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ORNL/ER-326

ENVIRONMENTAL RESTORATION PROGRAM

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

ENERGY SYSTEMS ER

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.
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Health and Safety Plan for the Molten Salt Reactor Experiment Remediation Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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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) 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 Structure 1.4.12.6.2.01.05.02 (Activity Data Sheet 3701, "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.

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ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AHERA	Asbestos Hazard Emergency Response Act
ALARA	as low as reasonably achievable
CAA	controlled access area
CAAS	Criticality Accident Alarm System
CCE	Center for Continuing Education
CGI	combustible gas indicator
CNS	central nervous system
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
D	daily
DAC	derived air concentration
D&D	decontamination and decommissioning
dBA	decibels on the A-weighted scale
DOE	U.S. Department of Energy
EC	ORNL Office of Environmental Compliance and Documentation
ECC	Emergency Communications Center
EMS	emergency medical services
Energy Systems	Lockheed Marietta Energy Systems, Inc.
ER	Environmental Restoration
ES&H	environmental safety and health
eV	electron volts
EZ	exclusion zone
FID	flame ionization detector
FP	flash point
GET	General Employee Training
GI	gastrointestinal tract
H&R	hoisting and rigging
HASP	health and safety plan
HAZCOM	communication of potential hazards
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

ABBREVIATIONS (continued)

IDLH	immediately dangerous to life and health
IH	industrial hygiene
IS	industrial safety
LEL	lower explosive limit
LSS	Laboratory Shift Superintendent
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
MSRE	Molten Salt Reactor Experiment
NCS	nuclear criticality safety
NE	not established
NESHAPS	National Emission Standards for Hazardous Air Pollutions
NIOSH	National Institute of Occupational Safety and Health
OVA	organic vapor analyzer
ORNL	Oak Ridge National Laboratory
ORP	ORNL Office of Radiation Protection
ORR	Oak Ridge Reservation
ORS	Occurrence reporting system
OSHA	Occupational Safety and Health Administration
OSHP	Office of Safety and Health Protection
OVM	organic vapor meter
PAPR	powered air-purifying respirator
PEL	permissible exposure limit
PHASP	Project Health and Safety Plan
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
QA	quality assurance
RADCON	radiation control (as in RADCON Manual)
RCRA	Resource Conservation and Recovery Act
RDF	Radiochemical Development Facility
REAC/TS	Radiation Emergency Assistance Center/Training Site
REL	recommended exposure limit
RI	remedial investigation
RMSA	Radioactive Materials Storage Area
RPP	Radiation Protection Procedures
RWP	Radiation Work Permit

ABBREVIATIONS (continued)

SCBA	self-contained breathing apparatus
S&H	safety and health
SHEST	Safety and Health Evaluation and Support Team
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SRIDs	Standards/Requirements Identification Documents
STEL	short-term exposure limit
SWP	Safety Work Permit
TLD	thermoluminescent dosimeter
TLV	threshold limit value
TSHASP	Task-Specific Health and Safety Plan
UEL	upper explosive limit
UL	Underwriters' Laboratory
W	weekly
WBGT	wet bulb globe thermometer
WOCC	Waste Operations Control Center
WP	work package
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 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 all applicable DOE Orders (e.g., 5400.5, 5480.4, 5480.11, 5480.24, 5483.1A, 5700.6C), applicable Occupational Safety and Health Administration Standards 29 CFR 1910 and 1926, 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 the DOE *Radiological Control Manual* (DOE/EH-0256T), the ORNL HAZWOPER Manual (ORNL/M-2716), and the guidelines set forth in the *Health and Safety Plan for the Environmental Restoration Program at Oak Ridge National Laboratory* (ORNL/ER-226).

This PHASP provides information applicable to scheduled activities at the MSRE facility including:

1. interim corrective measures to mitigate safety concerns of the MSRE,
2. a removal of uranium hexafluoride (UF_6) and other related gases (purge and trap reactive gases),
3. removal of uranium deposits, 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 and, thus, under the ORNL HAZWOPER program (see Sect 2.2).

This PHASP and subsequent related documents will be reviewed and approved by the MSRE Environmental Safety and Health (ES&H) Manager and ORNL personnel listed in the *ORNL HAZWOPER Procedures Manual* to ensure that all plans comply with regulations and procedures of the various ORNL ES&H disciplines.

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.

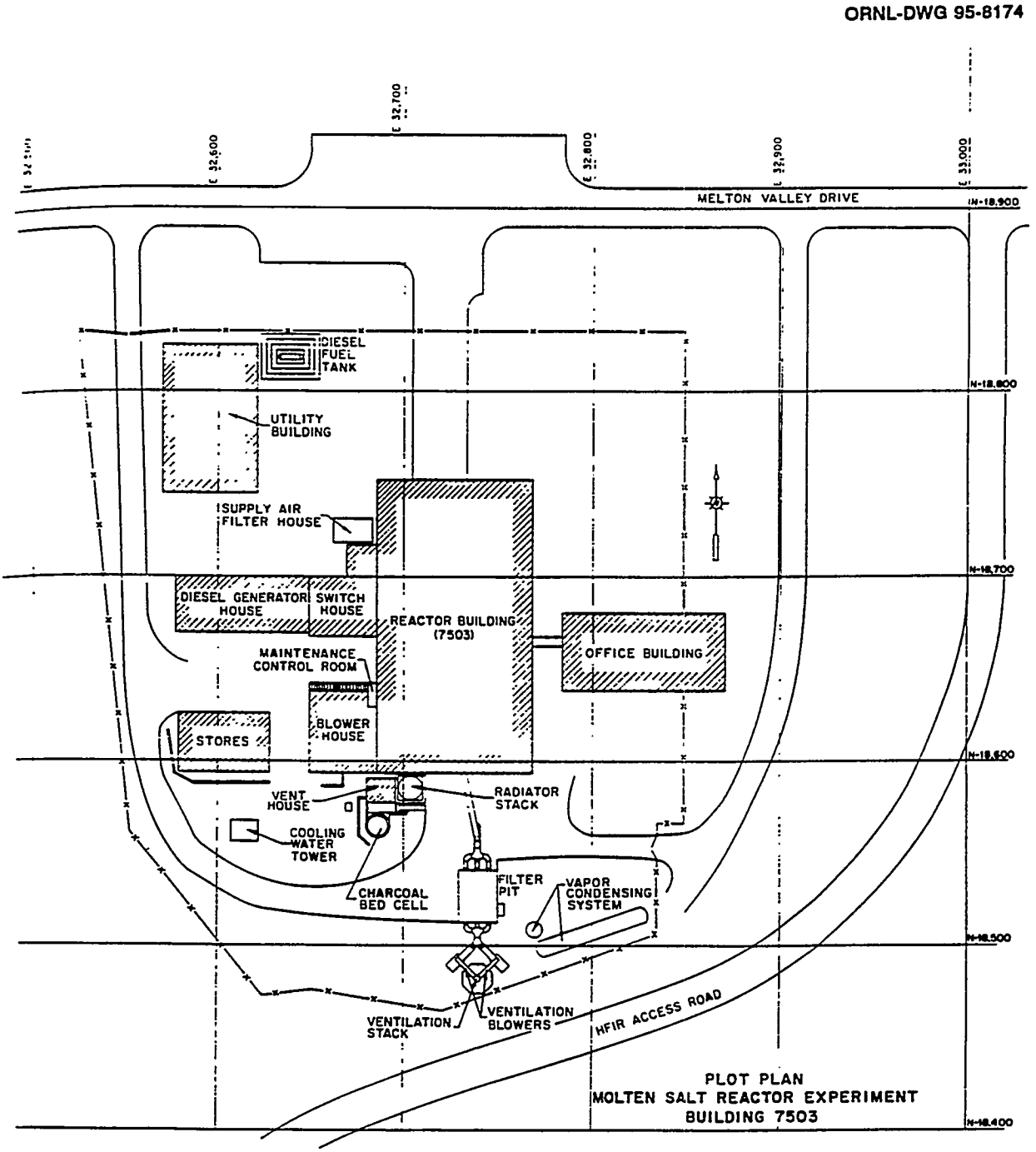

Fig. 1. Diagram of the Molten Salt Reactor Experiment site.

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) **or** a Task-Specific Health and Safety Plan (TSHASP),
- a Radiation Work Permit (RWP), 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 the appropriate disciplines [Office of Radiation Protection (ORP), Office of Safety and Health Protection (OSHP), etc.] for completion and sign-off. When completed, the package is forwarded to the MSRE ES&H Manager and, when appropriate, the ORNL Criticality Safety Section representative for review and approval. The package 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. If the task meets criteria established by the ORNL HAZWOPER program with regard to (1) hazards associated with the task, (2) duration of the task, and (3) level of effort to accomplish the task, HAZWOPER requirements will be initiated.

TSHASP development shall be a cooperative effort involving the MSRE ES&H Manager, the Site Safety and Health Officers (SSHOs), and the MSRE ORP representative (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 and ORNL personnel listed in the *ORNL HAZWOPER Program Manual* (ORNL/M-2716). This review and approval 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 the facility staff for the duration of the project. Upon completion of the project, all appropriate documentation will be retained as historical records and forwarded to the ORNL Environmental Restoration (ER) Program Document Control Manager. Required project documentation may include, but is not limited to, the following:

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

2.3.1 Project Logbook

A project H&S logbook shall be maintained for tasks at the MSRE that fall under the scope of 1910.120, HAZWOPER requirements. This logbook is for the purpose of documenting and summarizing all pertinent task 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, ORP representative, 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. Work shall be suspended until the corrective action has been taken. After corrective action, work will resume under the direction of the SSHO, OSHP representative, ORP representative, or ES&H Manager.

2.3.2.2 Occurrence Reporting

Department of Energy (DOE) Order 5000.3B, *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. Any other ORNL procedures for occurrence reporting will also be followed.

2.3.2.3 Field Changes and Variances

Any deviation from the PHASP, WP, or TSHASP, or any change in established work procedures or SOPs that affects health and safety or quality, must be recorded (when the deviation occurs) in a specified section of the project logbook for field changes and variances. A Field Change Request/Variance Form (provided as Attachment B) will be completed and signed by the appropriate persons.

A variance is a routine change in any aspect of the written procedure that would not affect the quality of data or analytical results. If a variance from the plan occurs, the box marked "Variance" is checked on the Field Change/Variance Form and the MSRE Project Manager is required to sign the form. A copy of the form will be distributed to the project quality assurance (QA) representative and the original maintained by the Project Manager. All personnel involved in the work process will be informed of these changes.

A field change is a deviation that could adversely affect the quality of data being generated. For major alterations or field changes, the "Field Change" box on the form is checked and the signatures of the Facility Manager and the Project Manager are required, in addition to the signatures listed on the form (see Attachment B). Changes must be explained to all site personnel. Each signee will receive a copy of the Field Change/Variance Form, which records the deviation, the substituted method or rationale for the change, and an explanation of how data quality will be affected. All variances that affect the health and safety of the site workers shall require the approval of the HAZWOPER Program Coordinator.

3. FACILITY ORGANIZATION

The MSRE facility is currently being managed as a part of the ORNL 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 1 and key project personnel in Table 2. Emergency contacts are listed in Table 3.

Table 1. MSRE health and safety personnel

Responsibility	Name	Telephone
MSRE Project Manager	J. E. Rushton	576-7000
MSRE Facility Manager	M. K. Ford	576-1902
Facility Coordinators	E. Easton G. A. Mays T. C. Morelock	241-4979 574-0268 574-5558
MSRE ES&H Manager	S. N. Burman	576-7364
MSRE Radiation Protection Coordinator (ORP Coordinator)	J. E. Francis	574-6701
ORNL HAZWOPER Program Coordinator; Safety and Health Evaluation Support Team (SHEST)	A. W. Saulsbury Pager number	576-5064 564-5805
ORNL Nuclear Criticality Safety Section	J. F. Mincey	574-4338
MSRE OSHP Representative	B. Miller	576-8218
MSRE Radiation Protection Representatives (ORP representatives)	B. D. Childs J. B. Cox	574-6558 574-6558
MSRE HAZWOPER Site Safety and Health Officer (SSHO)	J. P. Abston	574-4588

Table 2. MSRE project personnel

Responsibility	Name	Telephone
MSRE Project Manager	J. E. Rushton	576-7000
Assistant to MSRE Project Manager	W. O. Rentz	241-6706
ORNL D&D Program Representative	T. W. Burwinkle	576-0423
Criticality Safety Oversight	D. E. Mueller	576-4121
Quality Assurance Manager	J. S. Ivey	576-3876
MSRE Facility Manager	M. K. Ford	576-1902
Facility Coordinators	M. Easton G. A. Mays T. C. Morelock	241-4979 574-0268 574-5558
Safety Analysis Engineer	M. A. Green	574-8260
MSRE Technical Support Manager	B. D. Patton	576-0603
Interim Corrective Measures Manager	D. W. Ramey	574-5912
Purge and Trap 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	P. R. Sanders	
Senior Technical Advisors	L. P. Pugh J. R. Engel	
MSRE Waste Certification Officer	S. E. Childs	241-2807

Information contained in Table 3 must be included in all TSHASPs.

Table 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	M. K. Ford	576-1902
Facility Coordinators	M. Easton G. A. Mays T. C. Morelock	241-4979 574-0268 574-5558
MSRE ES&H Manager	S. N. Burman	576-7364
MSRE Radiation Protection Coordinator (ORP Coordinator)	J. E. Francis	574-6701
Radiation Protection (Off-Shift)		574-6700 Radio No. 152
ORNL ER ES&H Manager	C. Clark	574-8268
ORNL SHEST Representative	Ann Saulsbury	576-5064
ORNL Nuclear Criticality Safety Section	J. F. Mincey	574-4338
MSRE Waste Certification	S. E. Childs	241-2807

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), the ER ES&H Manager, and the appropriate ORNL discipline(s): HAZWOPER Program Coordinator, 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 all site participants should understand exactly who should be contacted before site activities are initiated. This chain of command is illustrated in Fig. 2.

3.3 ROLES AND RESPONSIBILITIES

Roles and responsibilities of the following project 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 ORP representative
- HAZWOPER Program Coordinator
- OSHP
- task personnel
- ORNL ER Program ES&H Manager

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.

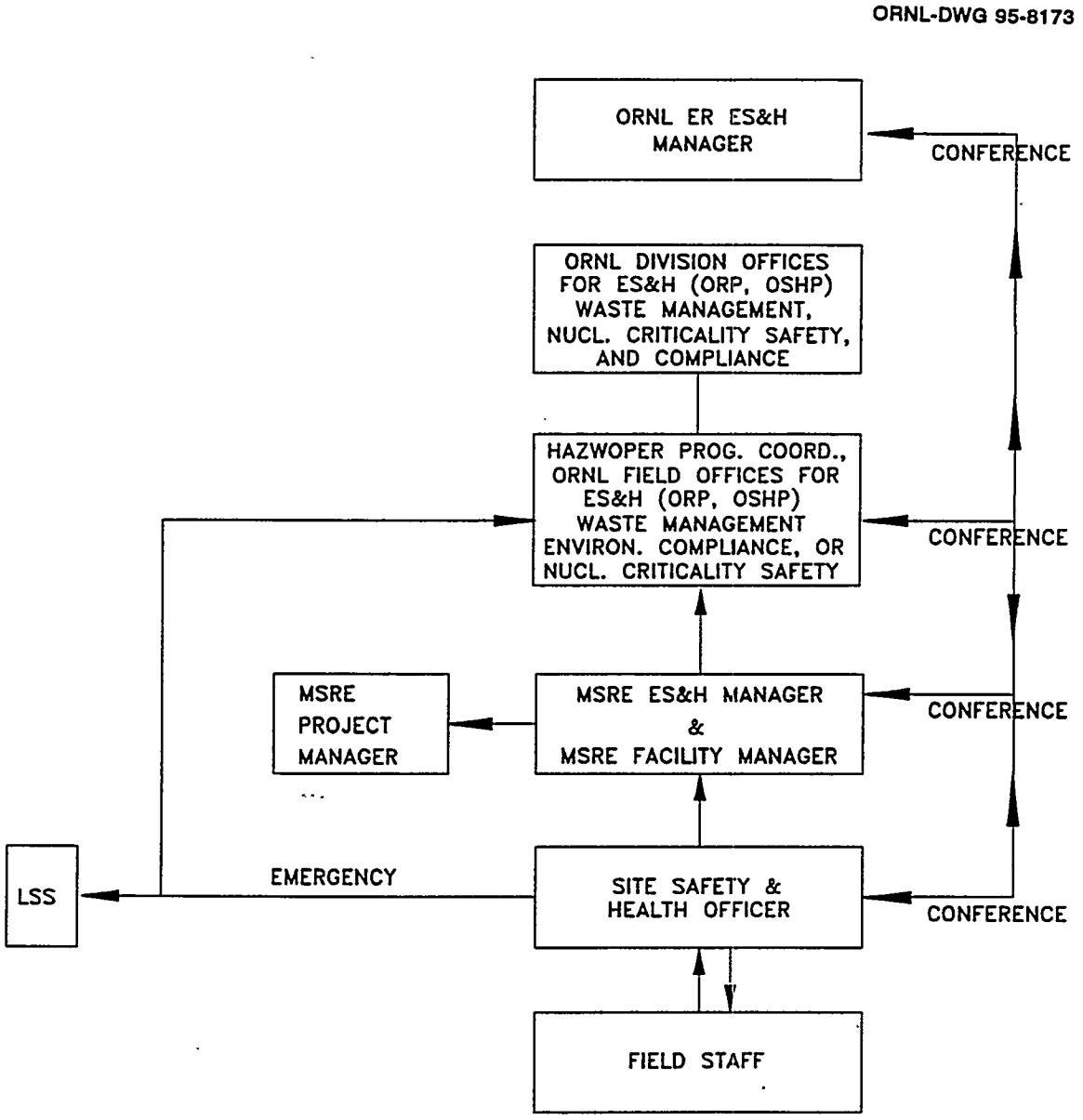

Fig. 2. MSRE chain of command for reporting health and safety issues. The SSHO, IH representative, or any task worker first contacts the MSRE ES&EH Manager and the MSRE Facility Manager. Then, a conference is initiated involving the SSHO, the MSRE ES&H Manager, the ER ES&H Manager, and the appropriate disciplines(s): HAZWOPER Program Coordinator, Office of Radiation Protection, Office of Safety and Health Protection, Waste Management, Environmental Compliance, or Nuclear Criticality Safety. In an emergency, contact the LSS. For nonermergency situations when neither the MSRE ES&H Manager (or designee) nor the Facility Manager is available, the SSHO should contant the appropriate disciplines(s) directly. The SSHO should contact the LSS when stop work conditions occur due to an unexpected hazard.

All individuals working at or visiting the MSRE facility must adhere to all 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.

3.3.1 Cessation of Work

According to Energy Systems 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). The respective SSHO, ORP representative, 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 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, ORP representative, or OSHP representative will evaluate the situation and notify 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. 2).

The ES&H Manager, SSHO, ORP representative/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. 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 an Energy Systems 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:

- Acting in an oversite capacity to ensure the H&S of workers and to protect the environment.
- Assisting the SSHOs, ORP representatives, 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.

- Providing oversight and supervision of all SSHOs.

- Developing the TSHASPs in a cooperative effort with the ORP representative, the Project Manager, the HAZWOPER Program Coordinator, Nuclear Criticality Safety, and other authorities.

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 by the ES&H Manager and the ORNL HAZWOPER Coordinator to fall under the requirements of the 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. Each SSHO must be approved in writing to the ES&H Manager by the ORNL HAZWOPER Program Coordinator. The approval or disapproval will be determined through a review of qualifications including those listed above. 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 ORP representative.

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

- 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 participates in the necessary medical surveillance programs and respiratory protection programs and 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.

- Conducting pre-entry and daily health and safety briefings that 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 Radiation Protection Coordinator and the ORP representative

All health physics monitoring and oversight services shall be provided through the ORNL ORP. HPs providing support at the MSRE will be provided by, subcontracted through, or approved by the ORP. An ORP Coordinator or ORP representative with working knowledge of the MSRE will be designated by the ORP to provide on-site support for each task. The responsibilities of the ORP representative 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 by signature or disapproval of the plan(s) on the basis of compliance with 29 CFR 1910.120 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 frisked for contamination before leaving Radiological Areas.

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

- Completing RWPs at the time the task commences.

- Assuring that equipment leaving the area has been properly bagged 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 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 DOE *Radiation Control Manual* procedures, ORNL Radiation Protection procedures, and MSRE SOPs and practices.
- 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.

3.3.5 HAZWOPER Program Coordinator or Safety and Health Evaluation Support Team

The HAZWOPER Program Coordinator is responsible for the written approval of this PHASP and for the oversight of all field activities with respect to compliance with the requirements of 29 CFR 1910.120. [The HAZWOPER Program Coordinator or the ORNL Safety and Health Evaluation Support Team (SHEST) is responsible for the approval of all TSHASPs.] The HAZWOPER Program Coordinator shall have the authority to perform on-site inspections of site operations at his or her discretion and shall have the authority to order the cessation of work activities. Responsibilities of the HAZWOPER Program Coordinator 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 and granting written approval by signature or disapproval of the plan(s) on the basis of compliance with 29 CFR 1910.120 and the adequate address of industrial hygiene concerns.

- Authorizing the commencement of work activities once the subject of concern has been resolved to the satisfaction of all health and safety personnel consulted.

- Assisting the SSHOs or ES&H Manager and the ORP representative in the selection of PPE and respiratory protection, as needed.

- Granting the written approval or disapproval to the ES&H Manager of each SSHO as being able to perform as a SSHO at the site, based upon the requirements for SSHO approval that are listed in Sect. 3.3.3 of this PHASP.

- 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).

3.3.6 Office of Safety and Health Protection

The OSHP at ORNL shall be responsible for oversight of 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 ORP representative in the selection of appropriate PPE and respiratory protection.

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 unsafe conditions to the SSHOs and the ORP representative.

- 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 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, telephones, and radios;
  - — 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 SSHOs and the Project Manager.

- 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 first.)

- 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 ORP representative for frisking prior to egress from the CRZ or EZ as directed by the SSHOs or HP.

- Becoming familiar with the procedures required by the PHASP, WPs, and TSHASPs.

- Conducting all tasks in accordance with the PHASP, WP, and TSHASPs for each task.

- Reporting to the ES&H Manager or SSHO, the ORP representative, 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.

3.3.8 ORNL ER Program ES&H Manager

The ORNL ER Program ES&H Manager is a designated Energy Systems Employee who is responsible for the oversight of all ORNL ER program activities. The ER ES&H Manager is responsible for reviewing this PHASP. The ER ES&H Manager will also be consulted on certain health and safety issues (see Fig. 2).

4. PROJECT HAZARD ANALYSIS

The MSRE program consist of four phases of remediation: (1) interim corrective measures, (2) purge and trap, (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) a RWP and a HAZWOPER TSHASP (for tasks that fall under the direction of 29 CFR 1910.120) or (2) a RWP and a SWP (for tasks that do not fall under the direction of 29 CFR 1910.120). Both 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 includes those areas and tasks that are 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. 3, 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 is to be partitioned originates at the three fuel storage tanks and eventually terminates in the charcoal bed cell. A segment of this system with a "T" configuration is separated off and runs through a sample enricher device (Fig. 3, area No. 2). This is the best and safest location throughout the complex to segregate the system. This will involve the closing of existing valves and the addition of a purge and trapping mechanism to control a pressure build-up in the system, if one should occur.

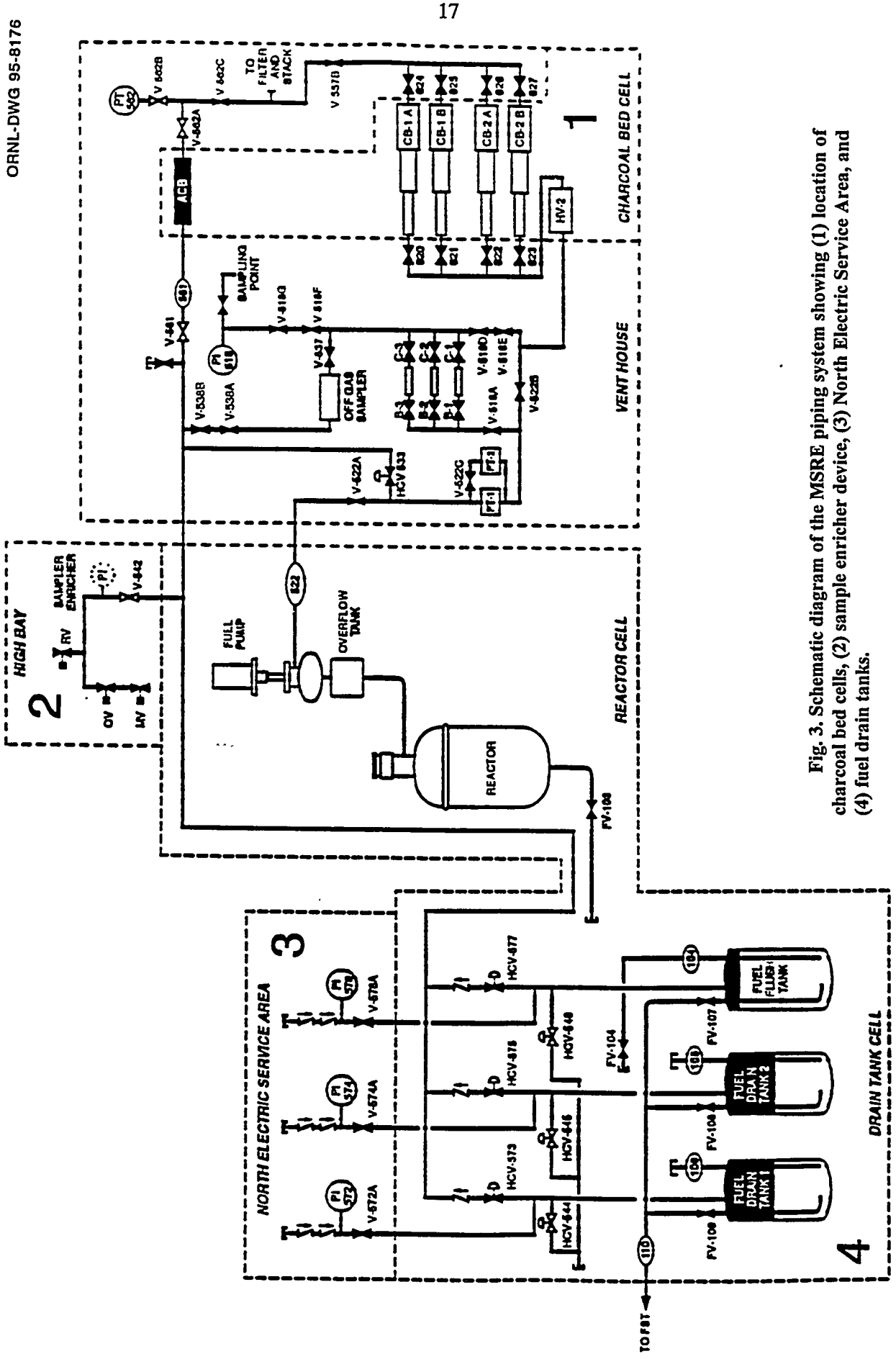

Fig. 3. Schematic diagram of the MSRE piping system showing (1) location of charcoal bed cells, (2) sample enricher device, (3) North Electric Service Area, and (4) fuel drain tanks.

The replacement of old, unreliable pressure transducers on existing lines will help to verify the pressure within the system more adequately. Four pressure transducers will be installed throughout the piping complex. Three transducers, one for each storage tank, will be affixed to existing lines originating from each tank. These lines will be accessed in the North Electrical Service Area (Fig. 3, area No. 3). With these transducers installed, adequate pressure data can be ascertained.

Other surveillance and maintenance activities that prepare the facility for removal activities are 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 are numerous including physical hazards such as limited space, electrical hazards, illumination concerns, and tripping and falling. Other concerns include exposure to lead, asbestos, temperature extremes, CO_2, UF_6 and other radionuclides.

4.1.2 Controls

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

4.2 PURGE AND TRAP OF REACTIVE GASES

It is speculated that over 10% of the uranium stored in the storage drain tanks has been converted to UF_6 gas and has migrated throughout the MSRE system. Also, it is suspected that fluorine atoms have been released from the salts to form F_2, which may be present throughout the lines. A purge and trapping system is being developed for the collection and separation of UF_6 and other gases into their individual components. (This operation will take place in area No. 2, Fig. 3.) Two shielded chemical trapping cylinder(s) are being fabricated. One cylinder will be filled with sodium fluoride (NaF) as the trapping media; alumina will be used in the other. These cylinders will be attached to the process lines, valved, and equipped with disconnects for the exchanging of unloaded cylinders. The other end of the piping system will be capped. Due to the possibility of exposure, a sealed glove box with a constant vacuum, maintained through HEPA filters, is being constructed and will be installed over the fittings where the collection cylinders will be attached. Technicians will be able to access the valves in the glove box and disconnect and reattach new cylinders through glove ports. When the cylinders are saturated, the valve will be closed and the cylinders disconnected, capped, and lowered through an opening in the bottom of the glove box into an individual lead cask. The cylinder will be 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 purge and trap efforts include exposure to UF_6, uranium, and fluorine; ergonomic issues; and possible temperature extremes.

4.2.2 Controls

Both administrative and engineering controls are being considered to ensure the safe completion of these tasks. Examples of controls being developed and/or considered for these tasks include glove box enclosures, respirators, glove-in/glove-out techniques, lead casks for transportation, and different type fittings for attaching the appropriate trapping vessels.

4.3 URANIUM DEPOSIT REMOVAL

The third phase of remediation involves removal of the remaining UF_6 located throughout the system and removal of accumulated uranium contained within the charcoal-filled pipes within the charcoal bed cell (Fig. 3, area No. 1). Through gamma scanning, the extent of uranium will be determined within each of the charcoal bed cell pipes. A Sea-Land container will be adapted for use as a secondary containment enclosure. The enclosure 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 charcoal bed cell. A mobile manipulator with two mounted cameras will be remotely guided into place. A robotics device will be guided alongside an auxiliary charcoal pipe. A "hot tap," which has the ability to cut and punch simultaneously, will be utilized to puncture the bottom of the charcoal-filled cylinder. A vacuuming device will be attached to the generated opening and sealed with "O" rings to prevent any release of gases to the environment. The uranium-bound charcoal will be evacuated into specially designed collection vessels. These containers will be transported 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.

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 within the storage drain cells (Fig. 3., area No. 4) and throughout the system will be considered. The fuel salts 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. The final removal process has to this date not been determined. 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 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 IDENTIFICATION AND ASSESSMENT OF POTENTIAL SITE HAZARDS

4.5.1 Physical Hazards

4.5.1.1 Noise

Hazards. The operation of large or heavy equipment such as cranes 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 will ensure compliance with posted warnings.

4.5.1.2 Site working conditions hazards

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 due primarily to varying working conditions. These hazards include, but are not limited to, 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 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.

4.5.1.3 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 (EPA 1992) shall be maintained from all lines 110 volts or greater. If the appropriate clearance cannot be maintained, the power lines shall be de-energized and grounded.

4.5.1.4 Electrical hazards

Numerous electrical hazards may exist throughout the MSRE facility, therefore personnel should always remain cognizant of the potential for electrocution or shock when conducting any activities. Common electrical hazards include buried power lines, overhead power lines (see Sect. 4.5.1.3), transformers, circuit boxes, electrical generators, and lightning. Other electrical hazards associated with MSRE activities may include, but are not limited to, the following: undetected live wires, circuit boxes or electrical systems, standing water or puddles, deteriorating wiring insulation, etc.

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

- 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 unless waived by a representative from OSHP;
- 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.

4.5.1.5 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) shall 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 of Occupational Safety and Health (NIOSH 1986).

- **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.

4.5.1.6 Confined space entry

A confined spaced is defined as an enclosed area with all of the following characteristics: not designed for human occupancy; entry and exit into the area is restricted in that it requires the entrant to contort his or her body or to use his or her hands in order to enter and/or exit the area; and the area contains known or potential hazards to the safety or health of the entrant. Examples of some potential hazards that may be encountered in a confined space are as follows: hazardous atmospheres, immediately-dangerous-to-life-or-health conditions, ionizing radiation, safety hazards, and hazardous energy (uncontrolled electrical energy).

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. Confined space entry will be conducted according to the OSHP procedure OSHP-014, *Confined Space Entry Program.*

4.5.2 Chemical Hazards

Many chemical hazards with various origins or functions (e.g., process contaminants, chemicals used in facility and task operations) may be present at the MSRE facility. Chemicals that have been identified at the MSRE facility as known or suspected site contaminants are listed in Table 4. 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.

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 the American Conference of Governmental Industrial Hygienists (ACGIH). 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 Date Sheets (MSDSs) for any chemicals brought on-site for site operations will be obtained by the ES&H Manager or project supervisor prior to the start of field activities. These MSDSs shall be obtained through the ORNL MSDS Database System or approved by ORNL OSHP and attached to the TSHASPs. The MSDSs shall be available on-site during all operations.

4.5.2.1 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.

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. 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 project workers will be required to be on the Lead Worker Program, which includes lead training and a medical monitoring program for lead workers.

Table 4. 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
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
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
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)	TLV: 0.15 mg/m^3		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)	Not listed	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

Table 4. (continued)

Contaminant	TLV/PEL[a]	STEL/ IDLH[b]	Target organs/ miscellaneous information[c]	Signs and symptoms	Physical and chemical properties
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
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, 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 1992, NIOSH 1990, MSDS sheets, and MSRE historical information.

4.5.3 Radiological Hazards

Radiological contamination will be assessed by a review of site characterization information and anticipated work activities by the ORP representative. On-site monitoring for detection of contamination levels will be performed by the ORP representative or an approved representative. A detailed evaluation of the radiological contamination present during each task will be included in the TSHASP or the RWP. Radiological hazards will be minimized to as-low-as-reasonably-achievable (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 ORP representative. Maximum contamination guides for frisking equipment released to a Controlled Area are contained in Table 5. Skin and personal clothing contamination limits shall be the same as the total contamination limits in Table 5, except

that averaging shall not be allowed. 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 ORP representative 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 6 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.

Table 5. Surface radioactivity values

Nuclide[a]	Removable (dpm/100 cm^2)[b]	Total (fixed + removable) (dpm/100 cm^2)[c]
U-natural, ^{235}U, ^{238}U, and associated decay products	1,000 alpha	5,000 alpha
Transuranics, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	500
Th-natural, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000
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
Tritium organic compounds, surfaces contaminated by HT, HTO, and metal tritide aerosols	10,000	10,000

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

[b]The amount of removable radioactive material per 100 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 three times the values in Table 5.

Table 6. 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
NATURALLY OCCURRING RADIONUCLIDES				
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
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.

4.5.4 Other Hazards

4.5.4.1 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.) Actual field measurements of illumination will not be taken. 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. In these situations, the SSHO or OSHP representative will evaluate conditions and possibly refer to illumination instrumentation to determine if additional lighting is required.

4.5.4.2 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, equipment vibrations, improper body positioning, and negotiation of physical obstacles when accessing confined spaces. 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.

4.5.4.3 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 SWP and 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.
- The material to be burned or welded upon and the atmosphere in the immediate area shall be examined by the SSHO and/or a representative of OSHP prior to the commencement of work activities to assess the possibility of hazardous fumes being created during hot work operations.
- A Hot Work Permit must be obtained and maintained on-site while work is in progress.

4.5.4.4 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 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 daily for leaks or other problems.

- Applicable monthly, quarterly, and special inspections shall be completed prior to equipment operation. Completed instruction forms shall be available on-site at all times.

- 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.

4.5.4.5 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:

- Flammable liquids shall be stored in an Underwriters' Laboratory-approved safety container designed and labeled for that purpose.

- Flammable materials shall be stored in a common location to be determined by the SSHO and the ORNL Fire Department.

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

- Area to be evacuated if readings of 10% of LEL are recorded.

4.5.4.6 Compressed gas cylinders

To reduce the potential for fire and explosion, carbon dioxide gas will be pumped into the charcoal bed cell to displace the oxygen, thus, necessitating the use of compressed gas cylinders at the MSRE complex.

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.

Controls:

- 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.
- No smoking or open flames will be permitted within 50 ft of stored compressed 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.
- Confined spaces and low areas of the facility will be monitored for the presence of carbon dioxide prior to anyone entering these areas. If, after a period of time, no carbon dioxide has been detected, this practice may be discontinued after consultation and concurrence with all H&S disciplines.
- 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.

4.5.4.7 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.

4.5.4.8 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 hoisting and rigging (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, 29 CFR 1926, and the contents of the *DOE Hoisting & Rigging Manual* (April 1993). In addition, proposed lift plans for hoisting and rigging activities shall be submitted to the ORNL H&R Program Manager for approval 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 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.

4.6 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 north doorway of Building 7503 and the east doorway of Building 7509. The log must be completed prior to proceeding.

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 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 radiation 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) and Radiation Worker II training.

- All visitors who are granted site access and have business in the Radiological Areas are required to be escorted at all times by an HP technician. If the area visited and time at the site pose a radiological concern, project management must arrange for a temporary TLD badge. 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. The HAZWOPER standards within 29 CFR 1910.120(e) reflect 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 waste 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 certificate or verification of completion of the classroom training and a copy of the Supervised Field Experience Form must be maintained by the MSRE Training Coordinator to verify compliance.

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. A copy of the certificate or verification of completion of this training or the ORNL Special Access Training Badge must be maintained on-site to verify compliance.

5.1.4 8-Hour SARA/OSHA HAZWOPER Supervisor Training

An additional 8 hours of HAZWOPER supervisory training will be required for individuals who manage or supervise workers during HAZWOPER work activities. This training is in addition to either the 24-hour or 40-hour training required for the specific task. The supervisor training elaborates on supervisor 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

Radiation worker training is designed to meet the requirements stipulated in the DOE *Radiological Training Manual* (DOE April 1994). A radiation 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 all facility workers have Radiation 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. A copy of each worker's certificate must be available to verify compliance. In specific cases where PPE is not required, Radiation Worker I training may suffice. Visitors who need to access Radiological Areas and need to don PPE may do so without meeting the requirement for Radiation Worker training if they are escorted by the ORP representative.

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; the National Emission Standards for Hazardous Air Pollutions (NESHAPS); the Asbestos Hazard Emergency Response Act (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 The Asbestos Hazard Emergency Response Act (AHERA) Final Rule, 40 CFR 763 Subpart E.

5.1.8 HAZWOPER Site Safety and Health Officer Training

This 1/2 day training course (or an equivalent SSHO training course approved by the Center for Continuing Education) is required by ORNL 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. All personnel requesting to be SSHOs must first be approved by the ORNL ER ES&H Manager and the ORNL HAZWOPER Program Coordinator. The ORNL ER ES&H Manager and the ORNL HAZWOPER Program Coordinator 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 ER ES&H Manager and ORNL HAZWOPER Program Coordinator will assign the applicant a level of competence, either SSHO Level 1, 2, or 3. After approval, the individual must attend the ORNL HAZWOPER Site Safety and Health Officer Training (TMIS # 11137). Based upon experience and educational background, this requirement may be temporarily waived by the ORNL HAZWOPER Program Coordinator 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 below in Table 7. The regulatory basis for the requirements presented in Table 7 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) and updated to include additional ORNL ER training requirements.

Table 7. Site training requirements

Operation/ personnel	Site health & safety briefing	24-h	40-h	8-hr super-visor	8-refresh-er[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 HP, 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]Radiation Worker II required at radiological sites.

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, radiation 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.

Personnel that do not meet the training or medical requirements will always be escorted by the SSHO, ORP representative, or other approved ES&H personnel. The safety and health of no individual 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

Training received outside ORNL or Energy Systems must be reviewed by the Center for Continuing Education. 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 HAZWOPER Program Coordinator and the Center for Continuing Education.

5.2 PRE-ENTRY HEALTH AND SAFETY BRIEFING

All task personnel shall be 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 jointly by the SSHO or MSRE ES&H Manager and the ORP representative or by designated representatives who have been approved by the SSHO and the ORP. 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 chemical 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 a dedicated section of the MSRE project logbook.

5.2.2 Daily Safety and Health Briefings

Daily S&H briefings shall be held by the MSRE ES&H Manager, SSHO, ORP representative, 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 ORP representative shall specify the PPE required for specific activities, tasks, and work zones. This specification shall be based on possible site contaminants, OSHA requirements, RADCON guidelines (DOE April 1994), and chemical and radiological hazards information. The SSHO and/or the ORP representative shall instruct all site personnel in donning and doffing procedures prior to beginning any work activities.

5.3.2 PPE Upgrade 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 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, ORP representative, ORP Coordinator, OSHP representative, and HAZWOPER Program Coordinator. At a minimum, the upgrade or downgrade of PPE levels must have the approval of both health and safety and ORP representatives. The consensus to upgrade or downgrade PPE levels and the basis for the decision shall be recorded on all applicable project documentation including the project 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 respiratory policy. Once the face-to-face-piece seal of the respirator has been broken (e.g., for lunch and other breaks), a new respirator will be donned in place of the previous one. No site personnel will be issued a respirator without a valid respirator card. Respirators will only be issued by qualified issuing personnel. The SSHO will verify qualification 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 HAZWOPER Coordinator, 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 the ORP representative. While work is being performed in the EZ/HAZWOPER designated site, monitoring will be performed approximately every 15 minutes, or 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 project logbook or on the SWP and RWP. Background readings shall be taken into account before action levels are established by the ORP representative, 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. The ORP representative, 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 6.

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, Sect. 10.2.1.3), all MSRE personnel at the facility should proceed to the designated assembly points at the north end of the site (Sect. 10.2.2) 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 to 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 located at the north end of the complex, 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 and ORNL OSHP. 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 by the SSHO or qualified designee.

- **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 SSHO 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. The administrative limit for worker exposure is 20 mrem/day.

- **Portable Alpha and Beta-Gamma Survey Meters**: To survey for radioactive contamination on personnel and equipment. These instruments shall be source-checked daily and calibrated at least quarterly. Action levels are surface radioactivity limits listed in Table 5.

- **Neutron Dose Rate Instrument:** To survey for neutron radiation dose rates. These instruments shall be source-checked daily and calibrated at least quarterly.

- **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 and calibrated at least quarterly.

- **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.
  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. Written standard procedures for instrumentation operation and calibration shall be used on-site and incorporated into this PHASP by reference or by attachment. All instrumentation operation and calibration shall be conducted in accordance with ORNL Radiation Protection and OSHP procedures, where applicable and available.

All chemical instrument calibration gas cylinders used in field calibrations must have a manufacturer's label with the lot number, the manufacturer's name, the type of gas, and the ppm or percent of gas concentration contained within the cylinder. Calibration readings, the lot number from the calibration gas cylinder, the calibration gas manufacturer, and each number of the radiological source will be recorded on the Daily Instrument Calibration Check Sheet, which is a section of the project logbook dedicated to daily instrumentation calibration, maintenance and use, as well as other information pertinent to field instruments.

6.3.2 Calibration of Fixed Alarm Systems

The calibration of MSRE fixed alarm systems will be performed on an annual 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 ORP representative, the ORNL OSHP, and the HAZWOPER Program Coordinator. These response guidelines are dependant upon the type of work being conducted, the suspected contaminants, and the health effects and toxicity of the contaminants. However, there are some general guidelines for monitoring response. If the reading on any organic monitoring device stabilizes at 5 ppm and holds steady for 1 min within the breathing zone, workers should be withdrawn from the CAA, CRZ, or EZ. ORNL OSHP should be notified and the area should be sampled and the chemical identified before work continues. This can usually be done on-site without a long delay. If a known chemical is present at a specific task, the action level should be based on the known chemical, and workers should be withdrawn when that action limit is reached. OSHP should be notified. If the monitoring instrument has a fluctuating reading that varies above the action limit, workers should be withdrawn from the area until the cause of the instrument's erratic readings can be determined. Conditions vary from task to task, therefore, monitoring response will vary due to these site conditions. Guidelines shall be established for real-time site assessments in each TSHASP.

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, 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 ORP representative, the ORP Coordinator, 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 HAZWOPER signs 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 the ORP representative. 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.

Because of physical restrictions and limitations of the MSRE facility, the routine practice of establishing concentric zones around the work area may need to be abandoned. Zones may need to be set up in unique areas and spaces, such as in confined spaces, around fitted obstacles, or around process piping.

The ES&H Manager, SSHOs, and the ORP representative 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 and 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 project 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 and the

ORP representative and 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, as determined by the SSHO and ORP Coordinator. 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 ORP representative or a designated representative properly trained to evaluate hazards. Equipment will also be surveyed for radiological contamination by the ORP representative, the ORP Coordinator, or a designee before exiting the CRZ.

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 of the means 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 ORP representative, 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 checks will be performed prior to entering a work area.

7.2.2 Plant Telephone System

The ORNL plant telephone system can be used to communicate within the plant by dialing the last five digits of the telephone number (e.g., 4-XXXX, 6-XXXX, 1-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 project waste management plan. Disposable contaminated PPE will be checked and bagged by the ORP representative and placed in the proper containment system as per the waste management plan. 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 throughout Buildings 7503 and 7509. 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 chemical and radiological contamination by the ORP representative and the OSHP representative.

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 mixed waste sites pose a primary concern in controlling the spread of radiological and/or chemical 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, tools, and vehicles. 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 ORP representative or the ORP Coordinator 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 HP, 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. Trigger levels 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 HP. 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. All disposable PPE will be placed in the appropriate containers for scanning and proper disposal by the ORP representative. Proper frisking procedures will also be posted. Individuals exiting the posted areas will either frisk themselves or be frisked by the ORP representative. If any contamination is detected, the ORP representative must be notified at once. The HP will then refrisk the individual in question to evaluate the level and extent of contamination and direct the individual on the proper decontamination techniques. These could be as simple as a "tape press" or as extensive as a body wash. Decontamination will take place in a designated area within the Radiological Area or the CRZ. The individual will be periodically monitored to determine the success of the decontamination effort.

For specific details on personnel decontamination, refer to the *DOE Radiation Control Manual*, Part 4, #541, "Skin Contamination."

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 large enough to protect the flooring from transferable contamination. The ORP representative, wearing the appropriate PPE, will scan 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 HP will wipe the piece in question with a cloth wipe and a cleaning agent. The article will be rescanned 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 ORP representative. 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 5.

9. STANDARD OPERATING PROCEDURES

All SOPs used for any task or effort connected with the MSRE project shall be written in accordance with established ORNL 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 ORNL SOPs will be referenced and, when applicable, included in the WP.

9.1 STANDARDS/REQUIREMENTS IDENTIFICATION DOCUMENTS (SRIDs)

Standards/Requirements Identification Documents (SRIDs) is a compliance assessment process in which policies, practices, procedures, and programs are reviewed to determine if all DOE Order requirements are properly implemented in site or facility programs. DOE established the SRIDs process to determine which orders, regulations, etc., are applicable for sites and facilities. DOE has designated that the MSRE (Building 7503) facility must comply with this directive. The MSRE SRIDs will identify and document the directly applicable requirements that line management considers necessary to provide an adequate level of protection for workers and public health and safety and the environment. Those functional units that pertain to the MSRE facility and project will be maintained in a data base that can be accessed by project personnel when needed. The SRIDs will be an on-going process; updates and revisions will be made throughout the life of the project.

10. EMERGENCY PREPAREDNESS AND CONTINGENCY PLANS

This section applies to any type of emergency, such as a fire, explosion, radiation releases, 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 Radiation 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.

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 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
HAZWOPER Program Coordinator	576-5064/576-6445	69
SHEST	576-6447	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 Emergency Response Plan.
- The location of site emergency exit routes.
- The location of the facility assembly point.
- 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 first aid kits, stretchers, emergency self-contained breathing apparatus, eye wash stations, emergency showers, and spill kits or other spill containment supplies and equipment.
- 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.

SITE	OFFICE	NUMBER	RADIO
ORNL	LSS	4-6606	KIN 294/295
	ECC	4-6646	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 direct the cessation of work, ensuring that all open systems have been secured, and instruct the workers on doffing specifications, if needed. The SSHO will further supervise the safe evacuation to the facility assembly point and ensure 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 the alarms described below, dial the following number from the plant system telephone:

SITE	NUMBER
ORNL	4-4462

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 Laboratory evacuation alarm

The laboratory evacuation alarm is a continuous 30-second warbling wail that is followed by PA instructions for the safest exit routes from the laboratory.

10.2.1.3 Edwards horn fire alarm

The Edwards horn alarm is a loud, continuous buzzer that functions as a fire alarm or local building evacuation alarm. Building or area occupants should immediately exit to the local assembly point through the designated evacuation routes.

10.2.1.4 Radiation emergency alarm

The local radiation emergency alarm is a clarion siren 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 or building. This alarm is often accompanied by flashing, rotating red or magenta beacon lights. Building occupants should exit by the shortest route and proceed to the local assembly point for further instructions. Facility occupants should progress to the local assembly point through the designated evacuation route. Personnel should not re-enter the building or area under any circumstances.

10.2.1.5 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

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 point 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. EZ evacuation routes shall be through the CRZ, if possible. The ORP representative 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 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 exit and to the designated assembly point 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.

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 point 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. 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. A copy of this plan is maintained at the facility and at the ORNL Fire Department.

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.

Personnel working at the MSRE will receive instructions specifying areas of the facility where they can personally use a fire extinguisher and areas where use of a fire extinguisher would cause a criticality concern. Fire extinguishers at the MSRE facility can be found in the following locations.

Building	Location
7509	Main hallway
7503	Southeast hallway outside men's change room
7503	High bay area behind fence, southeast wall
7503	East wall of mail hallway, next to lunchroom
7503	North hallway, next to door
7503	Hallway next to double exit doors
7503	North wall of high bay
7503	North annex of high bay, west wall
7503	Switch gear room, north wall
7503	Basement, outside transmitter room
7503	Basement, north wall of heater room
7503	Basement, west end of hallway

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

Building	Location
7509	Central hallway
7503	Central hallway

10.3 EMERGENCY MEDICAL SERVICES

10.3.1 Personnel Injuries

All injuries to project personnel, regardless how minor, must be reported to the SSHO. Job-related first-aid will be rendered by the SSHO, as necessary, and transportation to EMS will be made at the discretion of the SSHO, or at the injured person's request. All injuries and the circumstances involved will be recorded in the project 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 Bloodborne Pathogens

All site activities will be conducted in accordance with established ORNL procedures for the control of bloodborne pathogens and with the requirements of 29 CFR 1910.1030. Personnel designated to perform first-aid shall be enrolled in the ORNL Bloodborne Biological Hazards Program as collateral duty personnel.

10.3.3 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.

10.3.4 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 SPILL CONTAINMENT

A spill control kit shall be available on-site for use in the event of the uncontrolled release of materials considered potentially hazardous to site personnel, the community, or the environment. The spill control kit is considered a temporary provision to be used by site personnel to control the spread of contamination. The spill kit should be used by personnel only if they are properly protected from exposure to the spill constituents. If spill conditions exceed the control of the spill kit, the ORNL Spill Response Team should be summoned immediately to provide emergency services by contacting the LSS or ECC offices as described in Sect. 10.1.2.

10.6 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.

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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:

_____

Radiation Protection Coordinator — Date

_____

Safety and Health Evaluation and Support Team — Date
OR

_____

HAZWOPER Program Coordinator — Date

_____

MSRE ES&H Manager — Date

_____

Facility Manager — Date

_____

Site Safety and Health Officer — Date

Environmental Restoration Program ES&H Manager (Review only)

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 the ORNL *HAZWOPER Program Manual* and applicable ORNL, MMES, and DOE policies and procedures. 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 HAZWOPER Program Coordinator, SHEST, 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 HAZWOPER Program Coordinator with a list of personnel participating in work activities. The HAZWOPER Program Coordinator 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 HP, and clean up immediately using safe cleanup measures as directed by the SSHO or HP. 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 Radiation 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 and the HAZWOPER Program Coordinator will be responsible for the oversight and approval 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 and the HAZWOPER Program Coordinator will provide guidance regarding potential safety hazards, personal protective equipment, industrial hygiene monitoring, and sampling requirements. The SHEST will be contacted for all OSHP and HAZWOPER concerns at the site.

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 Procedures: OSHP-018

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 Procedures: OSHP-004, OSHP-024

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 Procedures: OSHP-014, OSHP-024, OSHP-059, OSHP-049

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 Procedures: OSHP-007

Tasks: _____

Heavy lifting? (Yes)_____ (No) _____

Vibrating equipment?(Yes)_____ (No) _____

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

Controls/protective equipment:

_____

_____

_____

_____

_____

4.6.1.5 Fire/explosion

Applicable Procedures: OSHP-072, OSHP-062, OSHP-043, OSHP-074

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 Procedures: OSHP-014,

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

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

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 Procedures: OSHP-047, OSHP-054, OSHP-059

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

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 Procedures: OSHP-001

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

4.6.4 Ionizing Radiation

Applicable Procedures: ORNL ORP procedures and DOE *Radiation Control Manual*

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 Radiation 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

Radiation 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. 4.5.3 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 Procedures: OSHP-019, OSHP-024

Location: _____

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

Location, distance, and voltage:_____

_____

_____

4.6.6 Sanitation

Applicable Procedures: OSHP-016

Water fountains, breakrooms, 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 Procedures: 29 CFR 1910.120, Table H-120.1

Additional illumination needed? ☐ Yes ☐ No

Specify: _____

4.6.8 Lead

Applicable Procedure: OSHP-032

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

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 5000.3B.

5.4.2 Modifications Allowed

5.4.2.1 Radiological conditions

The ORP representative 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 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 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 HAZWOPER Program Coordinator 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 or HAZWOPER Program Coordinator representative, OSHP representative, and the ORP representative 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 ORP representative. All ORNL RP procedures and *Radiation Control Manual* guidelines 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	**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)
_____ Radiation 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

FIELD CHANGE REQUEST/VARIANCE FORM

FIELD CHANGE REQUEST / VARIANCE FORM

☐ Field Change Change Number:_____

☐ Variance Date: _____

Project:_____

Task/Task No.:_____

Document:_____

_____

_____

_____

Substituted Method:_____

_____

_____

Impact on Data Quality or Health and Safety:_____

_____

_____

Justification._____

_____

_____

* † SSHO or H&S Representative:_____ Date:_____

Approvals: (Field Changes Only)

* † Project Manager:_____ Date:_____

† QA Specialist/Officer:_____ Date:_____

* Other Approvals [ES&H Representative(s), Nuclear Criticality Safety]:

Name / Organization

_____ Date:_____

_____ Date:_____

_____ Date:_____

* Signatures required for a health and safety issue or concern.

† Signatures required for a data quality issue or concern.

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