If yes, in what form? _____

Has a Lead Plan been written and approved? (Yes) _____ (No) _____

Will burning or cutting be required? (Yes) _____ (No) _____

PPE required: _____
Are workers involved in this activity on the Lead Program? (Yes) _____ (No) _____

Attach the approved Lead Program check list with this TSHASP.

5.0 TASK BREAKDOWN

Provide detailed description of the task (or refer to Sect. 2.1 of this TSHASP), engineering and administrative controls to be instituted, and required permits and training.

5.1 TASK DESCRIPTION (also see Sect. 2.0 of this TSHASP)

Type of work: ☐ Intrusive (MSRE primary containment system)
☐ Nonintrusive

Engineering controls: _____
_____
_____
_____
_____

Administrative controls (required permits, training, etc.): _____
_____
_____
_____

5.2 INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT

Level of protection: ( ) A ( ) C ( ) Modified
( ) B ( ) D

Respirator: ( ) SCBA ( ) Fullface ( ) 1/2 Face resp.
( ) PAPR[a] ( ) Other
Cartridge: _____

Protective clothing: ( ) Encapsulating suit ( ) Tyvek
( ) Saranex ( ) Splash suit
( ) C-zone ( ) Company clothing (khakis)
( ) Other

Head/eye/ear: ( ) Hard hat ( ) Safety glasses ( ) Goggles
( ) Splash shield ( ) Ear plugs ( ) Ear muffs
( ) Other

[a]Powered air-purifying respirator

Gloves:	( ) Nitrile	( ) Neoprene	( ) PVC
	( ) Latex	( ) Vinyl	( ) Leather
	( ) Other		
Footwear:	( ) Steel-toed leather	( ) Chemical overboots	
	( ) Steel-toed rubber	( ) Other	

5.3 DOFFING INSTRUCTIONS

Doffing instructions will be posted at the radiological buffer area.

5.4 REVISIONS/MODIFICATIONS TO THE TSHASP

5.4.1 Revisions/Modifications Requiring Approval

The following will warrant revision and approval of this TSHASP by the appropriate health and safety disciplines:

Change in tasks (or previously unidentified tasks) that would impact employee health and safety.

Change in Site Safety and Health Officer (e.g., if the SSHO is replaced with an individual who has not been reviewed/approved to serve as an SSHO).

Changes in hazards (unknown or not previously addressed) **that require a significant change in, or addition to,** respiratory protection, physical/barrier protection features, or other engineering controls.

Occurrences as defined by DOE Order 232.1A

5.4.2 Modifications Allowed

5.4.2.1 Radiological conditions

The RCT may upgrade the level of PPE, including the use of air-purifying respirators, for radiological concerns. These changes must be documented in the project log book (for HAZWOPER related activities) and the RWP. Upgrades that include respiratory protection for previously unidentified radiological issues or contaminants will require review/approval from the H&S disciplines and revisions to this TSHASP. Any downgrade, except from supplied air, must also meet the same requirements for approval and documentation.

5.4.2.2 Nonradiological conditions

The SSHO may upgrade PPE for nonradiological issues and contaminants. The change and the reason for the change must be documented in the project H&S logbook. For upgrades that include respiratory protection (including air-purifying respirators and supplied air) for previously unidentified nonradiological issues or contaminants, the appropriate health and safety disciplines must be contacted. The SSHO will approve and document PPE changes in the MSRE H&S logbook.

Upgrades which include respiratory protection will require that the SSHO ensure that workers have **40 Hour HAZWOPER Training** and meet any additional medical surveillance requirements. Additionally, upgrades in PPE will require a review by the SHEST representative to ensure that the SSHO meets the qualifications for the site.

Additional PPE information may be found in Sect. 11 of the ORNL *HAZWOPER Program Manual*.

6.0 MONITORING REQUIREMENTS

Note: The SHEST representative, OSHP representative, and the RCT should be consulted to assist in preparing this section.

		Monitoring		
		Check	Frequency	Action guidelines
6.1	**DIRECT READING INSTRUMENTS**			
	LEL meter			
	CO_2 meter			
	Colorimetric indicator tubes			
	Photoionization detector (PID)			
	Flame ionization detector (FID)			
	Alpha meter			
	Beta-gamma meter			
	Area radiation monitors			
	Noise meter			
	Criticality Accident Alarm System (CAAS)			
	Other (specify)			
6.2	**PERSONAL MONITORING**			
	Whole-body dosimetry			
	Extremity dosimetry			
	Whole-body count			
	Urinalysis/bioassay			
	Chemical air sampling			
	Radiation air sampling			
	Personal sampling pumps			

Instruments used by the ORNL OSHP representative will be calibrated and maintained in accordance with ORNL OSHP Standard Operating Procedures. Instruments used by the Office of Radiation Protection are source checked in accordance with established ORNL ORP procedures. Project/task monitoring requirements may change based on area conditions. All changes must be documented in the project log book.

7.0 SITE CONTROL

Work zones are discussed in the PHASP. In this section, specify work zone controls and briefly describe how they will be established.

(Note: Provide a site map marked with the location of the zones and the emergency evacuation route.)

8.0 DECONTAMINATION

Decontamination of equipment and personnel is described in Sect. 8 of the PHASP. If there is a possibility that individuals will become contaminated, measures that will be used to decontaminate those workers must be outlined in this section. This section will be prepared by the MSRE RCT. ORNL RP procedures will be followed in carrying out these efforts.

Location of decontamination area: _____

9.0 EMERGENCY PREPAREDNESS

The responsibility of day-to-day implementation of emergency information lies primarily with the SSHO. During an actual emergency response situation, the SSHO will serve as the Emergency Coordinator for the area/task until the Laboratory Shift Superintendent or emergency response team arrives.

The LSS will provide emergency response personnel and coordinate emergency assistance. The radio number for the LSS is Station 103. In addition, the LSS monitors the emergency response network (Radio No. 295). The telephone number for the LSS is 574-6606. The nearest fire alarm box is located _____ _____. Emergency services may be reached at the telephone numbers shown below.

The SSHO will perform the following pre-emergency tasks before starting field activities and will coordinate emergency response with the LSS:

1. Locate nearest telephone and alarm station.
2. Confirm and post emergency telephone numbers.
3. Post site map of work areas marked with evacuation routes.
4 Inventory and check out on-site emergency equipment and supplies, as warranted.

In the event of an emergency that requires evacuation of the work site, a verbal instruction will be given by the SSHO to evacuate the area. Personnel will exit to a predesignated area. At this point, the SSHO will account for all personnel, ascertain information about the emergency, and give further instructions to the on-site personnel. In all situations that require evacuation, personnel shall not re-enter the work area until the conditions causing the emergency have been corrected; the hazard reassessed; the Work Package and TSHASP revised, approved, and reviewed with on-site personnel; and instructions given for re-entry. Re-entry will not be allowed without approval by the LSS, who serves as the Laboratory Emergency Director.

Emergency Personnel	Phone	Radio #
ORNL Emergency Response (Plant phone only)	**911**	**295**
Laboratory Shift Superintendent	**574-6606**	**295**
Fire Department	574-5678	295
Medical Center	574-7431	295
Security	574-6646	295
SHEST	576-6447	231
Radiation Protection	574-6701	152
Environmental Compliance	574-8770	216
Nuclear Criticality Safety Section	574-4338	

The SSHO will brief workers on emergency response procedures and the evacuation route during the pre-entry briefing.

10.0 TRAINING/MEDICAL REQUIREMENTS

List applicable training/medical requirements for this task. All site personnel and visitors requiring access to the work zones will be required to meet these access requirements.

Training Required:

_____ 24 hour HAZWOPER (SARA/OSHA) training
_____ 40 hour HAZWOPER (SARA/OSHA) training
_____ Current HAZWOPER 8-hour Annual Refresher (as applicable)
_____ 8-hour HAZWOPER Supervisor training (SSHO only)
_____ Radiological Worker Training
_____ Nuclear Criticality Training (4 hours)
_____ Nuclear Criticality Training (16 hours)
_____ Nuclear Criticality Training for Supervisors
_____ Respirator fit test/training
_____ Confined space entrant (only those entering space)
_____ Confined space attendant
_____ Lead worker
_____ Other (list)

Medical Surveillance:

_____ ORNL Hazardous Waste Worker Medical Surveillance Program (only for individual meeting criteria as specified in Sect. 9 of the ORNL HAZWOPER Program Manual).

_____ Other, please list.

Note: If site/area conditions change, or other hazards are detected, the training and access requirements will be revised accordingly.

Appendix B

HEALTH AND SAFETY PLAN FIELD CHANGE FORM

HEALTH AND SAFETY PLAN FIELD CHANGE FORM

DATE: Change for Original HASP Number:

PROJECT:

INITIATOR OF CHANGE FORM: _____

TASK OR HAZARD THAT INITIATED FIELD CHANGE:

PROJECT/FACILITY MANAGER NAME(s)/PHONE NUMBERS:

ADDITIONAL HAZARDS (IF DIFFERENT FROM ORIGINAL HASP)

Physical Hazards

() Cold Stress	() Compressed Gases/Cylinders	() Confined Space
() Enclosed Space	() Ergonomics	() Explosive/Flammable
() Heat Stress	() High Pressure	() Manual Lift
() Noise	() Oxygen Deficient	() Oxygen Enriched
() Tripping/Falling	() Vibration	() Work in Boat/on Water

Safety/Construction Hazards

() Demolition	() Drum Handling	() Electrical
() Elevated Work	() Energized Sources	() Excavation/Penetration
() Hoisting/Rigging	(Lockout/Tagout)	() Overhead Hazards
() Trenching/Shoring	() Underground Hazards	() Welding/Cutting/Burning

Chemical Hazards

() Asbestos	() Carcinogen	() Corrosive
() Inorganics	() Lead	() Manmade Mineral Fibers
() Mercury	() Metals	() Mutagen
() OSHA Specific	() PCBs	() Reproductive Toxicant
() Volatile Organic	() Other	

Ionizing Radiological Hazards

() External Exposure

() Internal Exposure

Contamination Hazard Type _____

Types: ( )Ingestion, ( )Inhalation, ( )Absorption

Non-Ionizing Radiological Hazards

() High Voltage	() Laser	() Microwave
() RF	() UV	

Biological/Vector Hazards

() Bacterial	() Medical Waste	() Parasites
() Plants (Allergens)	() Wildlife	

CONTROLS (IF DIFFERENT FROM ORIGINAL HASP)

Engineering Controls: _____

_____

_____

Administrative Controls: _____
(required permits, _____
training, etc.) _____

Permits

	Yes	No
RWP required?	☐	☐
Configuration Management Plan required?	☐	☐
Excavation/Penetration Permit required?	☐	☐
Hoisting and Rigging Plan required?	☐	☐
Lockout/Tagout Permit required?	☐	☐
PACSE required?	☐	☐
Radiation Work Permit required?	☐	☐
Welding/Hot Work Permit required?	☐	☐

	Yes	No
Are design/specification changes needed?	☐	☐

Other (Specify) _____

Are changes required in existing permits?

PERSONAL PROTECTIVE EQUIPMENT

Level of Protection:

( ) A ( ) C ( ) Modified
( ) B ( ) D

Respiratory Protection:

( ) SCBA ( ) Fullface ( ) 1/2 Face Respirator
( ) PAPR ( ) Other ( ) Supplied Air
Cartridge: _____

Protective Clothing:

( ) Apron ( ) Company Clothing (Khakis)
( ) C–zone ( ) Encapsulating Suit
( ) Impermerable Suit ( ) Lab Coat
( ) Saranex ( ) Splash Suit
( ) Tyvek ( ) Welded Saranex
( ) Other _____

Head/eye/ear:

( ) Ear Plugs ( ) Ear Muffs
( ) Face Shield ( ) Goggles
( ) Hard Hat ( ) Laser Eyewear
( ) Monogoggles ( ) Safety Glasses
( ) Splash Shield ( ) Welding Goggles

Gloves:

( ) Cotton	( ) Insulating
( ) Latex	( ) Leather
( ) Neoprene	( ) Nitrile
( ) PVC	( ) Vinyl
( ) Welding Gloves	

Footwear:

( ) Chemical Overboots	( ) Shoe Covers
( ) Steel–toed Leather	( ) Steel–toed Rubber
( ) Other	

Health and Safety Monitoring Requirements (If different from original HASP)

Additional comments/changes:

APPROVALS:

FM

SSHO

HEALTH PHYSICS (if applicable)

SHEST (if applicable)

Other

DISTRIBUTION

1. J. F. Allred
2–3. S. N. Burman
4. R. L. Faulkner
5. J. E. Francis
6. L. L. Gilpin
7. R. C. Gosslee
8. C. L. Hedrick
9. J. S. Ivey
10. P. S. Johnson
11. S. G. Kimmett (U)
12. R. A. Kite
13. M. W. Kohring (U)
14. S. D. Mathews
15. L. E. May (U)
16. J. T. McGehee
17. B. D. Miller
18. P. T. Owen (U)
19. B. D. Patton
20. F. J. Peretz (U)
21. L. B. Raulston (U)
22. B. W. Ross
23. D. G. Rowland
24. J. E. Rushton
25. R. M. Szozda
26. P. F. Tiner
27. M. S. Uziel
28. K. L. Walker (U)
29. Central Research Library (U)
30. EMEF DMC—RC
31. EMEF DMC (U)
32. MAD Record Center