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**Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program**

**Environmental, Safety, and Health Plan for the Remedial Investigation
of Waste Area Grouping 10, Operable Unit 3, at Oak Ridge
National Laboratory, Oak Ridge, Tennessee**

Date Issued—October 1993

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400**

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ENVIRONMENTAL, SAFETY, AND HEALTH PLAN
FOR THE REMEDIAL INVESTIGATION OF WASTE AREA GROUPING 10,
OPERABLE UNIT 3, AT
OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AE	actual exposure
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
CAA	controlled access area
CFR	Code of Federal Regulations
CSL	Close Support Laboratory
DAC	derived air concentration
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ES&H	Environmental, Safety, and Health
ES&HC	Environmental, Safety, and Health Compliance Directorate
FAC	Field Activities Coordinator
FHSS	Field Health and Safety Supervisor
FOF	Field Operations Facility
FSL	Field Support Lead
FWG	field work guide
GC	gas chromatograph
HWP	hazardous work permit
IDLH	immediately dangerous to life or health
IDN	identification number
LEL	lower explosive limit
LSS	Laboratory Shift Supervisor
MSDS	material safety data sheet
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NHF	New Hydrofracture Facility
NIOSH	National Institute for Occupational Safety and Health
NRC	U.S. Nuclear Regulatory Commission
OHF	Old Hydrofracture Facility
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCB	polychlorinated biphenyl
PDCC	Project Document Control Center
PE	potential exposure
PEL	permissible exposure limit
PF	protection factor
PP	project procedure
PPE	personal protective equipment

ACRONYMS (continued)

QAA	quality assurance assessment
QAAP	quality assurance action plan
QA/QC	quality assurance/quality control
REAC/TS	Radiation Emergency Assistance Center/Training Site
REL	recommended exposure limit
RI/FS	remedial investigation/feasibility study
RTECS	Registry of Toxic Effects of Chemical Substances
SCBA	self-contained breathing apparatus
SOP	standard operating procedure
SRD	self-reading dosimeter
TLD	thermoluminescent dosimeter
TLV	threshold limit value
VOC	volatile organic compound
WAG	waste area grouping
WBC	whole-body count

EXECUTIVE SUMMARY

This document outlines the environmental, safety, and health (ES&H) approach to be followed for the remedial investigation of Waste Area Grouping (WAG) 10 at Oak Ridge National Laboratory. This ES&H Plan addresses hazards associated with upcoming Operable Unit 3 field work activities and provides the program elements required to maintain minimal personnel exposures and to reduce the potential for environmental impacts during field operations.

The plan discusses the structure of the Remedial Investigation/Feasibility Study Project ES&H Department, including the reporting chain within the ES&H Department and contacts made with Martin Marietta Energy Systems, Inc. Each job title that carries the authority to halt work activities is listed.

The hazards evaluation for WAG 10 is presented in Sect. 3. This section includes the potential radiological, chemical, and physical hazards that may be encountered. Previous sampling results suggest that the primary contaminants of concern will be radiological (cobalt-60, europium-154, americium-241, strontium-90, plutonium-238, plutonium-239, cesium-134, cesium-137, and curium-244). External and internal exposures to radioactive materials will be minimized through engineering controls (e.g., ventilation, containment, isolation) and administrative controls (e.g., procedures, training, postings, protective clothing).

Sections 4 and 5 discuss internal environmental assessments, readiness reviews, and project procedures. These sections address two areas where compliance with federal or state regulations and Energy Systems recommended guidance is attained. Internal environmental assessments and readiness reviews will be conducted for WAG 10 before initiation of work. Project procedures are reviewed routinely to ensure that field operations are in compliance with federal regulations and site guidance documents.

Sections 6 and 7 discuss personal protective equipment and respiratory protection requirements. Both sections guide the selection of clothing and other protective equipment to perform tasks in a safe manner.

Subsequent sections describe site and contamination control, personnel and equipment decontamination, and personnel training requirements. Section 12 describes hazardous work permits (HWP), one of the most important elements of the ES&H program. HWPs are written to control access to areas within WAG 10 where elevated levels of exposure may be encountered and to present safety requirements for entering controlled access areas (CAAs). These safety requirements ensure that exposures to project personnel and the environment are minimal.

The medical surveillance, bioassay, external radiation dosimetry, personnel air monitoring, as low as reasonably achievable philosophy, and perimeter monitoring sections

discuss monitoring of project personnel. Baseline monitoring by an occupational physician before personnel enter a CAA ensures that previous exposures are documented, and subsequent medical examinations are performed annually to detect physiological changes in the individual.

Section 20 describes the documentation that is kept in each individual's project ES&H personnel file. Records are kept current and readily retrievable.

The final sections discuss the packaging and shipping requirements for samples, the hazard communication program, and the chemical hygiene plan in use at the Field Operations Facility Close Support Laboratory.

1. INTRODUCTION

1.1 DESCRIPTION

This Environmental, Safety, and Health (ES&H) Plan presents the concepts and methodologies to be followed during the remedial investigation (RI) of Waste Area Grouping (WAG) 10, Operable Unit (OU) 3, at Oak Ridge National Laboratory (ORNL) to protect the health and safety of employees, the public, and the environment. The Remedial Investigation/Feasibility Study (RI/FS) Project ES&H Plan acts as a management extension for ORNL and Martin Marietta Energy Systems, Inc. (Energy Systems) to direct and control implementation of the project ES&H program. This ES&H Plan for WAG 10, a supplement to the project ES&H Plan, is intended for use in the WAG 10 investigation area during OU3 field work activities. The subsections that follow describe the program philosophy, requirements, quality assurance (QA) measures, and methods for applying the ES&H program to WAG 10 remedial investigations. Hazardous work permits (HWP) will be used to provide task-specific health and safety requirements.

1.2 PROGRAM PHILOSOPHY

Bechtel National, Inc. and its subcontractors are committed to limiting exposures to hazardous materials to levels that are as low as reasonably achievable (ALARA). The ORNL RI/FS Project radiation safety policy also applies ALARA principles to activities at the Close Support Laboratory (CSL) at the Field Operations Facility (FOF). Personnel working on the RI/FS Project in WAG 10 will be informed of known and potential hazards of the tasks to be performed so that they can effectively apply health and safety measures and required safety precautions. Training programs and HWP are developed to maintain consistency with the application of ALARA principles.

Because of the difficulties associated with quantifying potential hazards at many RI sites, a conservative graded approach will be used to protect employees, members of the general public, and the environment. This conservative application of protective measures and proper training will limit exposures to meet ALARA objectives.

1.3 ADHERENCE TO SAFETY REQUIREMENTS

Maintaining a safe and healthful work environment is the responsibility of all team members. Through a comprehensive training program, team members will be informed of hazard potential, proper use of personal protective equipment (PPE), applicable procedural requirements, and their responsibilities for maintaining safe working environments. Trained personnel are required to adhere to all safety requirements.

Environmental protection, health, and safety violations will not be tolerated. Personnel who develop a history of safety violations or who blatantly or willfully violate environmental protection, safety, and health procedures will be reprimanded by the RI/FS ES&H Manager and may be permanently removed from the project depending on the seriousness of the violation.

1.4 REGULATORY REQUIREMENTS, STANDARDS, AND GUIDELINES

The ES&H protection requirements applicable to the ORNL RI/FS Project are set forth in Department of Energy (DOE) orders, Energy Systems and ORNL procedures, and applicable federal, state, and local regulations and standards. Applicable DOE orders, ORNL implementing documents, and Bechtel corporate safety and health standards, as most recently revised, are as follows:

- DOE Order 1540.1, "Materials Transportation and Traffic Management";
- DOE Order 3790.1A, "Federal Employees Occupational Safety and Health Program";
- DOE Order 5000.3A, "Occurrence Reporting and Processing of Operations Information";
- DOE Order 5480.1B, "Environment, Safety, and Health Program for DOE Operations";
- DOE Order 5480.3, "Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes";
- DOE Order 5480.4, "Environmental Protection, Safety, and Health Protection Standards";
- DOE Order 5480.10, "Contractor Industrial Hygiene Program";
- DOE Order 5480.11, "Radiation Protection for Occupational Workers";
- DOE Order 5481.1B, "Safety Analysis and Review System";
- DOE Order 5482.1B, "Environment, Safety, and Health Appraisal Program";
- DOE Order 5483.1A, "Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities";
- DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements";
- DOE Order 5500.1A, "Emergency Management System";
- ORNL Health Physics Manual;
- ORNL Safety Manual;
- ORNL Industrial Hygiene Manual;
- ORNL Environmental Protection Manual;
- Quality Assurance Assessment for WAG 10;
- Quality Assurance Action Plan for WAG 10;
- Bechtel Safety and Health Procedures Manual; and
- Bechtel Safety and Health Manual.

As a matter of policy (DOE Order 5480.10), DOE and its contractors have made a commitment to comply with applicable Occupational Safety and Health Administration

(OSHA) regulations [specifically, Title 29, Code of Federal Regulations (CFR), Part 1910: *Occupational Safety and Health Standards*]. Concurrently, DOE and its contractors have adopted exposure guidelines listed in relevant American Conference of Governmental Industrial Hygienists (ACGIH) publications [specifically, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices*, most current edition]. When 29 CFR 1910 does not address a particular chemical substance or physical agent, the following values will be used in the order given:

- ACGIH TLVs, and
- National Institute of Occupational Safety and Health (NIOSH) recommended exposure limits (RELs).

For exposures to airborne radioactive material, the limiting values or derived air concentration (DAC) limits from DOE Order 5480.11 will be applied.

If more than one limiting value exists, whether it is from regulatory values or recommended values, the most conservative value [DAC, permissible exposure limit (PEL), TLV, or REL] will be applied.

The ES&H Plan for WAG 10 and relevant HWPs meet the requirements in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," and applicable regulatory requirements of the State of Tennessee. The packaging and shipment of samples to and from laboratory facilities will be performed in accordance with federal Department of Transportation (DOT) regulations in 49 CFR and with Tennessee DOT Regulations, Sect. 17 Annotated. Other regulations applicable to safe operations include National Fire Protection Association (NFPA) codes and federal and local fire codes.

1.5 ADHERENCE TO QUALITY ASSURANCE PROGRAM

The philosophies of the RI/FS Project ES&H program, its activities, and the project procedures that implement the program's requirements comply with and complement the requirements of the project Quality Assurance Plan. The specific ES&H procedures controlled by the QA Plan are listed in that plan. WAG 10 ES&H field activities will comply with requirements of task-specific QA project plans developed for WAG 10.

1.6 ES&H PLAN FOR WAG 10

Potential physical, radiological, and toxic chemical hazards that may be specific to WAG 10 are addressed in Sect. 3, "Hazards Evaluation." The ES&H Plan for WAG 10 and HWPs specify the ES&H requirements necessary to protect the safety of on-site investigators, the public, and the environment. Task-specific field work guides (FWGs) for WAG 10 are

also written, reviewed, and approved to ensure that personnel understand the purpose and scope of the tasks.

If similar field activities are scheduled in the future, the ES&H Manager, in consultation with the ORNL Hazardous Waste Operations Program Coordinator, will determine whether an approved ES&H Plan is applicable or whether a new plan must be developed.

2. ORGANIZATION, RESPONSIBILITIES, AND AUTHORITIES

2.1 ORGANIZATION

The Bechtel Team ES&H Department is an autonomous group within the RI/FS Project organization. As shown in Fig. 2.1, the Bechtel Team ES&H Manager reports to the corporate ES&H organization and works with the Program Manager to implement ES&H requirements and activities on the RI/FS Project. The Bechtel Team ES&H Department supports field operations and directs field safety decisions through the Field Health and Safety Supervisor (FHSS). The FHSS draws upon Health and Safety Specialists as required to ensure that field operations are conducted in accordance with field safety requirements, manuals, procedures, and plans.

2.2 RESPONSIBILITIES AND AUTHORITIES

ORNL management is ultimately responsible for environmental protection, safety, and health on the Oak Ridge Reservation. This responsibility includes "stop-work" authority. For the RI/FS Project, this management responsibility is extended through the ORNL ES&H Compliance (ES&HC) Directorate to the Bechtel ES&H Manager. The ES&H program is routinely audited by the ORNL ES&HC Contractor Interface Manager (or designee) to ensure compliance with ORNL policies and procedures.

The ES&H Manager reports directly to the Bechtel corporate ES&H organization and is responsible for compliance with all applicable DOE orders; Energy Systems and ORNL policies and procedures; and federal, state, and local environmental protection, safety, and health statutes, permits, and regulations.

2.2.1 Bechtel Corporate ES&H Organization

Responsibility for safety and health programs rests with Bechtel's Corporate Safety and Health Services Department, which operates under the direction of the Safety Services Manager and the Health Services Manager. The Health Services Manager is responsible for all programmatic elements of radiation safety and industrial hygiene. The Safety Services Manager is responsible for all programmatic elements of construction and industrial safety.

The corporate ES&H organization is responsible for ensuring that Bechtel projects are conducted in compliance with federal, state, and local laws as well as Bechtel safety and health policies and procedures. These corporate responsibilities and authorities are delegated to project ES&H managers. The corporate ES&H organization conducts timely audits of project activities and then records and distributes audit reports to appropriate Bechtel project management staff.

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Fig. 2.1. ORNL RI/FS program organization.

2.2.2 Program Manager

The Program Manager, the senior Bechtel manager for the ORNL RI/FS Project, oversees the technical and programmatic activities of the ES&H program. The Program Manager assigns sufficient resources to maintain and implement the ES&H program and is responsible for ensuring that adequate ES&H systems (including policy, plans, procedures, and materials) are in place and operational.

2.2.3 Environmental, Safety, and Health Manager

The ES&H Manager is responsible for preparing, implementing, and maintaining the Project ES&H program and its supporting elements. The ES&H Manager maintains communications with Energy Systems ES&H organizations and representatives to ensure that ORNL and Energy Systems management directions are incorporated into ES&H activities. Additionally, the ES&H Manager is directly responsible to the Program Manager and the corporate ES&H organization for all technical and regulatory aspects of environmental protection, safety, and health on the RI/FS Project.

The ES&H Manager has autonomy within the project organization and has the authority to immediately halt any activity that may pose a danger to employees, the public, or the environment. He has the responsibility to provide guidance in operations or designs as necessary to keep radiation exposures, hazardous substances exposures, or environmental releases within established requirements and ALARA goals. The ES&H Manager is responsible for developing ES&H plans, including supporting procedures, which are incorporated by reference into the WAG 10 plan.

2.2.4 Field Health and Safety Supervisor

The FHSS is responsible for implementing the ES&H program in the field by evaluating environmental protection, safety, and health concerns at the site level and applying the requirements of the WAG 10 ES&H Plan and project procedures. In performing these evaluations, the FHSS ensures that the ES&H Manager is informed of concerns about potential hazardous exposures. The ES&H Manager in turn communicates directly with the ORNL ES&HC Contractor Interface Manager. When conditions arise that are not covered by ES&H plans and procedures, the FHSS will halt work and inform the ES&H Manager, who will then coordinate proposed solutions with ORNL management through the ORNL ES&HC Contractor Interface Manager. [If survey results indicate that PPE requirements (Sect. 6) may be downgraded in an HWP, the FHSS or ES&H Manager will contact the ORNL ES&HC Contractor Interface Manager before changing the PPE needs.]

Through coordination with the Field Support Lead (FSL), the FHSS also determines the schedule of project ES&H support from the Bechtel Team for field activities and deploys available resources to provide required environmental, health, and safety coverage. Full-time safety and health coverage will be provided for WAG 10 operations that require entry into

or establishment of controlled access areas (CAAs). Tasks performed at locations with low potential for exposure to hazardous materials may not warrant full-time coverage.

The FHSS has the authority to halt operations that endanger the health and safety of workers, the public, or the environment. When site conditions differ from those on which the RI Plan is based, the FHSS will stop field activities and assess the conditions to determine whether work can proceed or whether the site needs to be reevaluated. Any changes in HWP requirements will be approved and documented by the FHSS and reviewed and approved by the Energy Systems RI/FS Field Coordinator before work resumes.

The FHSS will designate a Health and Safety Specialist who understands and is able to respond to potential hazards of field activities when the FHSS is off site.

2.2.5 Health and Safety Specialists

The Health and Safety Specialists (health physics, industrial hygiene, and safety technicians) report directly to the FHSS. To the extent practical, these technicians will be experienced in all disciplines, but in no case will technicians be responsible for areas outside their training. Specialists responsible for performing radiation monitoring will be required to demonstrate their qualifications by passing the ORNL examination for health physics technicians before they begin site activities. Bechtel Team Health and Safety Specialists will monitor WAG 10 field activities that warrant full-time coverage to detect and quantify hazardous materials. They will also assist personnel in the proper use of PPE, perform release surveys of personnel and equipment, and verify adherence to ES&H requirements.

Health and Safety Specialists also have stop-work authority. When field conditions develop that are unexpected, appear unsafe, or may cause environmental insult, the Health and Safety Specialists will immediately stop operations and inform the FHSS.

2.2.6 Industrial Hygienist

The Industrial Hygienist reports directly to the ES&H Manager and is responsible for developing industrial hygiene procedures, overseeing the medical surveillance programs, and maintaining the quality of industrial hygiene-related field measurements and records. The Industrial Hygienist periodically audits RI/FS Project field activities to verify compliance with federal regulations, DOE orders, ORNL and Energy Systems policies and procedures, and Bechtel policies and procedures. He also conducts training as required for personnel in his disciplines. The Industrial Hygienist has the authority to halt operations that endanger workers, the public, or the environment.

2.2.7 Health Physicist

The Health Physicist reports directly to the ES&H Manager and is responsible for developing health physics and health physics-related procedures; performing radiation hazard analyses, risk assessments, and radiation exposure assessments; and maintaining the quality of radiation field measurements and exposure records. The Health Physicist audits RI/FS Project field activities to verify compliance with DOE orders, Energy Systems and ORNL policies and procedures, and Bechtel policies and procedures. Project safety training is also conducted by the Health Physicist. The Health Physicist has the authority to halt operations that endanger the health and safety of workers, the public, or the environment.

2.2.8 Industrial Safety Specialist

The Industrial Safety Specialist reports directly to the ES&H Manager and is responsible for developing safety procedures, performing safety training, maintaining records related to worker illnesses and accidents, and reporting workman's compensation. The Industrial Safety Specialist audits RI/FS Project field activities for compliance with federal regulations, DOE orders, Energy Systems and ORNL policies and procedures, and Bechtel policies and procedures. The Industrial Safety Specialist has the authority to halt operations that endanger the health and safety of workers, the public, or the environment.

2.3 INTERFACES WITH ENERGY SYSTEMS SAFETY ORGANIZATION

The ORNL ES&HC Contractor Interface Manager is the primary contact between the ES&H Manager and the ORNL Environmental Restoration Division and Energy Systems Central Staff Office of Environment and Safety Activities. (See the ORNL RI/FS Project Management Plan for other interfaces with the Energy Systems safety organization.) The ORNL ES&HC Contractor Interface Manager provides the ES&H Manager with information pertaining to appropriate DOE orders, state and federal regulations, Energy Systems and ORNL requirements, and lines of communication. This information is then incorporated into RI/FS plans and procedures as appropriate. The ORNL ES&HC Contractor Interface Manager also provides review and approval of the plans and coordinates the ongoing safety program surveillance of the plans and procedure implementation.

Through the ORNL ES&HC Contractor Interface Manager, the ORNL Office of Environmental and Health Protection will verify that the RI/FS Project ES&H program is conducted in accordance with ORNL procedures and policies. ORNL will provide air-purifying respiratory protection, primary radiation detection instrument calibration, and general employee and radiation worker training for RI/FS Project personnel. (The course content for both general employee and radiation worker training is given in DOE Order 5480.11, "Radiation Protection for Occupational Workers.") If required for RI/FS Project personnel, bioassay, in vivo counting, and external dosimetry services will be supplied by ORNL. Radiation detection instrument calibration records associated with portable radiation

detection instruments are retained by the Office of Radiation Protection (Bldg. 2007). All RI/FS radiation detection instrument calibration records will be maintained by ORNL, and copies will be provided to the ES&H Manager on a routine and timely basis. (Equipment used to perform industrial hygiene/safety surveys is calibrated by RI/FS health and safety personnel or by the manufacturer.)

All instrumentation used by the Bechtel Team ES&H Department was purchased on behalf of DOE/Energy Systems and is government equipment. Equipment services supplied by Energy Systems are approved in accordance with Energy Systems guidelines. Costs are covered internally through the Environmental Restoration Division annual budget process. Other short-term equipment not supplied by Energy Systems is subject to lease or purchase arrangements as part of the cost proposal for each work release.

3. HAZARDS EVALUATION

This section discusses the radiological, chemical, and physical hazards that may be encountered during the RI of WAG 10 OU3 and outlines the ES&H requirements necessary to protect on-site investigators, the public, and the environment. Additional evaluation and analysis of these hazards and of the risk associated with failures in programmatic control systems designed to abate them will be documented in accordance with Project Procedure (PP) 1308, "Quality Assurance Assessments," before RI field activities begin.

The following hazards evaluation summary is based on information available from ORNL documents and the WAG 10 RI Plan as revised. Additional information was gathered during initial surveys of the WAG 10 and WAG 5 areas by Bechtel Team Health and Safety Specialists. WAG 5 data are used in this section because the New Hydrofracture Facility (NHF) and Old Hydrofracture Facility (OHF) are located within WAG 5.

In accordance with the Bechtel Team approach to ES&H practices as defined in the project's ES&H Plan, these hazards will be further assessed by individual work instruction guides, Quality Assurance Assessment (QAA), Quality Assurance Action Plans (QAAPs), task safety analysis, and HWP. Protective measures will be specified and documented in the HWPs controlling WAG 10 tasks (see Sect. 12). By this approach, the HWP for each field task benefits from at least three levels of hazard evaluation and assessment.

Major radiological contaminants in WAG 10 wells, lists of known radionuclide inventories, radiological surface contaminants and levels, and lists of chemical contaminants and inventories are contained in Appendixes A through E of this plan.

The practice of hazard assessment and abatement is controlled and guided by a comprehensive series of ES&H procedures updated to reflect changes in federal and state regulations, DOE orders and guidance documents, Energy Systems/ORNL health and safety procedures, and Bechtel Health and Safety Services policies, procedures, and directives. The provisions of the project ES&H procedures are at least as restrictive as those of Energy Systems procedures, in keeping with the management extension granted to the ES&H Department by Energy Systems/ORNL.

3.1 INTRODUCTION

WAG 10 is located in Melton Valley, south of the ORNL main plant area. The designation WAG 10 is limited to the exterior areas, wells, and subsurface components of the hydrofracture facilities. The Work Plan is limited to field activities for OU3.

The hydrofracture process was a unique waste disposal method used during a 25-year period (1959–1984) for more than 12 million liters of low-level radioactive waste containing an aggregate of 1.4×10^6 Ci of radioactivity. The technology involved injecting waste materials mixed with grout and additives under pumping pressures of 2000 psi or greater into the low-permeability shale formation 210 to 300 m below the local ground surface. The injected slurry spread along fractures and bedding planes hundreds of meters from the injection points, forming thin grout sheets. A summary of hydrofracture injections is presented in Table 3.1. The hydrofracture disposal sites are shown in Fig. 3.1.

As part of the DOE environmental restoration strategy for WAG 10, the WAG has been divided into three OUs. OU1 consists of the solidified grout and contaminated rock layered between or surrounding the grout sheets. OU2 consists of contaminated groundwater, including free liquids from hydrofracture injections and contaminated groundwater that may be migrating toward the surface. OU3 consists of the injection wells, deep observation and monitoring wells, and deep boreholes associated with WAG 10. Volume 2 of the WAG 10 Remedial Investigation Implementation Plan uses an observational approach to evaluate data needs for these OUs and specifies the following field activities, primarily for OU3:

- an ES&H survey of wellheads and adjacent areas to evaluate radioactive contamination, airborne radioactivity, and toxic air contaminants in preparation for nonintrusive and intrusive investigative tasks;
- civil surveying to establish local spatial control;
- nonintrusive evaluation of existing wellheads to determine physical and engineering characteristics;
- modification of selected wells and boreholes to allow wellhead gas pressure measurements;
- well headspace and well water sampling of existing wells and boreholes;
- borehole geophysical logging; and
- nonintrusive surface geophysical surveys.

An evaluation of the existing data available on WAG 10 indicates that the potential hazards to workers executing RI tasks fall within three classes: radiological, chemical, and physical.

Additional field activities that may be performed following preparation of a field sampling plan for OU1 and OU2 include the installation of new monitoring wells, background coreholes, and tear fault coreholes. Activities might also include additional modification of selected wells, groundwater sampling, and aquifer testing.

Table 3.1. Summary of hydrofracture grout injections

Injection type	Number of injections	Injection depth (ft)	Waste volume ^a (gal × 10 ³)	Water volume ^a (gal × 10 ³)	Grout volume (gal × 10 ³)	Primary waste constituents (Ci)					Total
						⁹⁰ Sr	¹³⁷ Cs	²⁴¹ Am	TRU ^b	Other	
HF-1											
Experimental (1959)	1	290	N/A ^c	N/A	27		35			8.7 (¹⁴⁷ Sm)	44
HF-2											
Experimental (1960)	2	934 and 694	N/A	N/A	224		50				50
OHF											
Experimental (1963-1965)	11	945 ^c	N/A	457	678	1,436	5,237	N/A ^c	N/A	N/A	6,673
Operational (1966-1979)	18	792 ^c	969	1,200	1,650	38,640	603,881	233	5.8 ^d	N/A	642,760
NHF											
Experimental (1982)	1	990	N/A	66	98					20 (¹⁹⁸ Au)	184
Operational (1982-1984)	13	990	2,240	2,540	2,873	644,505	83,765	7,464	2,125	13,314	751,173
Total	46				5,550						1.4 × 10 ⁶

Source: Modified from Myrick and Stow (1987). Grout injection depths were extracted from Haase and Stow (1988).

^aOther radionuclides were present in waste in much smaller quantities, were in equilibrium with listed radionuclides, or were not analyzed before injection.

^bValues are estimates of injected volumes only. Accurate determination of phase separation and bleed back volumes cannot be made for many of the injections.

^cTRU represents transuranic elements.

^dN/A = not analyzed.

^eThese depth values represent average depths for series of injections.

^fTotals here should be used with caution. Data on radionuclide content are not available for injections in this series.

Fig. 3.1. Locations of the hydrofracture sites.

3.2 RADIOLOGICAL HAZARDS

3.2.1 External Radiation Exposure Hazards

During an extensive radiological survey of the interior and exterior areas of OHF conducted in 1984 (Huang et al. 1984), elevated absorbed dose rates were measured over the entire area. The OHF waste tanks, approximately 225 ft from well 3-N200-RC, contain an estimated 200 TBq (5.4×10^3 Ci); the waste retention impoundment, approximately 125 ft from the well, contains an estimated 15 TBq (4.1×10^2 Ci); and the waste pit, 75 ft from the well, contains an estimated 20 GBq (5.4×10^1 Ci). The principal radionuclides include cobalt-60, strontium-90, cesium-134, cesium-137, europium-154, plutonium-238, plutonium-239, americium-241, and curium-244. Absorbed dose rates measured in the interior areas of OHF ranged from a minimum of 3.2 mGy/h (320 mrad/h) to a maximum of 65 mGy/h (6.5 rad/h). Absorbed dose rates measured at 10 cm over the OHF impoundment surface ranged from 1 to 3 mGy/h (100 to 300 mrad/h).

In the area immediately surrounding OHF, including the areas of interest to the WAG 10 field activities, absorbed dose rates were reported in the range of 0.32 to 1.3 mGy/h (32 to 130 mrad/h). These dose rates and their locations are shown in Fig. 3.2.

Project ES&H activities supporting the WAG 5 nonintrusive activities include health and safety surveys of a few wells of interest to the WAG 10 effort that are significantly removed from the OHF facilities. These surveys indicate that absorbed dose rates on contact with the well outer surfaces range from <0.01 to 8 mGy/h (1 to 800 mrad/h). General area radiation absorbed dose rates in these areas range from <0.01 to 0.25 mGy/h (1 to 25 mrad/h).

Work plan activities for characterizing well construction and physical parameters outside the OHF facility will result in 10- to 15-min exposures of a limited number of workers to general area absorbed dose rates in excess of 0.2 mGy/h (20 mrad/h) and potential extremity absorbed dose rates in excess of 10 mGy/h (1 rad/h). The maximum postulated individual dose will not exceed the weekly administrative limit for whole body or extremity.

Wells within the OHF facility will also need to be evaluated, and the potential for significant external radiation exposure exists within some of the structures, where reported general area absorbed dose rates exceed 0.05 Gy/h (5 rad/h).

General investigative tasks such as civil surveying and geophysical nonintrusive surveys outside the OHF facility have a low potential for exposing personnel to external radiation at levels recordable by personnel dosimeters. General area absorbed dose rates in most of the areas common to WAG 5 and WAG 10 range up to hundreds of pGy (μ rad/h).

Sampling of existing nonpressurized wells has the potential for exposing workers to external penetrating radiation from two sources. Initial conditions at the wells to be sampled may require establishing a radiation area or high radiation area, depending on the results of

SOURCE: ORNL DWG 84-12845

Fig. 3.2. OHF radiation survey results.

the prework survey. Localized external exposure rates greater than the general area initial conditions may result from high levels of contaminants within the sample volumes. Because of volume limitations in each sample, however, it is not anticipated that the absorbed dose rate from any one sample will exceed the contact handling criterion of 2 mGy/h (200 mrad/h).

Engineered controls are selected and/or evaluated for applicability on a task-by-task basis. They may consist of but are not limited to such methods as temporary shielding, ventilation and filtration systems, remote tooling, remote sensors, inert atmosphere, etc. Well opening and sampling activities that require engineering controls for depressurization or flow isolation have the potential for higher employee absorbed dose exposures because of the time required for the installation of engineering controls.

3.2.2 External Radiation Exposure Controls

WAG 10 operations have the potential for worker radiation exposure in excess of the ORNL ALARA goal of 0.02 Sv/year (2 rem/year) if work is conducted without administrative and engineering controls. Administrative controls in place include reviewed and compliant ES&H project procedures, effective ES&H surveillance of intrusive and nonintrusive tasks, and work task review and approvals. Engineering controls will be evaluated and developed where needed to minimize worker exposure in keeping with ALARA principles. A project ALARA goal for WAG 10 operations is that no individual external exposure will exceed 0.025 Sv/year (500 mrem/year).

External radiation exposure will be managed through administrative and engineering controls. Each activity associated with the WAG 10 RI will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," and FWGs will provide detailed descriptions of work activities, methods, materials, and personnel requirements. The work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts prejob ALARA evaluations and specifies the controls to be reflected in the HWP for ES&H aspects of the task. Initial conditions will be established for each proposed work site in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate Measurements"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold points are developed for the HWP controlling the work task on the basis of initial work site conditions. The HWP is prepared in accordance with PP 1235, "Hazardous Work Permits."

In accordance with PP 1235, the administrative approval levels required depend on the actual or anticipated absorbed dose rate or anticipated worker absorbed dose for the task. These approval levels are also in accordance with Energy Systems/ORNL Health Physics Procedure RP-3.1.

Dosimetry and exposure tracking will be conducted in accordance with PP 1280.2, "Dosimetry Services"; PP 1280.3, "External Radiation Dosimetry"; and PP 1280.6, "Use of Pocket Meters." CAAs, radiation areas, and high radiation areas will be established and posted in accordance with PP 1235, "Hazardous Work Permits"; PP 1255, "Work Area and Environmental Monitoring"; PP 1280.7, "Posting and Labeling"; and PP 1280.8, "Control Point Operations."

3.2.3 Internal Radiation Exposure Hazards

During an extensive radiological survey of the interior and exterior areas in 1984 (Huang et al. 1984), 139 soil samples from 17 borings were obtained throughout the OHF area. These samples were analyzed using gamma spectroscopy and, where indicated, radiochemical analyses for strontium-90, uranium, plutonium-238, plutonium-239, americium-241, and curium-244. Of the 17 borings, 12 were sampled in the 0- to 30-cm (surface) increment: 6 were in excess of 0.185 Bq/g (5 pCi/g), ranging from 0.19 to 3.5 Bq/g (5.1 to 94.6 pCi/g). The primary contaminants were mixed fission products.

Wastes processed at OHF originated from reprocessing activities and experimental and limited production processes. The wastes contained mixed fission products and traces of transuranic elements.

Because it will be necessary to evaluate wells within OHF, workers may be exposed to atmospheres with greater than 0.1 DAC from the high levels of surface contamination expected within the facility.

Work plan activities for characterizing well construction and physical parameters outside OHF will require workers to enter areas of known surface contamination. These activities are nonintrusive and have a very low probability of generating an airborne radioactivity hazard from worker activity. No known areas of airborne radioactivity have been observed in WAG 10 outside OHF.

General investigative tasks such as civil surveying and geophysical nonintrusive surveys outside OHF have a low potential for personnel exposure from uptake of radioactive materials. These activities will require workers to enter areas of known surface contamination, but the activities are nonintrusive and have a very low probability of generating an airborne radioactivity hazard.

The degree of change in contamination conditions cannot be predetermined, but the likelihood of encountering contaminants in concentrations high enough to create an airborne radioactivity hazard in excess of 0.1 DAC outside of OHF structures is small. Local environmental conditions (e.g., temperature, winds) and contaminant characteristics (e.g., fission products, transuranics, solubility class) will determine the real-time potential for airborne radioactivity hazards.

Sampling of existing nonpressurized wells has the potential for exposing workers to uptake of radioactive materials through absorption and inhalation. The absorption route is expected to dominate in this class of tasks. Worker contact with contaminated water could result in the uptake of solubility class W radionuclides, and these tasks can create an injection hazard through contaminated wounds. Splash dispersion of water contaminants in air is possible but is unlikely to produce an airborne radioactivity hazard because of the limited volume available. Local environmental conditions and contaminant characteristics (e.g., fission products, transuranics, solubility class) will determine the real-time potential for absorption through unprotected skin.

Weil opening and sampling activities that require engineering controls for depressurization or flow isolation have a higher potential for worker uptake through absorption, injection by high-pressure spray, or airborne radioactivity if engineering controls fail and a spray or other discharge event occurs. Depending on the pressure and duration of the spray event, an airborne hazard in excess of 0.1 DAC can result. The likelihood of engineering control failure is low but cannot be assessed until well surveys are completed and these controls are developed.

3.2.4 Internal Radiation Exposure Controls

WAG 10 operations have the potential for internal radiation exposure of workers if work is conducted without administrative and engineering controls. Administrative controls in place include reviewed and compliant ES&H procedures, effective ES&H surveillance of intrusive and nonintrusive tasks, and work task review and approvals. Engineering controls will be evaluated and developed where needed to minimize worker potential for internal exposure in keeping with ALARA principles. A project ALARA goal for WAG 10 operations is that no individual internal exposure will exceed 0.1 mSv (10 mrem) committed (50-year) effective dose equivalent.

Internal radiation exposure will be managed through administrative and engineering controls. Each activity associated with the WAG 10 RI will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," and FWGs will provide detailed descriptions of work activities, methods, materials, and personnel requirements. The work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts prejob ALARA evaluations and specifies the controls to be reflected in the HWP for ES&H aspects of the task. The ES&H Department works in close cooperation with the Technical Support Group to establish effective and reliable engineering control methods as part of this process.

Initial conditions will be established for each proposed work site in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate Survey"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing, respiratory protection, and equipment requirements are established and

ES&H hold points are developed for the HWP controlling the work task on the basis of initial work site conditions. The HWP is prepared as specified in PP 1235, "Hazardous Work Permits."

In accordance with PP 1235 and Energy Systems Health Physics Procedure RP-3.1, the administrative approval levels required depend on the potential or anticipated airborne hazard for the task.

Internal dosimetry and exposure tracking will be conducted in accordance with PP 1280.2, "Dosimetry Services"; PP 1280.4, "Internal Radiation Dosimetry"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." CAAs, contamination areas, and airborne radioactivity areas will be established and posted in accordance with PP 1235, "Hazardous Work Permits"; PP 1255, "Work Area and Environmental Monitoring"; PP 1280.7, "Posting and Labeling"; and PP 1280.8, "Control Point Operations."

3.3 CHEMICAL HAZARDS

Little information is available on hazardous chemicals in the WAG 10 area. Huang et al. (1984) reported the presence of polychlorinated biphenyls (PCBs) and trace concentrations of heavy metals in the OHF waste retention impoundment. PCBs were reported at an average concentration of 3.5 mg/g and a maximum reported value of 15 mg/g. Antimony, lead, arsenic, chromium, zinc, and copper were reported in the 1- to 30-ppm range. Groundwater from piezometer 1048 is reported to contain traces of barium and less than 14 µg/g total organic carbon (see Appendix C).

Data from WAG 5 wells indicate trace quantities of heavy metals and organic solvents such as acetone, trichlorethylene, and other halogenated organic compounds. Injection fluids were known to have a high pH and thus represent a potential caustic hazard. Background conditions were determined by direct organic vapor readings taken in the ambient atmosphere during walkdown of OHF exterior areas conducted as part of the initial inactive liquid low-level waste tanks program activities in June 1990.

Work plan activities for characterizing well construction and physical parameters outside OHF will require workers to enter areas where they may be exposed to heavy metals and volatile organic compounds (VOCs). Exposure to concentrations below the PEL for regulated chemicals can occur if the chemicals are volatile and escape from uncapped or loosely capped wells. The potential for inhalation of these volatile chemicals is low during nonintrusive work and will depend on their presence in groundwater, a condition that cannot be assessed without sampling. Heavy metal exposure through absorption is a potential hazard if surfaces contaminated with these metals come in contact with unprotected skin or if an open wound or penetration injury occurs. Although this probability is considered low because these tasks are observational, the potential cannot be further assessed until surfaces

are sampled to determine the presence and characteristics of heavy metal contaminants. The probability of generating an airborne chemical hazard from worker activity is also very low. No airborne chemical hazard areas have been observed in WAG 10. Appendix E contains hazardous health effects data on reported chemicals as well as postulated chemical hazards as required by 29 CFR 1910.120(b)(4)(4)(viii).

Because it may be necessary to evaluate wells within OHF or NHF facilities, the potential exists for worker exposure to regulated hazardous chemicals in air at or above the PEL (or TLV, REL as applicable) as a result of the high levels of surface contamination expected. Hazardous chemical constituents of the surface contamination are unknown but assumed to be present with the radiological contaminants. General investigative tasks such as civil surveying and nonintrusive geophysical surveys outside OHF are observational and have a low qualitative potential for exposing personnel to hazardous chemicals.

The degree of change in contamination conditions cannot be predetermined, but the likelihood of encountering contaminants in concentrations high enough to create an airborne chemical hazard in excess of the PEL is low. Local environmental conditions (e.g., temperature, soil moisture, and winds) and contaminant characteristics (e.g., the presence of heavy metals, PCBs, and VOCs, and solubility class) will determine the real-time potential for airborne chemical hazards.

Sampling of existing nonpressurized wells has the potential for exposing workers to hazardous chemicals present in groundwater through absorption and inhalation. The absorption route is expected to dominate in this class of tasks. Worker contact with contaminated water can result in exposure and can create an injection hazard through contaminated wounds. Splash dispersion of water contaminants in air is possible but unlikely to produce an airborne chemical hazard because of the limited volume available. Local environmental conditions and contaminant characteristics will determine the real-time potential for absorption through unprotected skin.

Well opening and sampling activities that require engineering controls for depressurization or flow isolation have a higher potential for worker exposure to chemical contaminants from absorption, injection by high-pressure spray, or airborne chemicals if the engineering controls fail and a spray or other discharge event occurs. Depending on the pressure and duration of the spray event, an airborne hazard in excess of the PEL can result. The likelihood of engineering control failure is low but cannot be assessed until well surveys are completed and these controls are developed.

WAG 10 operations have the potential for chemical exposures to workers if work is conducted without administrative and engineering controls. Administrative controls in place include reviewed and compliant ES&H procedures, effective ES&H surveillance of intrusive and nonintrusive tasks, and work task review and approvals. Engineering controls will be evaluated and developed where needed to minimize potential worker exposure. Where hazardous chemicals are discovered by monitoring, protective measures, worker briefing

information, and medical surveillance guidance will be based on standard industrial hygiene reference works such as Registry of Toxic Effects of Chemical Substances (RTECS), NIOSH/OSHA occupational health guidelines, or other recognized standard data.

The WAG 10 project goal for hazardous chemical exposures is that no individual exposure will exceed 10% of the PEL, TLV, and REL for any regulated hazardous chemical. Exposures will be managed through administrative and engineering controls. Each activity associated with WAG 10 RI work will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," and FWGs will provide detailed descriptions of work activities, methods, materials, and personnel requirements. The FWGs must be reviewed by Energy Systems and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts prework evaluations and specifies the controls to be reflected in the HWP for ES&H aspects of the task. The ES&H Department works in close cooperation with the Technical Support Group to establish effective and reliable engineering control methods as part of this process.

Initial conditions will be established for each proposed work site in accordance with PP 1220, "Initial Site Survey," and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing, respiratory protection, and equipment requirements are established and ES&H hold points are developed for the HWP controlling the work task on the basis of initial work site conditions. The HWP is prepared in accordance with PP 1235, "Hazardous Work Permits." The administrative approval levels required in accordance with PP 1235 depend on the potential or anticipated hazard for the task.

Real-time exposure assessment will be conducted in accordance with PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." CAAs, hot lines, contamination reduction zones, and carcinogen areas will be established and posted in accordance with PP 1235, "Hazardous Work Permits"; PP 1255, "Work Area and Environmental Monitoring"; PP 1280.7, "Posting and Labeling"; and PP 1280.8, "Control Point Operations."

3.4 PHYSICAL HAZARDS

Physical hazards associated with WAG 10 field investigation work include those typical of radiological facility survey tasks and light outdoor construction. General categories of potential physical hazards include fire, explosion, equipment and material failure (e.g., electrical, mechanical, or hydraulic), noise, heat, and cold. Because entry into OHF and NHF to evaluate interior wells will be required, a confined space hazard will also exist. This confined space hazard also exists for the evaluation of wells DM1-PV and DM2-PV because these wells are located inside sheds.

Physical hazards are controlled by administrative and engineering measures and by protective procedures and equipment as necessary. Administrative controls in place include

reviewed and compliant ES&H procedures, effective ES&H surveillance of intrusive and nonintrusive tasks, and work task review and approvals. Engineering controls will be evaluated and developed where needed to minimize potential worker exposure to physical hazards.

Each activity associated with WAG 10 OU3 work will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," and FWGs will provide detailed descriptions of work activities, methods, materials, and personnel requirements. The FWGs must be reviewed by Energy Systems and approved by the Project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts prejob evaluations and specifies the controls to be reflected in the HWP for ES&H aspects of the task. The ES&H Department works in close cooperation with the Technical Support Group to establish effective and reliable engineering control methods as part of this process.

In accordance with PP 1220, "Initial Site Survey," initial conditions will be established for each proposed work site. Administrative control limits and protective clothing, respiratory protection, and equipment requirements are established, and ES&H hold points are developed for the HWP controlling the work task on the basis of initial work site conditions. The HWP is prepared in accordance with PP 1235, "Hazardous Work Permits." Real-time hazard assessment will be conducted in accordance with PP 1275, "Industrial Safety Practices."

3.4.1 Pressurized Wells

A unique hazard from contained, pressurized wells has also been identified. A number of wells within WAG 10 are equipped with pressure containment controls and are assumed to remain pressurized. The need to obtain samples from these wells has been established (WAG 10 R1 Implementation Plan) but, should an attempt be made to open a pressurized well without appropriate pressure reduction controls, severe injury could result from the sudden depressurization or physical failure of the control structure.

To safely obtain samples from potentially pressurized wells, it will be necessary to evaluate the existing pressure control devices and to ascertain the pressurization status of these wells. Where pressurization status cannot be ascertained, or where control devices are found inadequate or inappropriate for obtaining samples that meet project data quality objectives, engineering methods will be developed for pressure measurements, for depressurization, or for withdrawing samples under formation pressure. Because each well so identified is a unique engineering situation, the engineering controls necessary to accomplish sampling safely cannot be predicted without physical survey results. The ES&H Department works in close cooperation with the Technical Support Group to establish effective and reliable engineering control methods to protect safety and health.

3.4.2 Fire and Explosions

The potential for fire or explosion during WAG 10 OU3 work activities may exist as the result of

- explosive atmospheres from organic chemicals or gases in wells and boreholes,
- use or transfer of fuels for powering equipment, and
- welding or burning (see safety requirements in 29 CFR 1926.352).

Each activity associated with WAG 10 work will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides." Evaluation and planning will be conducted to assess the potential for fire or explosion and to establish methods for minimizing or eliminating these hazards. Individual work task fire and explosion prevention methods will be established in accordance with PP 1275.11, "Fire Protection and Prevention," as part of the planning process and will become part of the controlling instruction guide.

Each field activity associated with WAG 10 work will be controlled by an HWP. Fire and explosion prevention planning will become part of the controlling limitations stated in each HWP for these tasks.

Before and during intrusive operations, monitoring for explosive atmospheres will be conducted by a qualified Health and Safety Specialist using appropriate and calibrated detection instrumentation. Fuels and other flammables will be handled in accordance with OSHA requirements, NFPA guidelines, and state and local fire codes. Special methods (e.g., inert atmosphere, nonsparking tools, fuel removal, intrinsically safe electrical equipment) will be used if explosive atmospheres are detected.

3.4.3 Confined Space

Some WAG 10 well and borehole work activities may require that workers enter areas where they will be exposed to confined space hazards. Each activity associated with WAG 10 work will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides." Where confined space entry or excavation is necessary to accomplish mission goals, evaluation and planning will be conducted to assess the degree of hazard to workers. Individual work task safety methods (ventilation, shoring, rescue devices, etc.) will be established as part of the planning process and will become part of the controlling instruction guide. When confined space entry or excavation may be required, personnel will be trained and potentially hazardous work will be planned, conducted, controlled, and monitored in accordance with 29 CFR 1926 and PPs 1275.8, "Confined Space Entry and Work," and 1275.3, "Excavation and Trenching."

Each field activity (or similar activities) associated with WAG 10 work will be controlled by an HWP, and safety methods established in planning will become part of the controlling

limitations stated in each HWP for these tasks. Confined space entry will be coordinated with the Energy Systems/ORNL Confined Space Coordinator.

Before each field task, the ES&H Department will conduct necessary monitoring to determine initial conditions and establish protective levels for workers. WAG 10 work will be monitored by qualified Health and Safety Specialists.

3.4.4 Noise Hazards

Long-term exposure to noise from equipment operation in excess of 85 dBA has been determined to cause hearing impairment. Therefore, noise levels will be routinely monitored, and operations with sound levels in excess of 85 dBA will require hearing protection. Additional hearing protection will be provided or equipment modifications implemented, as appropriate, to maintain acceptable noise levels. Noise monitoring and control and hearing conservation procedures outlined in PP 1270, "Industrial Hygiene Practices," will be followed.

3.4.5 Other Physical Hazards

Exposure to heat or cold can cause severe stress and, possibly, death. The procedures outlined in PP 1270 will be followed to control heat and cold stress hazards. Other physical hazards include uneven topography; poisonous plants, animals, and insects; and an electrical fence on the White Oak Creek floodplain. Building conditions will be checked before a building is entered.

Improper operation of equipment and equipment malfunctions can cause injury and physical damage. Engineering controls, periodic inspections, and strict adherence to safe practices will minimize the potential for injury and impairment.

3.5 SUMMARY

When the presence and concentrations of specific chemical and radiological materials are confirmed, the resulting hazards will be reassessed as necessary to reevaluate the hazards classification. This is accomplished by reference to standards and guidelines; key guidelines are listed in Table 3.2. Table 3.3 identifies health and safety equipment that will be used at WAG 10.

Table 3.2. Guidelines for assessing chemical, physical, and radiological hazards

Hazard	Guideline	Explanation	Source ^a
Inhalation of airborne contaminants	Threshold limit value (TLV)	One of three categories of chemical exposure levels, defined as follows:	
	• TLV, time-weighted average	Time-weighted average concentration for a normal 8-h workday and a 40-h work week, to which nearly all workers may be repeatedly exposed without adverse effect. Should be used as an exposure guide rather than absolute threshold.	ACGIH
	• TLV, short-term exposure limit	A 15-min time-weighted average exposure that should not be exceeded at any time during the work day.	ACGIH
	• TLV, ceiling	The concentration that should not be exceeded even momentarily.	ACGIH
	Permissible exposure limit (PEL)	Time-weighted averages and ceiling concentrations similar to (and in many cases derived from) the TLVs published in 1968.	OSHA
	Recommended exposure limit (REL)	Time-weighted averages and ceiling concentrations based on NIOSH evaluations.	NIOSH
	Immediately dangerous to life or health (IDLH)	Maximum level from which a worker could escape within 30 min without any escape-impairing symptoms or irreversible health effects.	NIOSH
Dermal absorption of chemicals through airborne or direct contact	Designation "skin"	Designation "skin" in the ACGIH, OSHA, and NIOSH references indicates that a substance may be readily absorbed through the intact skin; however, it is not a threshold for safe exposure. Direct exposure should be avoided. Biological monitoring should be considered to determine the relative contribution of dermal exposure to the total dose.	ACGIH/OSHA/NIOSH
Dermal irritation		Many substances irritate the skin. Consult standard references.	
Carcinogens	TLV	Some carcinogens have an assigned TLV.	ACGIH
	PEL	OSHA has individual standards for some specific carcinogens.	OSHA
	REL	NIOSH makes recommendations regarding exposures to carcinogens.	NIOSH

Table 3.2 (continued)

Hazard	Guideline	Explanation	Source ^a
Noise	TLV	Sound pressure levels and durations of exposure that represent conditions to which it is believed that nearly all workers may be repeatedly exposed without an adverse effect on their ability to hear and understand normal speech.	ACGIH
	PEL	Limits for acceptable noise exposure.	OSHA
	REL	Limits for acceptable noise exposure.	NIOSH
Ionizing radiation	Derived air concentration (DAC)	DAC is the concentration of any given radionuclide in air, which, if inhaled continuously during a working year (2000 hours), would irradiate a person to the annual dose equivalent limit.	DOE
	Derived concentration guide (DCG)	DCG is the concentration of any given radionuclide in water or air, which, if ingested at reference man values, would result in an effective dose equivalent of 1 mSv (100 mrem). The DCGs are generally applied to environmental exposures.	DOE
	Annual limiting values for occupational workers	Annual dose equivalent limit for occupational exposures.	DOE
Explosion	Lower explosive limit	Minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.	NFPA
	Upper explosive limit	Maximum concentration of vapor in air above which propagation of a flame will not occur in the presence of an ignition source.	NFPA
Fue	Flash point	The lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air.	NFPA

^aSource: ACGIH, 1990-1991, *Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment and Biological Exposure Indices*, Cincinnati, Ohio; DOE Order 5400.5, 1990, *Radiation Protection of the Public and the Environment*; DOE Order 5480.11, 1988, *Radiation Protection for Occupational Workers*; NIOSH, Centers for Disease Control, *NIOSH Recommendations for Occupational Health Standards, Morbidity and Mortality Weekly Report Supplement*; NIOSH, 1990, *Pocket Guide to Chemical Hazards*, Cincinnati, Ohio; NFPA, 1990, *Fire Protection Guide on Hazardous Materials*, Boston, Massachusetts; OSHA, 29 CFR Part 1910 (OSHA standards are legally binding). (The most current standards and guidelines in the references will be used.)

Table 3.3. Example health and safety equipment

Equipment name or type	Contaminant or hazard to be detected
Ion chamber	Radiation exposure rate
Pancake-type Geiger Mueller detector	Beta-gamma contamination
Alpha scintillation detector	Alpha contamination
Nal scintillation detector	Gamma radiation
High-purity germanium detector	Gamma-emitter identification and quantification
Liquid scintillation counter	Tritium and carbon-14
Proportional counters	Smear and air sample analysis
Air samples	Radioactive particulates
Organic vapor analyses	Organic vapors
Oxygen/lower explosive limit (LEL) meter	Oxygen and explosive vapors
Sound level meter	High noise areas and equipment
Heat stress monitor	Hot or cold temperatures
Sorbent tubes	Organic vapors, mercury, etc.

4. INTERNAL ENVIRONMENTAL ASSESSMENT, NEPA DOCUMENTATION, AND READINESS REVIEWS

An environmental review and a readiness review will be conducted for WAG 10 before field activities begin. These reviews are required to ensure that RI field activities are conducted in a safe and cost-effective manner and in accordance with ALARA principles. Programmatic requirements for each type of review are summarized in the following subsections.

4.1 INTERNAL ENVIRONMENTAL ASSESSMENT AND NEPA DOCUMENTATION

The purpose of the internal environmental assessment is to promote compliance with all applicable environmental permits, rules, regulations, and statutes; to promote environmental protection by implementation of ORNL's ALARA policy; and to maintain the quality of the environment throughout all activities, operations, and projects carried out at ORNL.

The RI/FS Project is subject to the ORNL Internal Environmental Assessment and National Environmental Protection Act (NEPA) Documentation Program, which designates the organizations responsible for conducting NEPA documentation reviews for ORNL. Environmental reviews will be performed by Energy Systems.

4.2 READINESS REVIEW

The purpose of the readiness review is to ensure—by identifying and minimizing associated risks—that an activity is ready to proceed to the next stage. The review will promote compliance with all applicable ORNL, Energy Systems, DOE, federal, state, and local regulations, orders, procedures, and guidelines. WAG 10 documents will be included in the readiness review to ensure that all possible avenues for personal and environmental exposures have been accounted for (e.g., site characterization summaries, WAG 10 RI implementation plans, comprehensive work plans, and WAG 10 ES&H plans). The readiness review encompasses all operational divisions, including health and safety.

The RI/FS Project is subject to the ORNL Readiness Review and Documentation Program. The readiness review will be conducted by Energy Systems.

5. PROJECT ES&H PROCEDURES

RI/FS ES&H activities will be conducted in accordance with current project procedures. Newly prepared project procedures will be submitted to Energy Systems for review and concurrence prior to issue. Revisions to existing project procedures will be forwarded to Energy Systems. Controlled copies of project procedures are maintained by the ES&H Manager, the FHSS, and the FSL. Controlled copies of the project procedures are also provided to, and maintained by, Energy Systems. Where appropriate, manufacturers' instructions for equipment operation, calibration, and maintenance will be used in lieu of specific project procedures.

Each project procedure will be reviewed internally by the Bechtel Team at least annually for continuing applicability and adequacy. The review will include an evaluation for compliance with applicable ES&H regulations, standards, and guidelines and Bechtel/Energy Systems policy and procedures. Procedures that require changes to be compliant with federal or site requirements will be revised and reissued. Table 5.1 lists applicable project procedures.

Programmatic assessments of the various ES&H programs will be performed at least quarterly to ensure proper use of the procedures.

Table 5.1. ES&H project procedures

Project procedure number	Procedure title
1201	Environmental, Safety, and Health Management Oversight Program
1202	Site Access Requirements
1205	Medical Surveillance
1210	ES&H Training
1220	Initial Site Survey
1230	Personal Protective Equipment
1235	Hazardous Work Permits
1240	Emergency Response
1240.1	Unusual Occurrence Reporting
1245	Personnel Decontamination
1250	Equipment Decontamination and Release for Unrestricted Use
1255	Work Area and Environmental Monitoring
1260	Hazardous Materials Transportation
1260.1	Determination of Hazardous Materials Classification
1260.2	Packaging of Hazardous Materials for Transport
1260.3	Transport Vehicle Requirements
1260.4	Transport Vehicle Operator Requirements
1260.5	Transportation Safety Requirements
1260.6	Surveying, Marking, and Placarding of Transport Vehicles and Containers
1260.9	Shipping Papers
1265	Environmental, Safety, and Health Recordkeeping
1270	Industrial Hygiene Practices

Table 5.1 (continued)

Project procedure number	Procedure title
1270.1	Air Surveillance of Radiological and Chemical Contaminants
1271	Inspection, Maintenance, Use, and Testing of the Mobile Decontamination Trailer-1 (MDT-1) Breathing Air System
1275	Industrial Safety Practices
1275.1	Electrical Equipment and Systems
1275.2	Control of Hazardous Energy Source (Lockout/Tagout)
1275.3	Excavation and Trenching
1275.4	Ladders
1275.5	Scaffolds
1275.6	Cranes, Heavy Equipment, and Motor Vehicles
1275.7	Welding and Cutting
1275.8	Confined Space Entry and Work
1275.9	Housekeeping/Sanitation
1275.10	Hand and Portable Power Tools
1275.11	Fire Prevention and Protection
1275.12	OSHA/Bechtel/DOE Recordkeeping
1280	Health Physics Practices
1280.1	Methodology for Performing Radiological Contamination Surveys
1280.2	Dosimetry Services
1280.3	External Radiation Dosimetry
1280.4	Internal Radiation Dosimetry
1280.5	Radiological Dose Rate Measurements
1280.6	Use of Pocket Meters
1280.7	Posting and Labeling
1280.8	Control Point Operations

Table 5.1 (continued)

Project procedure number	Procedure title
1280.9	Radiation Source Control
1280.10	Development and Use of Control Charts for Radiation Scalers
1280.11	Determination of Tritium and Carbon-14 Activity in Urine Using Packard Tri-Carb Liquid Scintillation Counting Systems
1280.12	Determination of Transferable Tritium and Carbon-14 Activity on Surfaces Using Packard Tri-Carb Liquid Scintillation Counting Systems
1285	Calibration and Maintenance of ES&H Instruments

6. PERSONAL PROTECTIVE EQUIPMENT

6.1 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT

PPE for a particular job will be selected by the FHSS or ES&H Manager on the basis of the hazards anticipated or previously detected at a work site. The equipment selected will provide protection from contamination by chemical or radiological materials known or suspected to be present and having any potential for worker exposure. Respiratory protection (discussed in Sect. 7) may be required.

On the basis of a preliminary on-site survey, requirements for PPE will be specified in an HWP. When conditions occur that are not covered by existing plans and procedures, the FHSS will halt work and inform the ES&H Manager, who will then coordinate proposed solutions with ORNL management through the ORNL ES&HC Contractor Interface Manager. This may include changing PPE requirements in the HWP. (Changed PPE requirements in an HWP will be documented in the HWP.) Numerical designations of levels of PPE are reversed from OSHA designations to more closely correspond to Energy Systems designations.¹ Donning and doffing procedures are defined in Attachment 5 of PP 1230, "Personal Protective Equipment."

6.2 LEVELS OF PERSONAL PROTECTIVE EQUIPMENT

The levels of PPE shown in Table 6.1, which will meet or exceed Energy Systems requirements, will be used as a starting point for ensemble creation; however, each ensemble will be tailored to the specific situation to provide the appropriate level of protection.

6.2.1 Level 1 PPE

Level 1 PPE will be used when the hazards analysis indicates that field investigations will be conducted in areas known or thought to be free of significant contamination. Use of Level 1 PPE may continue if field measurements or monitoring data confirm the following conditions.

- Airborne contaminants are less than 10% of the applicable limiting value (DAC, PEL, TLV, REL).
- The absorbed dose rate is less than 25 $\mu\text{Gy/h}$ (2.5 mrad/h), generally taken at waist level (approximately 1 m).
- Radioactive materials contamination is maintained at levels less than 20 dpm/100 cm^2 (0.3 Bq/100 cm^2) for removable alpha contamination; 300 dpm/100 cm^2 (5 Bq/100 cm^2)

¹The numerical designations for PPE used on the RI/FS Project correspond to the OSHA alphabetical designations as follows: Level 1 to Level D; Level 2 to a modified Level D requiring additional protection (typically gloves, booties, and coveralls); Level 3 to Level C (air-purifying respirator); Level 4 to Level B (supplied air); and Level 5 to Level A (isolation suit).

for total alpha contamination; 200 dpm/100 cm² (3.3 Bq/100 cm²) for removable beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 20 dpm/100 cm² (0.3 Bq/100 cm²)]; and 1000 dpm/100 cm² (16.7 Bq/100 cm²) for total beta-gamma contamination.

6.2.2 Level 2 PPE

Level 2 PPE will be used initially when the hazards analysis indicates that hazardous materials are present in quantities that do not present a potential for significant exposures to airborne or skin contaminants. Continued use of Level 2 PPE will be based on field measurements or monitoring data that confirm the following conditions.

- Airborne contaminants are greater than or equal to 10% but less than 50% of the applicable limiting value. If more than one contaminant is identified, the unity rule* will be used to assign the appropriate limiting value.
- The absorbed dose rate is greater than or equal to 25 µGy/h (2.5 mrad/h), and pocket dosimeters are required. Because elevated dose rates and contamination levels do not always coincide, it may be necessary to evaluate absorbed dose rate PPE requirements as a separate issue (see Table 6.1, footnote b).
- Radioactive materials contamination is maintained at levels less than 500 dpm/100 cm² (8.3 Bq/100 cm²) for removable alpha contamination; 2500 dpm/100 cm² (41.7 Bq/100 cm²) for removable beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 500 dpm/100 cm² (8.3 Bq/100 cm²)]; and 1.25×10^5 dpm/100 cm² (2100 Bq/100 cm²) for total beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 2500 dpm/100 cm² (41.7 Bq/100 cm²)].
- PPE for protection against skin irritants may be highly specific to the chemical constituents comprising the irritant. Accordingly, chemical-resistant PPE materials will be chosen on the basis of the chemical substances encountered (see Table 6.1, footnote a).

*The unity rule:
$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n} < 1$$

where

C_n = atmospheric concentration of contaminant n,

T_n = TLV, PEL, REL, or DAC of contaminant n.

6.2.3 Level 3 PPE

Level 3 PPE will be used initially when the hazards analysis indicates a potential for direct contact with hazardous contaminants that will not adversely affect exposed skin. Continued use of Level 3 PPE will be based on continuous field measurements or monitoring data that confirm the following conditions.

- Concentrations of individual airborne contaminants are less than 50 times the applicable limiting value. If more than one contaminant is identified, the unity rule will be used to assign the appropriate limiting value.
- The absorbed dose rate is greater than or equal to 25 $\mu\text{Gy/h}$ (2.5 mrad/h), and pocket dosimeters are required. Because elevated dose rates and contamination levels do not always coincide, it may be necessary to evaluate absorbed dose rate PPE requirements as a separate issue (see Table 6.1, footnote b).
- Radioactive materials contamination is maintained at levels less than 25,000 dpm/100 cm^2 (417 Bq/100 cm^2) for removable alpha contamination; 1.25×10^5 dpm/100 cm^2 (2100 Bq/100 cm^2) for total alpha contamination; 1.25×10^6 dpm/100 cm^2 (21,000 Bq/100 cm^2) for removable beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 25,000 dpm/100 cm^2 (417 Bq/100 cm^2)]; and 6.25×10^6 dpm/100 cm^2 (1.04×10^5 Bq/100 cm^2) for total beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 1.25×10^5 dpm/100 cm^2 (2100 Bq/100 cm^2)].
- PPE for protection against skin irritants may be highly specific to the chemical constituents comprising the irritant. Accordingly, chemical-resistant PPE materials will be chosen on the basis of the chemical substances encountered (see Table 6.1, footnote a).

6.2.4 Level 4 PPE

Level 4 PPE represents the same level of skin contaminant protection as Level 3. Level 4, however, will be used for concentrations of specific substances that do not represent a severe skin hazard but are immediately dangerous to life or health (IDLH); for atmospheres containing less than 19.5% oxygen; for concentrations in excess of the protection factors for air-purifying respirators; or in the presence of incompletely identified vapors or gases as indicated by direct-reading organic vapor detection equipment. Use of Level 4 PPE will be based on continuous field measurements or monitoring data that confirm the following conditions.

- Concentrations of individual airborne contaminants are less than 100 times the applicable limiting value. If more than one contaminant is identified, the unity rule will be used to assign the appropriate limiting value.

- The direct radiation dose rate is greater than or equal to 25 $\mu\text{Gy/h}$ (2.5 mrad/h), and pocket dosimeters are required. Because elevated dose rates and contamination levels do not always coincide, it may be necessary to evaluate dose rate PPE requirements as a separate issue (see Table 6.1, footnote b).
- Radioactive materials contamination is maintained at levels less than 50,000 dpm/100 cm^2 (830 Bq/100 cm^2) for removable alpha contamination; 2.5×10^5 dpm/100 cm^2 (4200 Bq/100 cm^2) for total alpha contamination; 2.5×10^6 dpm/100 cm^2 (4.167×10^4 Bq/100 cm^2) for removable beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 50,000 dpm/100 cm^2 (830 Bq/100 cm^2)]; and 1.25×10^7 dpm/100 cm^2 (2.83×10^5 Bq/100 cm^2) for total beta-gamma contamination [except for iodine-125, iodine-129, and actinium-227, for which the guide is 2.5×10^5 dpm/100 cm^2 (4200 Bq/100 cm^2)].
- PPE for protection against skin irritants may be highly specific to the chemical constituents comprising the irritant. Accordingly, chemical-resistant PPE materials will be chosen on the basis of the chemical constituents encountered (see Table 6.1, footnote a).
- Skin irritants are present.

6.2.5 Level 5 PPE

Level 5 PPE is reserved for emergency response operations in unknown atmospheres; work in IDLH atmospheres where specific substances represent a severe skin exposure hazard; work in extremely corrosive atmospheres; work in atmospheres containing concentrations of hazardous contaminants in excess of the protection factors for pressure-demand respirators; and work in atmospheres containing known hazardous contaminants that have not been adequately evaluated. The following guideline will be used for selection of Level 5 PPE.

- Almost any environment that will not degrade, permeate, or penetrate the PPE, or jeopardize planned radiation exposure limits, may be entered with Level 5 PPE.

These PPE requirements may be modified to provide the appropriate level of protection. Except in emergency situations, special PPE requirements will be recommended by the FHSS on the basis of field survey information and appropriate laboratory analyses. These requirements will be approved by the ES&H Manager before they are implemented.

Table 6.1. Levels of personal protective equipment

Level	Equipment description
1	<p>Required</p> <ul style="list-style-type: none"> - Nonregulated cloth work uniform - Steel-toe and steel-shank work boots - Safety glasses - Hard hat - Disposable gloves^a - Whole-body thermoluminescent dosimeter (TLD) badge <p>Optional, as required</p> <ul style="list-style-type: none"> - Work gloves^a - Personal flotation device - Ear plugs or muffs - Two-way radio - Sweat bands - Flashlight or lantern
2	<p>Required</p> <ul style="list-style-type: none"> - Tyvek[®] coveralls with openings taped closed - Regulated area cloth work uniform - Chemical-resistant outer gloves^a taped to Tyvek[®] coveralls - Chemical-resistant inner gloves^a taped to cloth coveralls - Steel-toe and steel-shank work boots - Neoprene boots, or chemical-resistant boot covers^a taped to Tyvek[®] coveralls - Hard hat - Safety glasses - Whole-body TLD badge <p>Optional, as required</p> <ul style="list-style-type: none"> - 0- to 200-mR pocket dosimeter ($0.025 \leq \text{mGy/h} < 1.0$, penetrating absorbed dose)^b or electronic equivalent - 0- to 200-mR plus 0- to 1-R pocket dosimeter ($\geq 1.0 \text{ mGy/h}$, penetrating absorbed dose)^b or electronic equivalent - Extremity dosimeters - Personal flotation device - Ear plugs or muffs - Two-way radio - Flashlight or lantern

Note: Access to areas and operations requiring Level 2 PPE will be restricted. Each such area will be barricaded so that dose rates and airborne exposure levels are $<0.025 \text{ mGy/h}$ and <0.1 derived air concentration (DAC/PEL/TLV/REL) guide, respectively, at its boundary.

Table 6.1 (continued)

Level	Equipment description
3	<p><u>Required, inner set</u></p> <ul style="list-style-type: none"> - Regulated cloth work uniform with openings taped closed - Steel-toe and steel-shank work boots - Chemical-resistant shoe covers^a taped to cloth coveralls - Chemical-resistant gloves^a taped to cloth coveralls <p><u>Required, outer set</u></p> <ul style="list-style-type: none"> - Full-facepiece, air-purifying, canister-equipped respirator - Chemical-resistant coveralls or chemical splash suit^a with openings taped closed - Chemical-resistant hood^a taped to coveralls - Chemical-resistant gloves^a taped to chemical resistant coveralls, or chemical splash suit - Neoprene boots, or chemical-resistant boot covers^a taped to coveralls - Hard hat - Whole-body TLD badge - Personal air sampler - Two-way radio <p><u>Optional, as required</u></p> <ul style="list-style-type: none"> - 0- to 200-mR pocket dosimeter (0.025 < mGy/h < 1.0, penetrating absorbed dose)^a or electronic equivalent - 0- to 200-mR plus 0- to 1-R pocket dosimeter (> 1.0 mGy/h, penetrating absorbed dose)^a or electronic equivalent - Extremity dosimeters - Personal flotation devices - Ear plugs or muffs - Sweat bands - Flashlight or lantern <p>Note: Access to areas and operations requiring Level 3 PPE will be controlled. Each such area will be constructed with a two-barricade system containing an inner "hot line" and an outer "contamination control" line. Construction and operation of a Level 3 PPE CAA will ensure that the environmental dose rates and airborne exposure levels are <0.025 mGy/h and <0.1 DAC/PEL/TLV/REL, respectively.</p>
4	<p><u>Required, inner set</u></p> <ul style="list-style-type: none"> - Modesty garments - Tyvek[®] (chemical-resistant^a as appropriate) coveralls with openings taped closed - Chemical-resistant gloves^a taped to coveralls - Steel-toe and steel-shank work boots - Chemical-resistant shoe covers^a taped to coveralls

Table 6.1 (continued)

Level	Equipment description
	<p><u>Required, outer set</u></p> <ul style="list-style-type: none"> - Pressure-demand, full-facepiece self-contained breathing apparatus (SCBA), or pressure-demand, supplied-air respirator with escape SCBA provisions¹ - Chemical-resistant coveralls² or chemical-resistant splash suit² with openings taped closed - Chemical-resistant hood² taped to coveralls - Hard hat - Neoprene boots, or chemical-resistant boot covers² taped to coveralls - Chemical-resistant gloves² taped to coveralls - Whole-body TLD badge - Personal air sampler - Two-way radio <p><u>Optional, as required</u></p> <ul style="list-style-type: none"> - 0- to 200-mR pocket dosimeter ($0.025 < \text{mGy/h} < 1.0$, penetrating absorbed dose)³ or electronic equivalent - 0- to 200-mR plus 0- to 1-R pocket dosimeter ($> 1.0 \text{ mGy/h}$, penetrating absorbed dose)³ or electronic equivalent - Extremity dosimeters - Personal flotation device - Ear plugs or muffs - Sweat bands - Flashlight or lantern - Cooling garment <p>Note: The same controlled access restrictions that apply to Level 3 PPE areas also apply to Level 4 PPE areas/operations.</p>
5	<p><u>Required, inner set</u></p> <ul style="list-style-type: none"> - Modesty garments - Chemical-resistant Tyvek[®] coveralls² with openings taped closed - Steel-toe and steel-shank work boots - Chemical-resistant shoe covers² taped to coveralls - Chemical-resistant gloves² taped to coveralls - Two-way radio - Cooling garment <p><u>Required, outer set</u></p> <ul style="list-style-type: none"> - Airline, continuous-flow, full-facepiece or hood respirator with self-contained breathing apparatus (SCBA) escape provisions¹, or pressure-demand, full-facepiece SCBA; or pressure-demand supplied-air respirator with escape SCBA provisions, as appropriate

Table 6.1 (continued)

Level	Equipment description
	<ul style="list-style-type: none"> - Full-encapsulating, chemical-resistant suit^a with openings taped closed - Chemical-resistant boot covers - Personal air sampler - Whole-body TLD badge - Knife
	<u>Optional, as required</u>
	<ul style="list-style-type: none"> - 0- to 200-mR pocket dosimeter ($0.025 < \text{mGy/h} < 1.0$, penetrating absorbed dose)^b or electronic equivalent - 0- to 200-mR plus 0- to 1-R pocket dosimeter ($> 1.0 \text{ mGy/h}$, penetrating absorbed dose)^b or electronic equivalent - Extremity dosimeters - Flashlight or lantern - Hard hat

Note: If Level 5 PPE work is anticipated, reasonable efforts will be made to use engineering controls that will mitigate the hazard(s) to requirements of Level 4 PPE or less. If such engineering controls are not feasible, a risk assessment will be performed before work begins. The risk assessment will demonstrate that environmental dose rates and airborne exposure levels can be controlled to $< 0.025 \text{ mGy/h}$ and $< 0.1 \text{ DAC/PEL/TLV/REL}$, respectively, or the task may not be performed at the primary location.

^aClean or new chemical-resistant gloves should always be used when handling samples. The most appropriate chemical-protective clothing will be chosen by the FHSS or Industrial Hygienist on the basis of historical information and field measurements. Where data are inadequate, conservative assumptions will be used to ensure that clothing resists permeation, degradation, and penetration by chemicals.

^bRadiation dosimetry will be issued in direct relation to field-measured absorbed dose rates, as indicated. If field conditions change significantly from those shown on the HWP, that HWP will be terminated, PPE requirements reevaluated, and a new HWP initiated. Existing HWPs can be changed with the approval of the FHSS or the ES&H Manager.

^cThe decision to use respiratory protection for airborne concentrations in excess of the appropriate DAC or TLV may be based on field evaluations with a field radiation detector, Photovac-TIP, or equivalent instrument for hazardous chemical organic vapors; decisions should always be confirmed with laboratory analyses.

7. RESPIRATORY PROTECTION PROGRAM

Respiratory protection program procedures require that when engineering controls cannot maintain airborne contaminants at acceptable levels, appropriate respiratory protection devices will be used by affected persons. An effective respiratory protection program is essential to this project and will be implemented when necessary during WAG 10 field activities. HWP's will be issued to document the respiratory protection requirements for field personnel to minimize exposures to hazardous materials.

The respiratory protection program will

- establish respiratory protection requirements, including selection of devices to be used for each work situation as required by hazard potential (see Sect. 3):
- verify that personnel who use protective devices meet medical requirements for such use, that the fit of the assigned device is acceptable, that personnel are adequately trained in the use of the devices, and that they use the devices as specified on the job:
- verify that air supplies meet applicable requirements (such air supplies may include plant air, dedicated air supply systems, and air tanks); and
- provide for appropriate records of
 - respirator requirements for work situations,
 - medical status of individuals,
 - respirator fitting results,
 - training of employees and supervisors,
 - specification of respiratory protection requirements (e.g., on HWP's),
 - actual use of respirators on jobs requiring them,
 - emergency procedures, training, and device selection,
 - respirator inspection, cleaning, and maintenance activities,
 - results of bioassay program, and
 - tests and inspections of air supplies.

These elements of the program will be carried out in accordance with PP 1230, "Personal Protective Equipment," which complies with applicable regulatory requirements.

7.1 REGULATORY REQUIREMENTS

The most conservative requirements of DOE Order 5480.11 and OSHA regulations 29 CFR 1910.134 and 29 CFR 1910.120 will be met. The American National Standards Institute (ANSI) standard "Practices for Respiratory Protection," ANSI Z88.2-1980, is

incorporated in the preceding documents by reference and serves as the basic guide for such programs.

7.2 RESPONSIBILITIES AND AUTHORITIES

Acting under the overall guidance of ORNL management and the ORNL ES&HC Contractor Interface Manager, the ES&H Manager has responsibility and authority for administration of the respiratory protection program. In this capacity, the ES&H Manager may designate the FHSS as responsible for making decisions regarding the need for any type of respiratory protection equipment.

7.3 SELECTION OF RESPIRATORS

Only respirators approved by NIOSH, the Mine Safety and Health Administration (MSHA), or the Nuclear Regulatory Commission (NRC) and respirators that have been tested and certified (verified by test certification numbers) will be used. All component and replacement parts must also have NIOSH, MSHA, or NRC approval. Because respirators are approved as a system, cartridges, canisters, filters, air lines, and regulators cannot be interchanged among equipment, even among equipment of a single manufacturer, unless specifically approved by NIOSH, MSHA, or NRC.

Selection of approved makes and types of respirators will be based on mutual Bechtel and ORNL agreement and on the rationale provided in Sect. 6.

7.4 TRAINING

Training related to the respiratory protection program will be included in a 48-h hazardous waste operations training course and will include

- instruction in the nature of the hazard, whether acute, chronic, or both, and an accurate appraisal of what can happen if the respirator is not used;
- explanation of why engineering or administrative controls may not be feasible, including explanation of efforts being made to reduce or eliminate the need for respirators;
- discussion of the reasons for using a certain type of respirator for a particular purpose;
- discussion of the respirator's capabilities and limitations;
- discussion of proper inspection and maintenance of the respirator.

- instruction, training, and actual use of the respirator and close, frequent supervision to ensure that it is being used properly; and
- classroom and field training in recognizing and coping with emergencies.

Instruction in the actual application of the respirator under field conditions will include

- opportunities to handle the respirators;
- proper fitting, including demonstrations and practice in determining fit, donning, wearing, adjusting, and removing the respirator;
- testing the facepiece for face seal;
- a period for familiarization with wear in normal air; and
- wearing the respirator in a test atmosphere.

ES&H personnel will receive comprehensive training concerning respirators and respiratory protection practices. This training will include, but not necessarily be limited to,

- basic respiratory protection practices;
- selection and use of respirators to protect employees against hazards to which they may be exposed;
- nature and extent of the respiratory hazard(s) to which employees may be exposed;
- structure and operation of the respiratory protection program, including ES&H responsibility to facilitate functioning of the program, maintenance and issuance of respirators, control of use, and evaluation of program effectiveness, and
- legal requirements pertinent to the use of respirators.

Personnel receiving training will be required to demonstrate an adequate level of knowledge through testing, demonstration, or both. Documented records will be maintained for each trainee.

7.5 FITTING

Employees will be fit-tested annually (and must be kept up to date) by an ORNL-approved service for each type of respirator that may be worn to ensure proper seal of the respirator facepiece. Documentation of fit test results will be retained by the ES&H Manager as part of the fit-testing procedure, and each fit-tested employee will be issued a card showing the individual's fit test expiration date. Each employee will be evaluated to determine whether facial features interfere with proper sealing. Employees with corrective lenses will be provided with specially designed respirator glasses (inserts) that do not interfere with respirator seal. Employees with facial hair that interferes with the respirator seal will neither be fit-tested nor allowed to enter areas where respiratory protection is required. Employees will be required to be clean shaven at all respirator-sealing surface contact points (before fit-testing or before occupational use), or they will not be allowed in areas that require respiratory protection. If the fit test is not performed within 60 days after the physical exam, the physical must be performed again.

Tests to be used in respirator fitting are described in Sects. 7.5.1 and 7.5.2

7.5.1 Quantitative Test

This test involves exposing the respirator wearer to a challenge atmosphere. The concentration of particles is measured both inside and outside the respirator, and this ratio represents the protection factor afforded by the respirator.

Personnel required to use respiratory protective devices will be quantitatively tested. A separate test is required for each type of device to be worn by an individual.

7.5.2 Field Tests

Field tests consisting of the following will be performed before entry into any area requiring respiratory protection:

- Test 1—Positive Pressure Test. This test is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage.
- Test 2—Negative Pressure Test. During this test, the inlets of the canister, cartridge(s), or filter(s) are closed off, and the wearer inhales gently so the facepiece collapses slightly, and holds his breath for 10 seconds. If the facepiece remains slightly collapsed and no inward leakage is detected, an adequate fit has probably been obtained. This test can be used only on respirators with tightly fitting facepieces and is only a rough determination of fit.

7.6 INSPECTION, CLEANING, MAINTENANCE, AND STORAGE

7.6.1 Inspection Procedures

The OSHA standard states that respirator inspection will include the following:

- checking straps and rubber seals for signs of deterioration;
- checking tightness of the connections;
- checking the facepiece for cleanliness and secure attachment;
- inspecting valves to ensure that they are seated properly, are flexible, and have no noticeable deterioration;
- inspecting connecting tubes for holes or deterioration;
- checking canisters, filters, or cartridges for damage; and
- checking all flexible components for wear and deterioration.

In addition, the standard states that the regulator and warning devices on an SCBA will be checked for proper function.

ORNL will inspect and maintain the air-purifying respirators used on the project. The air-supplied respirators will be inspected routinely by Bechtel Team field personnel, and repairs will be performed by certified personnel.

7.6.2 Defects Found During Field Inspections

If defects in a respirator are found during field inspections, it will be identified as nonconforming and removed from service until it can be repaired. All air-purifying respirators will be repaired by Energy Systems, and all SCBAs will be sent to the manufacturer for major repair (e.g., regulator adjustment). Under no circumstances will a defective device be allowed to remain in the field.

7.6.3 Inspection During Cleaning

ORNL provides inspection and cleaning of ORNL-supplied respirators. Because cleaning usually involves some disassembly, it presents an opportunity for thorough examination of each respirator.

7.6.4 Cleaning and Disinfecting

As a minimum, ORNL-supplied respirators will be cleaned and disinfected by ORNL after use. Any Bechtel-supplied respirators will be collected, cleaned, and disinfected in accordance with PP 1230, "Respirator Maintenance, Cleaning, Decontamination, and Storage." Respirators used during training exercises in the field will be sanitized in the field. If needed, ORNL's cleaning services may be used. Emergency-use respirators will be cleaned and disinfected after each use.

7.7 MEDICAL ASPECTS

Employees required to wear a respirator must be examined annually by a physician to determine medical fitness for tasks requiring respirators. An employee will not be assigned to a task that requires a respirator unless it has been determined that the employee is physically capable of performing the work while using the respirator. A release statement signed by the physician is kept on file in the ES&H Manager's office area.

During respirator fitting, any distress exhibited by an individual will be reported; reexamination by a physician may be required to determine whether the employee can safely continue to use the equipment. In addition, any evidence that an employee is having difficulty using any respiratory protective device will be reported to the ES&H Manager. That individual will then be reassessed by a physician.

7.8 PROGRAM EVALUATION

Periodic surveillance of work areas that require use of respirators and an evaluation of the program for effectiveness are important aspects of the respiratory protection program.

7.8.1 Surveillance of the Work Area

Many variables affect the need to use respirators. To determine the necessity for respiratory and additional protection, appropriate surveillance of work conditions and of the degree of employee exposure or stress is provided by Health and Safety Specialists as determined by the FHSS or ES&H Manager. Program changes will be implemented as needed.

The results of work area sampling and exposure measurement are the basis for selection and use of respiratory protection equipment and for modification of the respiratory protection program.

Used respirators are monitored to determine the quantity of radioactive material on the interior of the facepiece. (Positive survey results will require bioassay sampling and analysis

for the radioactive material to which the individual was probably exposed.) The respirator is placed in a bag, and the bag is tagged as containing radioactive material and taken to the ORNL laundry for cleaning and inspection.

7.8.2 Evaluation of Effectiveness

The results of periodic inspections of respirator use, consultation with wearers, measurements of airborne levels of contamination in work areas, bioassays, and medical surveillance of wearers will be reviewed and analyzed to determine the effectiveness of the respirator program. Any evidence of excessive exposure to hazards will be investigated to determine why adequate protection was not provided, and action will be taken to remedy the problem.

Users will be consulted periodically about their acceptance of respirators, including discomfort, unacceptable resistance to breathing, and fatigue. Users will also be consulted concerning their confidence in the respirator's effectiveness and the degree to which the respirator interferes with vision and communication, restricts movement, and interferes with job performance.

Examination of respirators in use and in storage will indicate how well the equipment is being maintained. Improper use or maintenance of respirators will not be tolerated. Intentional abuse of respirators is cause for dismissal from the project.

8. SITE AND CONTAMINATION CONTROL

WAG 10 activities will be performed in a manner that controls site access and minimizes the potential for spread of contamination. Site control measures include the establishment of CAAs at individual work locations in accordance with PP 1235, "Hazardous Work Permits." Project personnel will be required to have an ORNL-approved Melton Valley access "slash badge." A physical examination, external dosimetry, bioassay, and either the 24- or 40-hour hazardous waste operations training are required to obtain a slash badge. Visitors will be allowed to enter WAG 10 under the direct supervision of an authorized individual only after the facility manager has been notified.

At each major activity work location, a site map will be provided. The site map will be marked by the FHSS or designee to indicate the shortest evacuation route from the individual work site to a predesignated assembly area and to indicate the location of the nearest medical assistance, which is ORNL Medical in Building 4500 North.

8.1 WORK AREA CONTROL

Work within each CAA at WAG 10 will be controlled by PP 1235, "Hazardous Work Permits." The HWP system provides authorization for named employees to do a particular job involving exposure to radiation or radioactive contamination, hazardous chemicals, physical hazards, or other potentially dangerous work situations. The HWP system incorporates appropriate approvals for named personnel to enter areas under specified requirements. Daily entry and exit times for those personnel are recorded. If time-exposure operations are involved, appropriate time and exposure data are also recorded. The minimum work crew for operations within a CAA will be two individuals. Additional information on CAAs and the HWP system is given in Sect. 12 of this plan. Project procedures established to govern the establishment, entry, work activities, and monitoring of CAAs are listed in Table 5.1.

Work areas will be controlled by the HWP system as described in PP 1235. HWPs will be used to control employee exposure to hazards and to control each work task where warranted by the potential for such exposure. This system contains elements necessary to provide direction on the establishment of CAAs, including site maps, designated work zones, use of a "buddy system," site communications (e.g., emergency alerting, work practices, and procedures), and identification of the nearest medical assistance.

8.2 CONTAMINATION CONTROL

For operations, it will be necessary to apply existing project procedures and protocols to control the spread of radioactive, chemical, and biological contaminants to prevent or

minimize exposure to the environment, the public and project personnel. General methods to be used are as follow.

- Contaminant protection training to increase workers' understanding of contaminant hazards and work practices is required to prevent the spread of contaminants. See PP 1210, "ES&H Training."
- Various contamination control measures will be initiated when CAAs are necessary. Exits from CAAs will be monitored by portable instruments to minimize the potential for spreading contaminants. Engineering and administrative controls will be used when applicable to minimize personal and environmental exposures to site-generated contaminants.
- An HWP system controls access to areas where contaminants are known to exist and specifies protective equipment for work in those areas. See PPs 1235, "Hazardous Work Permits," and 1280.7, "Posting and Labeling."
- Contaminant surveys identify areas containing materials requiring control, establish the boundaries of CAAs, and provide input for HWPs. See PPs 1220, "Initial Site Survey"; 1255, "Work Area and Environmental Monitoring"; and 1280.1, "Methodology for Performing Radiological Contamination Surveys."
- Anticontamination clothing will be used in areas with accessible surface contamination, and respiratory protection equipment will be used in areas with known airborne contaminants. See PP 1230, "Personal Protective Equipment."
- Air sampling for radiological and organic compounds will establish the level of respiratory protection required and will provide input for HWPs. If original vapors are measured at a concentration of 1 ppm in the breathing zone, respiratory protection and PPE will be implemented until the vapors can be identified. When the vapors are identified, respiratory protection will be required above 10% PEL. See PPs 1255, "Work Area and Environmental Monitoring," and 1270.1, "Air Surveillance of Radiological and Chemical Contaminants."
- Monitoring and decontamination of personnel and equipment (e.g., tools and vehicles) leaving CAAs will prevent the spread of contamination. See PPs 1245, "Personnel Decontamination"; 1250, "Equipment Decontamination and Release for Unrestricted Use"; and 1280.8, "Control Point Operations."
- Tasks will be reviewed and analyzed to make sure that they are, or will be, performed with minimal spread of contamination.

Personnel must be monitored for radioactive contamination when they exit a CAA and at other times designated by the FHSS. Monitoring will be conducted in accordance with Sect. 4.2 of PP 1280.8, "Control Point Operations." Outer anticontamination clothing will be surveyed and disposed of in accordance with PP 1402, "Waste Handling." Work clothing will be placed in appropriate containers for cleaning by ORNL's laundry. Respiratory

protection equipment will be surveyed to segregate items that exhibit radioactivity, and contaminated respirators will be properly packaged and labeled.

Work area and personnel monitoring will be conducted in accordance with PPs 1280 through 1280.9, "Health Physics Practices"; 1270, "Industrial Hygiene Practices"; and 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." These procedures specify the types of monitoring to be performed, instrumentation to be used and its maintenance and calibration, and techniques to be used in sampling and analysis.

9. PERSONNEL DECONTAMINATION

9.1 INTRODUCTION

All personnel and equipment (including tools and vehicles) exiting a contaminated zone will be monitored to verify that they are free of significant contamination and that contamination is not being carried beyond the contamination zone. Personnel monitoring will be performed in accordance with PPs 1245, "Personnel Decontamination"; 1280.1, "Methodology for Performing Radiological Contamination Surveys"; and 1280.8, "Control Point Operations."

When monitoring indicates that an employee has become contaminated with chemicals, biological agents, or radioactive materials, decontamination efforts will be initiated immediately. The employee's immediate supervisor will notify the FHSS, who will record the details of the incident, determine whether any injury is involved, and notify the ES&H Manager. The ES&H Manager will immediately report all contamination incidents to ORNL management through the Laboratory Shift Supervisor (LSS) and the ORNL ES&HC Contractor Interface Manager to ensure that prompt procedural notifications and appropriate emergency response actions take place.

9.2 FACILITIES

The ES&H Manager will designate the FHSS to verify that facilities provided for decontamination of Bechtel personnel are maintained in acceptable condition and that supplies of decontaminating agents and other materials are kept available. Personnel decontamination facilities at the FOF will be equipped with showers, supplies of clean work clothing, decontamination agents, and a decontamination area where ES&H personnel can assist in decontaminating individuals. Provisions will be made to retain all wash solutions and materials for appropriate disposal and to maintain separation between clean and contaminated areas and materials. Provisions will be included at the CAA boundary for decontaminating the exterior surfaces of fully encapsulating suits before personnel remove them.

9.3 DECONTAMINATION TECHNIQUES

The affected employee will remove all contaminated clothing and equipment. If radioactive contamination is involved, Health and Safety Specialists will monitor the employee and will notify the FHSS if designated action levels have been exceeded.

The employee will wash thoroughly with soap and water and may use a soft-bristled brush for cleaning the hands and fingernails. Care will be taken to avoid irritating or abrading the skin. If there is evidence, including radiation-monitoring results, that cleaning is not complete, the washing may be repeated. When the ES&H Manager believes it is warranted (e.g., contamination of the eye, contamination abraded into the skin), any further decontamination efforts will be carried out under the direction of a physician.

9.4 RELEASE LIMITS

The following radioactive contamination guidelines for skin and hands, used by ORNL, will be used throughout the RI/FS Project.

<u>Item</u>	<u>Transferable (smear)</u>		<u>Direct readings^a</u>	
	<u>Alpha</u>	<u>Beta-gamma</u>	<u>Alpha</u>	<u>Beta-gamma</u>
General body	Nondetectable ^b		2.5 (150)	16.67 (1000)
Hands	Nondetectable ^b		5.0 (300)	16.67 (1000) ^c

Source: ORNL Health Physics Procedure RP-2.5, "Radioactive Contamination Control."

^aUnits are Bq/100 cm² (dpm/100 cm²).

^bRemovable skin contamination should be nondetectable. Detection limit is related to the instrumentation used.

^cHigher limit may be used if the identity of the contaminant is known.

9.5 EMERGENCY DECONTAMINATION

If personnel are contaminated with highly caustic, strongly acidic, or high-level radioactive materials (>0.01 mGy/h), emergency shower facilities at the FOF will be used for first-level decontamination. These facilities will be adequate to treat a minimum of two contaminated individuals at one time, and use of these facilities will be in accordance with PP 1245, "Personnel Decontamination." Appropriate Energy Systems medical and radiation safety personnel will be relied on to assist as needed.

In accordance with PP 1240, "Emergency Response," arrangements will be made to coordinate actions with ORNL and the Radiation Emergency Assistance Center/Training Site (REAC/TS) at the Methodist Medical Center (Oak Ridge Hospital) to deal with employees who are injured and contaminated with hazardous chemicals or radioactivity. Coordination will be between the ES&H Manager and the LSS.

10. EQUIPMENT DECONTAMINATION

10.1 RESPONSIBILITIES AND AUTHORITIES

The FHSS is responsible for ensuring that tools and equipment (including vehicles) are surveyed before they are removed from CAAs in accordance with PP 1280.1, "Methodology for Performing Radiological Contamination Surveys," and PP 1250, "Equipment Decontamination and Release for Unrestricted Use." The Field Activities Coordinator (FAC) is responsible for ensuring that tools and equipment determined to be contaminated in excess of applicable limits are decontaminated to acceptable levels before they are released for unrestricted use.

10.2 FACILITIES

Before release from the CAA, tools and equipment determined to be contaminated with removable radioactive and detectable chemical materials in excess of applicable limits are manually decontaminated at the field location. Field decontamination efforts are conducted in accordance with PP 1250, "Equipment Decontamination and Release for Unrestricted Use," to prevent contamination from being spread to uncontaminated areas, facilities, or personnel.

Tools and equipment that cannot be field-decontaminated to levels below applicable release limits are appropriately packaged, removed from the CAA, and decontaminated in the Bechtel mobile decontamination trailer. The mobile facility is self-contained and uses recycle and cleanup technology to minimize generation of waste.

Reusable contaminated PPE is collected and packaged in contamination-free containers and taken to the contaminated clothing and respirator wash facilities at ORNL. The facilities have integral recycle and cleanup capabilities to minimize the volume of waste generated. Chemical decontamination is performed for all items that are to be reused for additional field sampling. This decontamination is accomplished at the Bechtel decontamination trailer(s) or in the field, as described above.

10.3 DECONTAMINATION CLEARANCE LIMITS

The radioactive materials contamination limits and guides for release for unrestricted use are shown in Tables 10.1 through 10.3. The limits shown in Table 10.1 may be used if the nuclides have been identified. For unidentified nuclides, the more restrictive limits shown in Table 10.2 must be used. Table 10.3 addresses limits for free release of equipment, shoes, and clothing. Tools and equipment given an unconditional release from CAAs must always be accompanied by ORNL Form UCN-14 ("Green Tag"), as specified in PP 1250.

Chemical decontamination is performed in accordance with project procedures based on procedures accepted by the Environmental Protection Agency (EPA) and PP 1250. Random sampling and analysis of final rinse solutions will be performed to check the effectiveness of the decontamination procedures.

10.4 DISPOSAL OF CONTAMINATED FLUIDS AND MATERIALS

Fluids and materials resulting from decontamination processes are contained, sampled, and analyzed for contaminants. Materials determined to be contaminated in excess of appropriate limits are packaged in ORNL-approved containers and disposed of in accordance with the ORNL RI/FS Waste Management Plan and appropriate project procedures.

Table 10.1. Surface radioactivity guides

Nuclide ^a	Removable ^{b, c}	Total ^{b, c} (fixed plus removable)
²³⁸ U, ²³⁵ U, ²³⁹ U, and associated decay products	1000 dpm α /100 cm ² ^b	5000 dpm α /100 cm ²
Transuranics, ²²⁶ Ra, ²²⁸ Ra, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	20 dpm/100 cm ² ^b	300 dpm/100 cm ²
²³² Th, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁶ Ra, ²³³ U, ¹²⁶ I, ¹³¹ I, ¹³³ I	200 dpm/100 cm ² ^b	1000 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above ^c	1000 dpm β - γ /100 cm ² ^b	5000 dpm β - γ /100 cm ²

Source: DOE Order 5480.11, *Radiation Protection for Occupational Workers*.

^aWhere surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

^bAs used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive materials as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

^cThe amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. (Note: The use of dry material may not be appropriate for tritium.) When removable contamination on objects of a surface less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. Except for transuranics and ²²⁶Ra, ²²⁸Ra, ²²⁷Ac, ²³⁰Th, ²³²Th, and ²³¹Pa alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

^dThe levels may be averaged over 1 m², provided that the maximum surface activity in any area of 100 cm² is less than three times the guide values. For purposes of averaging, any square meter of surface will be considered to be above the activity guide, G, if: (1) from measurements of a representative number of sections it is determined that $1/n [S_i \geq G]$, where S_i is the dpm/100 cm² determined from measurement of section i ; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100-cm² area exceeds 3 G.

^eThis category of radionuclides includes mixed fission products, including the ⁹⁰Sr present in them. It does not apply to ⁹⁰Sr that has been separated from the other fission products or mixtures in which the ⁹⁰Sr has been enriched.

Table 10.2. Recommended maximum* contamination guide for items given radiation or contamination clearance

<u>Direct survey</u>		<u>Transferable (smear)</u>	
<u>Alpha</u> (Bq/100 cm ²)	<u>Beta-gamma</u> (Bq/100 cm ²)	<u>Alpha</u> (Bq/100 cm ²)	<u>Beta-gamma</u> (Bq/100 cm ²)
[dpm/100 cm ²]		[dpm/100 cm ²]	
5.0	17	0.33	3.3 ^b
[300]	[1000]	[20]	[200]

Source: ORNL Health Physics Procedure RP-2.5, "Radioactive Contamination Control."

*No 100-cm² area to average greater than this value.

^bExcept ¹²⁵I, ¹³¹I, and ²²⁷Ac, for which the guide is 0.33 Bq/100 cm² (20 dpm/100 cm²).

Table 10.3. Contamination guides^a

	Direct survey ^b		Transferable (smear)	
	Alpha (Bq/100 cm ²)	Beta-gamma (Bq/100 cm ²)	Alpha (Bq/100 cm ²)	Beta-gamma (Bq/100 cm ²)
	[dpm/100 cm ²]	[dpm/100 cm ²]	[dpm/100 cm ²]	[dpm/100 cm ²]
Areas, work surfaces, tools, equipment	5.0 [300]	16.7 [1000]	0.3 [20]	3.3 [200]
Skin (general body)	2.5 [150]	16.7 [1000]	0.3 [20]	3.3 [200]
Skin (hands)	5.0 [300]	16.7 [1000]	0.3 [20]	3.3 [200]
Shoes (personal)	5.0 [300]	16.7 [1000]	0.3 [20]	3.3 [200]
Clothing (personal and company)	5.0 [300]	16.7 [1000]	Not applicable	
Clothing, C-zone area	16.7 [1000]	250 [15,000]	Not applicable	

Source: ORNL Health Physics Procedure RP-2.5, "Radioactive Contamination Control."

^aThe guides for alpha are based on the limit for transuranics, and the beta-gamma guides are based on the limit for ⁹⁰Sr. In those cases where specific nuclides are known, these values may be adjusted by radiation protection personnel in accordance with established internal procedures.

^bThese levels may be averaged over 1 m² provided that the maximum surface activity in any area of 100 cm² is less than 3 times the guide values.

^cRemovable skin contamination should be nondetectable. These values represent the lower limit of detection for smear counting systems in the field. The sensitivity of standard frisking techniques is such that only the direct-reading limits can be readily detected.

11. PERSONNEL TRAINING

11.1 INITIAL TRAINING

Initial Energy Systems general employee training is conducted for all personnel badged for site entry. The training programs are presented at levels suitable for the various types of project personnel (e.g., management, sampling team members, and health and safety specialists). The training will introduce Bechtel Team personnel to key ORNL ES&H personnel, identify potential on-site hazards, and cover PPE, work practices, emergency preparedness, hazard communications, and site operational procedures. The Bechtel Team provides training for first responders; emergency response is primarily coordinated through the ORNL LSS.

In accordance with OSHA requirements of 29 CFR 1910.120, all employees assigned to work in hazardous waste areas must receive a minimum of 40 hours of training off site before job assignment and, at the time of job assignment, 3 days of actual field experience under the direct supervision of a trained and experienced supervisor. Supervisory personnel receive this same training plus an additional 8 hours of specialized training on managing hazardous waste operations. Documentation of current training records is retained in the ES&H Manager's office area. A monthly report from the ES&H training records data base identifies personnel who are nearing retraining, and dates are then scheduled; this ensures that all site personnel who require training are trained and that records are current.

Basic OSHA training for all employees will include the following, in accordance with PP 1210, "ES&H Training":

- names of personnel and alternates responsible for site safety and health;
- safety, health, and other hazards present on the site;
- use of PPE (including respiratory protection);
- work practices for minimizing risks from hazards;
- safe use of engineering controls and equipment on the site;
- medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazards;
- site control measures;
- decontamination procedures;

- legal background for waste disposal activities;
- emergency responses;
- confined space entry procedures; and
- use of respiratory protection devices, including actual practice in using applicable devices.

On-site management and supervisors directly responsible for operations in waste areas will receive 8 additional hours of instruction in the following:

- site standard operating procedures,
- HWP applications,
- spill control techniques, and
- structure and operation of the PPE program.

11.2 WAG 10-SPECIFIC TRAINING

Employees will be trained to the requirements of this ES&H Plan for WAG 10, the project ES&H Plan, and project procedures before being assigned to work in a specific area. A WAG 10 hazards evaluation (Sect. 3) is given to notify project personnel of nonroutine or unusual hazards that may be encountered in the field. On-site training will be required before the start of work, in accordance with PP 1210, "ES&H Training." This will be done over a 3-day period under the direction of a supervisor knowledgeable regarding hazardous waste activities. Operating personnel will review and visit all applicable areas where they will work. All workers will be instructed in all health and safety procedures applicable to their work area, and in PP 1275, "Industrial Safety Practices," and companion procedures 1275.1 through 1275.12. Project personnel whose job operations require entry into confined spaces will undergo confined space entry training.

Health and Safety Specialists will receive on-site instruction in all project ES&H procedures applicable to task operations, and each will receive specific instruction in PPs 1270, "Industrial Hygiene Practices," 1270.1, "Air Surveillance of Chemical and Radiological Contaminants," and 1280, "Health Physics Practices," and its companion procedures 1280.1 through 1280.10.

11.3 REFRESHER TRAINING

Employees and supervisors will receive an 8-hour annual refresher course covering the materials of the initial indoctrination and other pertinent topics. As part of this refresher, the bulleted items in DOE Order 5480.11 for general employee training are presented.

11.4 WEEKLY "TOOL-BOX" TRAINING

To maintain a high level of safety awareness on the part of employees and supervisors, the FHSS or designee will hold weekly meetings to highlight specific safety concerns. These meetings may occasionally be replaced by more formal safety meetings, sometimes held in conjunction with other work groups. The individual conducting the training will document the content and type of training performed and submit the training roster to the Project Document Control Center (PDCC) maintained by the Bechtel Team.

11.5 VISITOR POLICY

Visitors are given abbreviated training in accordance with Sect. 4.1 of PP 1210, "ES&H Training," addressing the following topics:

- site-specific hazards,
- conduct within work areas, and
- emergency response actions.

Visitors must always be escorted by an individual who has completed the 40-hour hazardous waste operations training. Visitors who have not completed this training or applicable 24-hour training are not allowed inside CAAs.

12. HAZARDOUS WORK PERMITS

The HWP system provides authorization for specified employees to do particular tasks within WAG 10 involving exposure to radiation or radioactive contamination, hazardous chemicals, physical hazards, or other potentially dangerous work situations. The HWP system incorporates appropriate approvals for named personnel to enter areas under specified requirements. The entry and exit times for those personnel are recorded. If timed-exposure operations are involved, appropriate time and exposure data are also recorded. The HWP program is conducted in accordance with PP 1235, "Hazardous Work Permits."

12.1 CONDITIONS REQUIRING AN HWP

An HWP will be required before beginning work for which any of the following conditions is anticipated or possible:

- when an individual can receive a radiation dose equivalent in excess of 0.2 mSv (20 mrem) to the total body or 2 mSv (200 mrem) to the extremities during the work shift;
- when an individual can be exposed to a radiation dose equivalent rate greater than 1 mSv/h (100 mrem/h);
- when the airborne concentration of radioactive material is greater than 10% of the respective DAC;
- when the airborne concentrations of hazardous chemical substances are in excess of 10% of the TLV (PEL, REL);
- when a CAA is required to control the spread of known contamination and to protect observers, the public, and the environment;
- when intrusive characterization efforts can encounter radioactive or hazardous chemical contaminants of unknown types or concentrations;
- when work is performed in confined spaces; and
- when work might be conducted in oxygen-deficient atmospheres or high-noise environments, involve confined spaces, flammable atmospheres, flammable reagents, fuels, compressed gases, hazardous energy control, electrical hazards, flammable environments, or other such dangerous environments.

12.2 HWP INITIATION

Any project personnel familiar with work scheduled to be performed may initiate an HWP. After the initiator enters his name, description of work, work location, and names of involved employees, the HWP form is routed and completed as follows.

- The FHSS specifies appropriate radiation and contamination data and applicable working time limits. If hazards other than radiation or radioactive contamination are involved, the FHSS will specify industrial hygiene and safety conditions at the work location on the HWP form on the basis of industrial hygiene survey results. If necessary, special protective equipment or safety measures will be incorporated on the HWP form.
- The FSL reviews the HWP form to verify that all appropriate elements of the permit have been completed. The HWP is submitted to the ES&H Manager for staff concurrence.
- The FHSS submits the HWP with all relevant attachments to the Energy Systems/ER ORNL RI/FS Field Coordinator for Energy Systems approval.
- A copy of the approved form is returned to the originator and another is available at the work site. A copy of the approved form is also retained in an "active" file by the FHSS.
- Workers are briefed on HWP requirements and any subsequent changes.

12.3 POSTING REQUIREMENTS

Any CAA designated in an HWP must be protected by an appropriate barricade or flagging. Entry into the CAA requires the approval of the FHSS or designee, who verifies that all individuals involved meet training and medical requirements, have properly completed the appropriate log-in or log-out records, are outfitted with appropriate PPE, and understand the potential exposure hazards in the CAA.

12.4 CONTAMINATION CONTROL

If the spread of chemical or radioactive contamination is possible, appropriate PPE will be determined and PPE disposal bins and step-off pads will be established at the perimeter of the area. PP 1280.8, "Control Point Operations," specifies protocols for establishing CAAs to control the spread of radioactive contamination.

12.5 TERMINATION OF HWPs

HWPs remain active until the work is completed, any preset time limits expire, or actual field conditions differ from those stated in the HWP. If personnel exposure conditions or work practices differ significantly from those stated, the HWP will be terminated, conditions reevaluated, and a new HWP issued. Terminated HWPs are closed out and become part of the project record.

12.6 RECORD RETENTION

Upon completion of work, the FHSS or designee terminates the HWP and documents its termination on the HWP Log Sheet. The FHSS or designee documents the reason for termination on the HWP and forwards it to PDCC for proper record retention and ES&H staff distribution.

13. MEDICAL SURVEILLANCE

The RI/FS Project medical surveillance program will conform to DOE Order 5480.10, OSHA 29 CFR 1960, and OSHA 29 CFR 1910.120. Employees to be included in the medical surveillance program include (1) employees who are, or may be, exposed to hazardous substances or health hazards above the permissible exposure limit or published exposure level for more than 30 days per year; (2) employees working in activities that fall under the scope of 29 CFR 1910.120 who wear a respirator for 30 or more days a year as required by 29 CFR 1910.134; and (3) employees who are injured by overexposure from an emergency incident or who show symptoms of illness that may have resulted from exposure to hazardous substances in the course of their work. Periodic physical examinations will be offered to each employee, with the frequency of examinations related to the age of the employee and potential for exposure. The extent of these reevaluations will be determined by the consulting physician. In addition, a health status review will be made for all terminating employees.

Supplemental health assessments are required whenever there is an actual or suspected exposure to chemical contaminants in excess of applicable limits or when site personnel experience any symptoms of exposure. The Bechtel Team Industrial Hygienist, Health Physicist, and Industrial Safety Specialist will cooperate closely with consulting physicians to supply pertinent information concerning toxic materials involved, to assist in evaluating incidents of suspected exposure, and to optimize the maintenance of a healthful work environment.

Complete and specific details of the medical surveillance program are contained in PP 1205, "Medical Surveillance."

14. BIOASSAY PROGRAM

The RI/FS Project field characterization efforts will include intrusive investigations of areas of unknown but highly probable contamination potential. Given the uncertainties associated with this type of field work, the project's internal exposure monitoring program is based on the assumption that personnel will be exposed to significant quantities of radioactive or hazardous chemical contaminants. Accordingly, the internal dosimetry program will be conducted in accordance with the provisions of PP 1280.4, "Internal Radiation Dosimetry." These provisions are outlined in the following paragraphs. (Monitoring and control of internal contamination by hazardous chemical contaminants are included in the medical surveillance program, described in Sect. 13 of this document.)

14.1 BASELINE BIOASSAYS

Individuals who are assigned to field activities or who have reason to visit or inspect field activities are assigned one of the four job function categories shown in Table 14.1. All such individuals (except Category IV) must submit urine samples and must receive whole-body counting (WBC) and lung counting before participating in field activities. The baseline urine samples are analyzed for the solubility Class D and Class W compounds reasonably expected to be encountered at ORNL. WBCs are analyzed for the gamma-emitting radionuclides reasonably expected to be encountered at ORNL.

Table 14.1. Job function categories

I.	Individuals spending more than 20% of their time in CAAs where uncontained radioactive material is likely to be present.
II.	Individuals spending 5-20% of their time in CAAs where uncontained radioactive material is likely to be present.
III.	Individuals spending less than 5% (but more than 0%) of their time in CAAs where uncontained radioactive material is likely to be present.
IV.	Any individual who is not included in the above categories and who will not enter CAAs.

Results of the baseline bioassay analyses are evaluated by the project Health Physicist for evidence of previous exposure. Individuals exhibiting evidence of previous internal contamination will not be permitted to enter CAAs until an evaluation of the previous exposure indicates that additional planned radiation exposure will not result in doses in excess of applicable regulatory limits. This evaluation may include additional rigorous sampling and counting to establish the physical and temporal parameters necessary to adequately assess the committed effective dose equivalent.

14.2 ROUTINE BIOASSAY PROGRAM

The routine bioassay program is used as a measure of the effectiveness of the respiratory protection and contamination control programs. Therefore, bioassay frequency will be a function of potential exposure to airborne radioactive materials and will be based on the sampling intervals shown in Table 14.2.

Evidence of inadequate respiratory protection will be cause for an investigation of the responsible field operation(s). The ES&H Manager is responsible for investigating and identifying probable causes of the respiratory protection program failure and for recommending corrective actions.

14.3 DIAGNOSTIC BIOASSAYS

In accordance with the provisions of PP 1280.4, "Internal Radiation Dosimetry," diagnostic bioassays are used to quantify internal depositions that could result in an annual effective dose equivalent of 1 mSv (100 mrem) or an annual organ or tissue dose equivalent of 50 mSv (5 rem). The need for diagnostic bioassays is determined on the basis of routine action levels specified in PP 1280.4.

Diagnostic bioassays involve removing the exposed individual from further internal and external exposure potentials and performing the bioassays necessary to establish the physical and temporal parameters essential for estimating the committed effective dose equivalent. The individual may return to planned exposure work if it has been determined that any such planned exposure will not result in a dose in excess of regulatory limits.

14.4 TERMINATION BIOASSAYS

All individuals participating in the bioassay program are required to submit excreta samples and to receive WBCs and lung counts before they are released from the project. Results of the termination bioassay analyses are reviewed by the project Health Physicist. Individuals may be recalled for diagnostic bioassays if they exhibit unexpectedly high results that indicate a potential for exposure in excess of regulatory limits.

14.5 BECHTEL-ENERGY SYSTEMS INTERFACE

Energy Systems will provide all bioassay analytical services for the RI/FS Project. Consequently, routine and nonroutine bioassay requirements (e.g., overexposure assessments) will be closely coordinated with Energy Systems. The ES&H Manager is responsible for coordinating bioassay requirements with the ORNL ES&HC Contractor Interface Manager and will notify the ORNL ES&HC Contractor Interface Manager as soon as possible about

individuals to be included in the bioassay program and their assigned job function categories. In turn, Energy Systems will provide the ES&H Manager with copies of all analytical bioassay results for each Bechtel Team member in the program.

Table 14.2. Guide for routine sampling for those who work with radioactive material

Radioactive material	Routine sampling		
	Job function ^a Category I	Job function ^a Category II	Job function ^a Category III
²⁴¹ Pu and alpha emitters other than Class D and W uranium	Urine each 3 months, lung count each 12 months	Urine each 6 months, lung count each 12 months	Urine each 12 months, lung count each 12 months
⁹⁰ Sr and Class D and W uranium	Urine each 6 months	Urine each 12 months	Urine each 12 months
³ H	Urine twice each week	Urine twice each month	Urine each 6 months
¹³¹ I	Thyroid scan monthly	Thyroid scan each 3 months	Thyroid scan each 6 months
⁶⁰ Co and ¹³⁷ Cs	WBC each 6 months	WBC each 12 months	WBC each 12 months
All others	Consult with Energy Systems ES&H Coordinator	Consult with Energy Systems ES&H Coordinator	Consult with Energy Systems ES&H Coordinator

^aCategory defined in Table 14.1. Category IV does not require routine bioassay.

15. EXTERNAL RADIATION DOSIMETRY PROGRAM

15.1 THERMOLUMINESCENT DOSIMETRY PROGRAM

Energy Systems will provide TLD services to Bechtel Team members assigned to the RI/FS Project. Energy Systems is responsible for evaluating dosimeter response and for maintaining permanent records. Following each dosimeter exchange, Energy Systems will provide the ES&H Manager with a copy of dosimetry results for Bechtel Team members.

The ES&H Manager is responsible for evaluating exposure potentials and assigning Bechtel Team members to the TLD program. He is also responsible for evaluating exposure data to verify that exposures are maintained at ALARA levels and for ensuring that exposure data are transmitted to the appropriate Bechtel Team members. Access to data will be limited to individuals with a need to know.

15.2 SELF-READING DOSIMETER PROGRAM

Self-reading dosimeters (SRDs) (pocket ionization chambers or electronic equivalent) are used to administratively control accrual of penetrating exposure. Field measurements are used to administratively control accrual of nonpenetrating skin exposure.

These field-received dose estimates will be recorded as a function of HWP number (with location and work category) from SRDs for each individual (with job function category), to establish a data base for ALARA evaluations. Field-dose estimating protocols are instituted when the absorbed dose rates (measured in air) to the whole body, skin, forearms, and hands exceed 25 $\mu\text{Gy/h}$ (2.5 mrad/h), 0.1 mGy/h (10 mrad/h), 0.2 mGy/h (20 mrad/h), and 0.35 mGy/h (35 mrad/h), respectively.

15.3 RADIATION DOSE CONTROL PROGRAM

When the field-received dose estimate data indicate that an individual has accrued 1 mSv (100 mrem) over a 1-week period, the individual is not allowed to enter CAAs until the TLD badge is processed. The individual may be allowed to reenter CAAs only after project health physics review. (ORNL's Environmental and Health Protection Division will also be contacted.) The TLD badge data are used to update the individual's dose history (quarter, year, or life, as appropriate) and to correct the dose estimate data for ALARA evaluation purposes. The received dose estimates are then "zeroed," and the estimating protocol is reinstated. Table 15.1 shows the ORNL administrative limits that will be used on this project to ensure that personal exposure will remain below the DOE limits.

Table 15.1. Dose limits

Type of exposure	Condition	Administrative limit [mSv (rem)]	DOE limit [mSv (rem)]
Whole body	Annual effective dose equivalent	20 (2)	50 (5)
Skin of the whole body	Annual dose equivalent	150 (15)	500 (50)
Extremity	Annual dose equivalent	150 (15)	500 (50)
Organ or tissue	Annual dose equivalent	150 (15)	500 (50)
Lens of eye	Annual dose equivalent	50 (5)	150 (15)
Unborn child (entire gestation period)	Annual dose equivalent	5 (0.5)	5 (0.5)

Source: DOE Order 5480.11, *Radiation Protection for Occupational Workers*, and ORNL Health Physics Manual Procedure RP-3.1, "Radiation Protection Standards."

16. PERSONNEL AIR MONITORING

The purpose of the personnel air monitoring program is to measure approximate concentrations of chemical and radioactive contaminants in the air breathed by RI/FS Project personnel. The RI/FS Project respiratory protection program will be designed to meet OSHA and DOE requirements, and the protection factors specified for various protective devices will be considered when the actual air concentrations entering the lungs of monitored employees are evaluated.

Whenever practicable, lapel-type samplers will be used in accordance with PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants," for monitoring work activities because they reasonably approximate a true breathing-zone sample. Where higher flow rates of air than can be pulled with a lapel sampler are required, various configurations of ac-powered air pumps will be used in accordance with PP 1270.1. These air pumps will be positioned to provide the closest possible approximations to the true breathing zone.

Records of personnel exposures to concentrations of airborne contaminants will be used:

- to establish that employees are not exposed to airborne contaminants above DACs, PELs, RELs, or TLVs;
- to determine whether respirators specified are the most appropriate types for the work;
- to provide records of contaminants to which individual personnel have been exposed and estimates of exposure levels; and
- to determine whether specific ALARA actions may be appropriate.

17. ALARA PROGRAM

This section provides guidance for applying the ALARA philosophy to the ORNL RI/FS Project at WAG 10. ALARA is to be used by management (e.g., ES&H and support services) and the work force at all times to minimize exposures to chemicals and radioactive materials. ALARA principles must be stressed to project personnel to increase their awareness of how to implement those principles in day-to-day activities. This guidance may be in the form of tool-box safety meetings, procedural and mock-up training, dosimetry reports and consultation, and HWP's.

The basic ALARA philosophy for ORNL RI/FS Project activities is simply to "limit personal and environmental chemical and radiation exposures to the lowest levels commensurate with sound economic and social considerations." This basic statement presupposes that no exposure should occur without a positive net benefit, considering technological, economic, and social factors. Implicit in the ALARA philosophy is the assumption that any exposure, however small, carries with it some detriment or probability of detriment (i.e., risk), which should be balanced by a benefit. This philosophy for exposures to radiation and radioactive materials is based on the linear, nonthreshold hypothesis that detriment from radiation is directly proportional to the dose incurred and that no threshold or dose exists below which there is no detriment. This is the heart of the ALARA philosophy, and it implies that all individuals, including management and field personnel, should not stop looking for ways to minimize exposures for a given output of work, as long as the cost of the potential detrimental effect exceeds the net benefit.

A primary principle of on-the-job safety is that safety is everyone's responsibility. This principle applies also to ALARA. Day-to-day operational ALARA responsibilities are borne by all; some have additional and special responsibilities. Management is responsible for maintaining personnel to provide the technical support and assistance necessary to achieve ALARA goals, and line management adopts technical, administrative, and supervisory methods applicable to the operations under their control. Each individual worker then implements ALARA principles and procedures and can also make significant further contributions.

17.1 POLICY STATEMENT

It has been and continues to be the policy of Bechtel RI/FS management to maintain personnel exposures to radiation, radioactive materials, and chemical and other hazardous materials at ALARA levels. ALARA is to be used in procedure development, work habits, and facility and operation design to minimize both internal and external exposure. ALARA planning will apply to identifiable and quantifiable hazards regardless of type (i.e., radiological or chemical). The philosophy applies to personnel exposed occupationally in

CAAs in the field and to persons exposed due to environmental releases in uncontrolled areas.

WAG 10 operations have the potential for worker radiation exposure in excess of the ORNL ALARA goal of 0.02 Sv/year (2 rem/year) if work is conducted in the absence of administrative and engineering controls. Administrative controls are in place in the form of reviewed and compliant ES&H procedures, effective ES&H surveillance of intrusive and nonintrusive tasks, and work task review and approvals. Engineering controls will be evaluated and developed where needed to minimize worker exposure in keeping with the optimization principles of ALARA.

The project ALARA goal for WAG 10 operations is that no individual external exposure will exceed 5 mSv/year (500 mrem/year) and no individual internal exposure will exceed 0.1 mSv (10 mrem) committed (50-year) effective dose equivalent. The WAG 10 project goal for hazardous chemical exposures is that no individual exposure will exceed 10% of the PEL for any regulated hazardous chemical.

17.2 WORKPLACE ALARA EFFORTS

Judicious application of basic time, distance, physical control, and PPE principles will be used to limit exposures to ALARA levels. To verify that established control is adequate, workplace monitoring for radioactive materials and chemicals detectable by field instruments will be conducted in direct proportion to expected or observed levels of exposure. Activities that result in unexpectedly high potential exposures will be terminated until provisions are made that allow work to proceed in acceptable ALARA fashion.

HWPs are used during field activities in conjunction with approved operating procedures, engineering drawings, or FWGs. The HWP is required when there is a potential for either internal or external exposure to chemicals or radioactive materials. The FHSS notes the safety requirements on the permit, and these requirements are used by workers to minimize potential exposures.

For personnel radiological hazard assessment, an electronic personal dosimeter (if available) is worn by each individual assigned to an HWP. A whole-body penetrating dose equivalent action level is assigned to each individual before entering a CAA; an individual whose action level has been exceeded may not be assigned an electronic dosimeter. If the action level is exceeded during field operations, an audible alarm will sound and the individual will exit the area. This data base-controlled external dosimetry system is updated daily at badge exchange and maintains a record of individual daily and accumulated exposures.

For personnel and area chemical and radiological hazard assessment, initial conditions will be established for each proposed work site in accordance with PP 1220, "Initial Site

Survey," and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing, respiratory protection, and equipment requirements are established and ES&H hold points are developed for the HWP controlling the work task on the basis of initial work site conditions. The HWP is prepared in accordance with PP 1235, "Hazardous Work Permits." The administrative approval levels required in accordance with PP 1235 depend on the potential or anticipated hazard for the task.

Real-time exposure assessment will be conducted in accordance with PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." CAAs, hot lines, contamination reduction zones, and carcinogen areas will be established and posted in accordance with PP 1235, "Hazardous Work Permits"; PP 1255, "Work Area and Environmental Monitoring"; PP 1280.7, "Posting and Labeling"; and PP 1280.8, "Control Point Operations."

17.3 ALARA PROGRAM ASSESSMENT

Personnel exposure data are maintained in the Bechtel RI/FS data base (refer to the Data Base Management Plan for additional information). Recorded external and internal exposures consist of TLD badge and bioassay data, respectively. Field dose calculation, direct-reading pocket meter, and event-based lapel air sampling data are used to maintain estimates of personnel exposures to both radioactive materials and hazardous chemicals. These estimates are correlated with job-specific activities (work location and work category) and individual-specific activities (job function) (see Sect. 14).

Periodic reviews of personnel exposure estimates are conducted by the Bechtel Team Project Health Physicist to identify unfavorable trends and unexpectedly high potential exposures, as compared with the task hazards analysis (see Sect. 3). Activities (as functions of work location, work categories, and job functions) identified as resulting in chronically unfavorable trends will be investigated, and additional administrative or physical measures will be implemented as appropriate.

All unfavorable trends and unexpectedly high potential exposures must be reported to appropriate project management by the ES&H Manager who, if necessary, will stop work and provide for corrective action.

18. PERIMETER MONITORING

To verify that personnel, facilities, and the environment in areas adjoining work locations are not subject to chemical or radioactive exposure, Bechtel will routinely monitor the perimeter of these activities. The perimeter (CAA) is the boundary of the work area defined by the applicable HWP.

18.1 AIR MONITORING

When an HWP is initiated in response to existing or potential airborne contamination, perimeter air sampling must be carried out during the course of the work. Because the areas defined by HWPs generally will be relatively small, air samplers may be located in specific downwind and upwind directions that are determined when the work begins. At these locations, sampling will monitor for airborne radioactive contamination and for hazardous chemicals thought to be present.

If hazardous chemical or radioactive contamination in excess of applicable guidelines is indicated, the ORNL RI/FS Program Manager and the ORNL ES&HC Contractor Interface Manager will be notified. The area will be evacuated, and the level of PPE required to complete the task will be upgraded, if applicable. Under the guidance of ORNL's Environmental and Health Protection Division, appropriate investigations will then be carried out as quickly as possible by RI/FS personnel to identify the cause, evaluate possible exposures to persons in adjacent work areas, initiate any necessary bioassay or medical evaluations, and assess environmental impacts.

18.2 SURFACE WATER MONITORING

To the greatest extent practicable, physical and administrative controls will be used to minimize the potential for the spread of contamination through surface water runoff. If this potential exists, efforts will be made to sample and analyze water from primary runoff sources that might be contaminated. If contamination exceeding the guidelines for water discharge from the site is found, ORNL's Environmental and Health Protection Division will oversee an investigation to identify and correct the cause, evaluate possible exposure to persons in adjacent work areas and off site, and assess environmental impacts. Bechtel will initiate remedial action to decontaminate affected areas.

18.3 RADIATION ABSORBED DOSE RATE MONITORING

Daily absorbed dose rate surveys will be made of each CAA perimeter when occupied. Operations resulting in absorbed dose rates in excess of $25 \mu\text{Gy/h}$ (2.5 mrad/h) beyond the CAA boundary will be halted, the ORNL RI/FS Program Manager and ORNL ES&HC Contractor Interface Manager will be notified, and the perimeter boundary will be extended if practicable. Following notification of the ORNL ES&HC Contractor Interface Manager, immediate actions will be taken by the FHSS to mitigate such conditions. Action may include expanding the CAA perimeter, shielding, removing the source, or any combination of these, depending on the magnitude of the perimeter exposure rate(s). Work will not be allowed to continue until physical or administrative controls are instituted to ensure that perimeter absorbed dose rates are controlled to $30 \mu\text{Gy/h}$ (3 mrad/h) or less.

19. EMERGENCY ACTION PLAN

19.1 GENERAL EMERGENCY ACTION PROCEDURES

The Bechtel RI/FS Team is knowledgeable of the hazards associated with work involving potentially pressurized wells. The task hazards analysis developed for WAG 10 identifies hazards and preventive measures to reduce risk during the investigation. The Field Sampling Plan, included as Appendix A of the WAG 10 Remedial Investigation Implementation Plan, includes provisions to depressurize wellheads before well sampling activities begin. These provisions are supplemented by PP 1240, "Emergency Response."

PP 1240 specifies personnel responsibilities and actions to be taken in emergencies. The general emergency action plan requires that the person discovering an emergency take immediate action to notify other employees and supervisors. The ORNL ES&HC Contractor Interface Manager and LSS will also be notified immediately. The LSS will control and supervise the emergency response, involving Energy Systems ES&H personnel (e.g., Radiation Protection, Environmental Control) as appropriate.

Although the ORNL organization will respond to these situations, RI/FS personnel will be responsible for first response and lending support as required. The FHSS will verify that emergency notification information is available at each work area.

19.2 SITE IDENTIFICATION

Each location where RI/FS work is being conducted at WAG 10 will be accurately identified and designated on an appropriate map or in relation to a readily identifiable structure. This designation will be available at the FOF. RI/FS personnel working in the area will be responsible for knowing this designation so that requests for assistance can be made promptly and clearly. Methods for notifying other personnel (e.g., telephone numbers, radio call numbers) will also be posted as appropriate.

19.3 PROCEDURES

All procedures will be reviewed and approved by Bechtel Team management before they are implemented. Approved procedures will be submitted to the Environmental Restoration Division for Energy Systems distribution before field activities begin. The following additional factors addressed in PP 1240 may also be contained in other detailed emergency procedures to be developed:

- credible potential emergencies (e.g., preemergency planning, emergency recognition and prevention procedures, safety distances and places of refuge, and emergency treatment and first aid);
- authorities, responsibilities, and actions to be taken by site personnel;
- all situations under which the LSS will be notified for assistance;
- lines of communication and criteria for notifying RI/FS Project and ORNL personnel of emergency situations;
- resources available from off-site sources (requests for off-site assistance to be initiated by the LSS);
- provisions for radiation monitoring of injured employees, with highest priorities being given to emergency medical treatment and first aid;
- requirements for PPE, emergency, and communications equipment;
- notification to employees of emergency situations outside their immediate area of activity (e.g., notifications received through the National Warning System);
- evacuation of personnel, including details concerning
 - routes,
 - situations requiring evacuation,
 - plant emergency signals,
 - means of notifying affected personnel,
 - transportation of evacuees,
 - accountability of personnel, and
 - procedures;
- reentry planning;
- critique of response and follow-up;
- decontamination; and
- site security and control.

20. RECORDS

In addition to the personnel dosimetry records maintained by Energy Systems, Bechtel will maintain its own set of records. As appropriate, electronically retained records will be maintained on the Bechtel VAX computer system and will be designed to facilitate effective employee exposure management and timely ALARA evaluations. (Survey and instrumentation records are retained in the Bechtel PDCC.)

20.1 INDIVIDUAL MASTER RECORDS

A master record for each individual will contain at least the following information:

- personal identification number (IDN).
- full name,
- date of birth,
- sex,
- date of most recent medical evaluation.
- medical status code,
- training type IDN,
- training date,
- life-to-date whole-body dose [note that whole-body dose includes contributions from internal emitters (committed effective dose equivalents)].
- quarter-to-date whole-body dose.
- year-to-date whole-body dose.
- quarter-to-date skin dose.
- year-to-date skin dose.
- quarter-to-date extremity dose.
- year-to-date extremity dose.

- annual (for current calendar year) committed effective dose to or concentration of contaminant in:
 - organ A,
 - organ B,
 - organ Z, and
- job function category.

20.2 DOSIMETRY RECORDS

This data base will contain the recorded external radiation exposure (i.e., TLD badge data). The following minimum information will be retained:

- personal IDN,
- penetrating radiation dose, and
- nonpenetrating skin radiation dose.

20.3 EXTERNAL DOSE ESTIMATES

This secondary data base will supplement the dosimetry records and master records data bases. The following minimum information will be retained:

- personal IDN,
- HWP IDN,
- date and time of area entry,
- date and time of area exit,
- net time spent in area,
- pocket dosimeter or instrument IDN, and
- estimated exposure.

20.4 INTERNAL DOSE ESTIMATES

Internal dose estimates will be calculated from bioassay and whole-body count data. The following minimum information will be retained:

- personal IDN,
- bioassay medium,
- date of collection or measurement,
- date of analysis,
- concentration or activity of contaminants, and
- laboratory or report IDN.

20.5 EXPOSURE TO AIRBORNE CONTAMINANTS

This secondary data base will be used for administrative control of exposures to airborne concentrations of radioactive and nonradioactive hazardous chemical contaminants. The following minimum information will be retained:

- personal IDN,
- HWP IDN,
- date of measurement,
- sampler IDN,
- individual's assigned protection factor (PF),
- concentration of contaminants,
- time of exposure,
- potential (unprotected) exposure (PE),
- actual (protected) exposure (AE) (Note: $AE = PE/PF$), and
- concentration worksheet IDN.

20.6 ALARA ACTIVITY RECORDS

This secondary data base will be used to support any other data base or report requiring work location, work category, job function, exposure, or temporal data.

20.7 SUPPLEMENTAL DATA BASES

Supplemental data bases will be required to provide complete record sets and to support the foregoing data bases. The required data sets are

- HWP information file,
- respirator use file,
- medical history file, and
- training history file.

Though all records will be maintained by Energy Systems, hard copies of supporting primary records (e.g., TLD and bioassay reports, NRC 4 forms, air sample worksheets, calibration certificates, training tests, and course outlines) will also be retained by Bechtel. All records will be maintained until completion of the project, at which time a copy of all records will be provided to Energy Systems.

21. ANALYTICAL SAMPLE PACKAGING AND SHIPMENT

Samples of waste, soil, sediment, biota, and water collected for analysis at WAG 10 will be packaged and transported in accordance with DOT regulations, EPA regulations, and Energy Systems protocols, as defined in PP 1260, "Hazardous Materials Transportation."

21.1 REGULATORY REQUIREMENTS

The regulatory requirements in 49 CFR 171 et seq. that apply to transportation of samples to and from the area will be strictly followed. Specific exemptions for transport of chemical samples are defined in 40 CFR 261.4(d). Samples meeting the levels of exempt. limited quantity, or low specific activity will be packaged in strong, tight containers.

21.2 RESPONSIBILITIES

The ES&H Manager is responsible for developing sample packaging and transportation procedures; developing, testing, or procuring DOT containers as appropriate; and ensuring compliance with regulatory requirements. Because ORNL has ultimate responsibility for compliance with regulations, Energy Systems will exercise oversight authority to verify compliance.

The FSL is responsible for characterization of samples and proper labeling in accordance with approved procedures. The Transportation Officer is responsible for verifying that samples are appropriately packed, that sample containers are properly labeled, that accurate sample identification data are entered into the appropriate data base, and that samples are delivered to their shipping destination. Bechtel will be responsible for shipping and for maintaining records of samples on behalf of and in the name of Energy Systems and DOE.

21.3 SAMPLE SCREENING TECHNIQUES

Sample screening for chemical contaminants may include historical data as well as the results of field monitoring for toxic and explosive atmospheres. Radiological screening consists of a review of field monitoring data, direct exposure rate measurements of each sample, gross alpha/beta counting, and gamma spectroscopy analysis, as necessary, in a field laboratory. These screening techniques are described in CSL procedures and in PP 1260.1, "Determination of Hazardous Materials Classification."

21.4 PACKAGING AND LABELING

Samples will be packaged for shipment in containers appropriate for the hazard class they represent and in accordance with requirements of 49 CFR. For samples transported by the Bechtel Team, an exclusive-use vehicle will be employed.

22. HAZARD COMMUNICATION PROGRAM

The hazard communication program informs RI/FS Project employees of the hazardous chemicals used in the conduct of operations. Within this program is a basic overview of the types of hazardous chemicals, their storage or use locations, the location of information concerning these chemicals, and the location of written programs and procedures associated with employee protection.

Regardless of the plans, procedures, documents, and programs, each employee is responsible for knowing what chemicals are used to perform a job, for obtaining available pertinent information, and for using chemicals safely.

Each employee engaged in work associated with the RI/FS Project will be provided with written information regarding this hazard communication program. Employees of subcontractors to the Bechtel Team will also be provided with this information and a copy of the most recent hazardous materials list and any changes made in it during the period of performance of the contract. On request, subcontractor-designated safety representatives will be provided copies of all material safety data sheets (MSDSs) applicable to the hazardous materials list.

Subsections 22.1 through 22.9 describe the requirements, procedures, training, and information about hazardous substances involved in the RI/FS Project.

22.1 WARNING LABELS

Warning labels are applied to containers of chemicals. The warning label system used for chemicals is a nonstandardized system; the labels vary in appearance and content, but they contain at least the following information:

- identity of the hazardous agent or material;
- appropriate hazard warnings; and
- name and address of manufacturer, importer, or other responsible party.

Any employee who uses or handles chemicals must read these labels. If the employee does not understand the label, *the employee shall not use the chemical or agent*. The individual's immediate supervisor will be contacted to determine the necessary requirements.

Temporary or secondary containers will bear the identity of the chemicals and appropriate hazard warnings. All drums containing hazardous chemicals will be marked with

the NFPA diamond. This label gives information at a glance regarding flammability, reactivity, and degree of health hazard for the chemical.

The FHSS will be notified immediately if labels become defaced or damaged. The chemicals in the container are not to be used until the label has been restored.

22.2 HAZARDOUS MATERIALS LIST

A list of hazardous chemicals currently in use on this project is maintained at the FOF at ORNL, Building 6565A. These documents are available for employee viewing or copying at the FOF. Should a chemical be discovered that is not on this list, it is to be reported to the FHSS immediately.

The potential hazardous chemicals located at the ORNL site within the immediate site work area are evaluated and listed in Appendix C, and a copy of this document is available at the FOF.

22.3 MATERIAL SAFETY DATA SHEETS

An MSDS is available for each hazardous agent or chemical used. As materials are procured or purchased for project use, MSDSs for these substances are obtained before acceptance, storage, or use. Old or outdated MSDSs are discarded as new safety and health data are obtained. MSDSs are discarded when the chemical they represent is no longer used or stored at the FOF.

These documents are available at the FOF for employee use. Upon written request, employees may receive personal copies of the MSDSs for hazardous materials in their work areas.

22.4 HAZARDS OF NONROUTINE TASKS

The purpose of this project is to locate, characterize, and evaluate environmental and public health hazards and impacts. Therefore, field work is intensely monitored for chemical, radiological, and physical hazards. The tasks with the highest potential for encountering a hazardous material are attended full-time by a qualified Health and Safety Specialist.

Before initiation of a nonroutine task, the FHSS will conduct a briefing, appropriately documented as described in PP 1265, "ES&H Recordkeeping," on the hazards associated with the task and the protective measures to be used. Additionally, the weekly tool-box safety meeting may be used as a vehicle for the distribution of hazards data.

While engaged in field work as part of the RI/FS Project, employees may encounter hazards that are not related to their work. These hazards are evaluated and listed in each task HWP, available to employees at the FOF.

22.5 EMPLOYEE INFORMATION AND TRAINING

The following general operations at ORNL involve hazardous materials:

- drilling—fuels, lubricants, alcohols, cements, grout;
- sample handling and analysis—acids, sodium hydroxide solution, organic solvents, radioactive materials;
- decontamination—detergents, alcohols, nitric acid;
- health and safety instrument calibration—methane, isobutylene, radioactive materials, chlorinated solvents, carbon monoxide, hydrogen sulfide; and
- housekeeping—ammonia, ethylene diamine tetra acetic acid, disinfectants, detergents.

22.6 STORAGE LOCATIONS FOR HAZARDOUS MATERIALS

Hazardous materials are stored in appropriate and compatible containers either at the point of use or at designated issue points as follows:

Location	Material	Custodian
Building 6556A	Commercial and consumer cleaning supplies	FSL
Storage trailer 1	Petroleum fuels in safety cans, isopropanol, lubricating oils, chlorine bleach, detergent powders, adhesives	FSL
Storage trailer 2	Lead bricks, stannous chloride smoke tubes, lubricating oils, residual gasoline in generators	FSL/FHSS
Container prep	Nitric acid, sodium hydroxide, hydrochloric acid	Lab Supervisor or Instrumentation Specialist

Location	Material	Custodian
ES&H instrument trailer	Hydrogen compressed gas, isobutylene, carbon monoxide, hydrogen sulfide, compressed air, methane, radioactive materials sources, trichloroethylene	FHSS
Satellite accumulation area (controlled access area)	Up to 55 gal of hazardous wastes or up to 1 quart of acutely hazardous waste	FHSS
Special techniques lab (restricted area)	Biohazardous materials, carcinogenic dyes, liquid scintillation fluors, acids, bases, chromatographic standards, radioactive materials, methyl alcohol, phenols, hydrogen compressed gas, helium compressed gas	Lab Supervisor or ES&H Manager
Counting lab (restricted area)	P-10 compressed gas, nitrogen refrigerated liquid, radioactive materials	Lab Supervisor
Sample prep lab (restricted area)	Acids, bases, volatile organic standards, scintillation fluors, organic solvents, detergents, radioactive materials	Lab Supervisor
Decontamination trailer SWSA 6 (restricted area)	Isopropanol, detergents, lubricating oils, radioactive materials	Decontamination Supervisor

Restricted areas require the custodian's authorization for entry and may or may not require HWP sign-in. CAAs require HWP sign-in and authorization by the FHSS. Hazardous materials may be temporarily located at points of use other than those listed above. This listing is a general guide to locations of hazardous materials found in use or in storage.

22.7 TRAINING

All employees engaged in field work are required to be trained as described in PP 1210. "ES&H Training." No employee will be allowed to enter a hazardous materials area or to work with a hazardous material without completion of the following training:

- initial site entry training—48 h.
- Energy Systems general employee training—4 h.
- initial RI/FS site briefing—not less than 2 h. and
- annual refresher training (if applicable)—8 h.

Each employee is provided with a training manual containing a detailed description of the RI/FS ES&H organization, the hazard communication program, and MSDSs and how to use them. Further information on employee training is contained in PP 1210, "ES&H Training." As required by PP 1210, each employee will receive approximately 16 hours of training in the use of PPE.

The initial RI/FS site briefing will inform employees of the specific hazards associated with the use of hazardous materials in job performance and the specific potential hazards resulting from their job task at WAG 10.

Weekly tool-box safety meetings will be used to communicate hazards information to the employees.

Before allowing employees to use a hazardous chemical for the first time, the supervisor is responsible for providing training on the proper handling, use, disposal, and protective measures associated with that particular chemical or agent. The FHSS is responsible for providing necessary training and for documenting that training has been provided in accordance with PP 1210, "ES&H Training," and PP 1265, "ES&H Recordkeeping." Employees who may not be familiar with the protective measures necessary to handle hazardous chemicals are responsible for seeking appropriate training from their supervisors or the FHSS. Hazard communication conducted through training will be documented in accordance with PPs 1210 and 1265.

22.8 ADDITIONAL EMPLOYEE PROTECTION TRAINING

On the RI/FS Project, the FHSS or his designee will conduct weekly safety meetings to convey hazardous material data to field personnel in a discussion format. The FHSS, ES&H Manager, or FSL may require additional training of individual employees engaged in nonroutine tasks or those required to use nonroutine PPE. This training will be on an individual basis and will be tailored to the hazards and PPE required to safely conduct the task. Training sessions and safety meetings will be documented in accordance with PPs 1210 and 1265.

22.9 EMPLOYEE PROTECTION MEASURES

Each use of hazardous material (as defined in 29 CFR) with a potential for employee exposure at or near the federally defined PEL or TLV, as defined by ACGIH, requires an HWP. In areas where radioactive materials are handled, where employees could be exposed to 10% of the DAC, or where absorbed dose rate levels could exceed 2.5 mrad/h, an HWP will also be required. As part of the process of issuing an HWP, protective measures, monitoring requirements, and work methods are set by ES&H to minimize employee exposure. The 1200 series project procedures associated with this process are available to employees at the FHSS's office or at the ES&H Manager's office. Standard protection data (including exposure symptoms, effects, routes of entry, etc.) are available through the FHSS. Texts include the RTECS directory and NIOSH/OSHA occupational health guidelines.

23. CHEMICAL HYGIENE PLAN

23.1 SCOPE AND APPLICATION

In accordance with 29 CFR 1910.1450, the chemical hygiene plan outlines the methods the Bechtel Team will use to limit exposure of workers to hazardous chemicals in the CSL to ALARA levels. This plan applies to all activities conducted within the CSL complex where exposure to hazardous chemicals is possible.

This plan will be provided to all laboratory workers and posted conspicuously in all laboratory buildings and spaces. Appendix D provides general safety principles for laboratory practice.

23.2 INITIAL AND PERIODIC MONITORING OF LABORATORIES AND WORKERS

23.2.1 Monitoring of Laboratory Spaces

Laboratories will be monitored by the ES&H Department in accordance with

- PP 1255, "Work Area and Environmental Monitoring";
- PP 1270, "Industrial Hygiene Practices";
- PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants";
- PP 1280, "Health Physics Practices"; and
- PP 1280.1, "Methodology for Performing Radiological Contamination Surveys."

The work environment will be initially monitored upon the establishment of new work areas or techniques or the introduction of new hazardous chemicals. Continuous radiological air monitoring has been established in laboratory spaces designated for preparing samples for radiological procedures. At least monthly, the ES&H Department will conduct radiological and chemical surveys of each laboratory and hazardous chemical storage area. In addition, the ES&H Department will conduct spot surveys and both area and personnel air monitoring when new laboratory procedures or new laboratory reagents are introduced.

23.2.2 Monitoring of Laboratory Workers

Laboratory workers will be classified as Level 1 access in accordance with PP 1202, "Site Access Requirements." They will be participants in the medical surveillance and bioassay programs as specified in PP 1205, "Medical Surveillance," and PP 1280.4, "Internal Radiation Dosimetry Program." External exposure to ionizing radiation will be monitored in accordance with PP 1280.3, "External Radiation Dosimetry," and PP 1280.6, "Use of Pocket Meters."

Personnel exposure to hazardous chemicals will be assessed quarterly. Methods of assessment will be in accordance with PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants."

23.3 TERMINATION OF MONITORING

Monitoring of laboratory spaces and laboratory workers for a particular hazardous chemical may be suspended or terminated when

- use of hazardous chemicals is terminated, and
- sampling results demonstrate statistically that at the 95% confidence level, exposures are less than 10% of the applicable limit for the hazardous chemical or that the exposure did not exceed the action level.

These provisions do not apply to monitoring for radioactive materials.

23.4 EMPLOYEE NOTIFICATION OF MONITORING RESULTS

The results of monitoring and surveys conducted in laboratory spaces will be posted conspicuously in each space no later than 15 days from the date of data availability.

Employees may have access to the results of personnel monitoring results in accordance with PP 1265, "ES&H Recordkeeping."

23.5 STANDARD OPERATING PROCEDURES

All methods, protocols, techniques, and tests conducted in the CSL will be controlled by project procedures or nationally recognized analytical procedures (EPA, NIOSH, etc.). Methods, protocols, techniques, and tests that are not addressed by written and approved laboratory procedure or that involve reagents or chemicals other than those specified by procedure are unauthorized. No unauthorized work will be conducted in the CSL.

Project procedures controlling laboratory work will be reviewed by the ES&H Department for safety and health considerations. The ES&H Manager will concur on all laboratory procedures.

Appendix D contains the general principles for laboratory work safety as they apply to the CSL. While hazardous chemicals or hazardous materials are present in the laboratory spaces, these areas will be designated CAAs and will be controlled in accordance with PP 1235, "Hazardous Work Permits." Where so designated, the HWP will delineate health and safety requirements beyond the general principles of laboratory work safety.

23.6 ENGINEERED CONTROLS FOR LIMITING EXPOSURES

23.6.1 Fixed Facilities

23.6.1.1 Close Support Laboratory: Sample preparation laboratory (Bldg. 6556G)

- **Potential hazards:**
 - ionizing radiation (external exposure);
 - internal radionuclide deposition through inhalation, ingestion, and absorption;
 - inhalation of volatile organic compounds from contaminated compounds;
 - skin absorption of volatile, semivolatile, and nonvolatile organic compounds from contaminated samples;
 - vapors, mists, and fumes resulting from the use of nitric acid, hydrochloric acid, sulfuric acid, sodium hydroxide, sodium thiosulfate, and zinc acetate; and
 - vapors from preparation and storage of standards and reagents used to make gas chromatograph (GC) standards including toluene, benzene, xylene, trichloroethylene, and trichloroethane.
- **Engineering controls:**
 - Engineering controls for minimization of inhalation hazards are in place and functioning. Two operational fume hoods are located in the facility, each with a minimum of 125 linear feet per minute (lfm) face velocity with the sash opening set at 14 in. The total volume of air drawn by both hoods results in >10 total air exchanges per hour. Existing laboratory standard operating procedures (SOPs) require that all sample handling and chemical or physical preparation activities be conducted in a hood.
 - Flammable material storage cabinets are to be used to contain flammable and volatile hazardous chemicals. These cabinets will be grounded to prevent a static electrical ignition source. The laboratory will be a no-smoking area because the cabinets are vented to the lab work area. (The cabinet vents to the ambient

atmosphere inside the lab because of the significant negative pressure differential between the outside and the lab.) Inorganic chemicals are stored in tightly closed containers in floor-level cabinets. Acids are stored separately in an acid-resistant storage cabinet.

- Fixed-position alpha particle and beta/gamma particulate monitors are installed near the solids preparation hood. Alarm points for these monitors are to be set at 1 DAC (averaged over an 8-h period) for plutonium-239 and strontium-90. Alarm conditions require evacuation of the facility and special monitoring for reentry.

23.6.1.2 Close Support Laboratory: Special techniques laboratory (Bldg. 6556F)

- **Potential hazards:**

- ionizing radiation (external exposure);
- internal radionuclide deposition through inhalation, ingestion, injection, and absorption;
- inhalation of volatile organic compounds from contaminated samples;
- skin absorption of volatile, semivolatile, and nonvolatile organic compounds from contaminated samples;
- inhalation of volatile organic compounds from liquid scintillation counting reagents;
- inhalation or injection of pathogenic bacteria and viruses from contaminated samples; and
- vapors from standards and reagents used to make GC standards, including toluene, benzene, xylene, trichloroethylene, and trichloroethane.

- **Engineering controls:**

- Engineering controls for the abatement of inhalation hazards are in place and functioning. Two operational fume hoods are located in the facility each with a minimum of 125 lfm face velocity. The total volume of air drawn by both hoods results in > 10 total air exchanges per hour. Existing laboratory SOPs require that all sample handling and work with reagents or standards be conducted in a hood.
- Storage of flammable and volatile hazardous chemicals in quantities greater than needed for immediate use is prohibited. A laminar-flow, high-efficiency, particulate-air-filtered cabinet is used to isolate workers from samples and media during microbiological work. The cabinet is certified by the manufacturer for National Institutes of Health Level P2 isolation.

23.6.1.3 Close Support Laboratory: Radiological counting laboratory (Bldg. 6556H)

- **Potential hazards:**
 - ionizing radiation (external exposure); and
 - internal radionuclide deposition through inhalation, ingestion, and absorption.
- **Engineering controls:**
 - Two fume hoods, not currently in use, are located in the facility and have been converted to isolated work space. Laboratory SOPs require that samples be delivered for counting in prepared and fixed form to this laboratory.
 - Storage of flammable and volatile hazardous chemicals in quantities greater than needed for instrument maintenance use is prohibited. Fixed-position alpha particle and beta/gamma particulate monitors are not installed in the general work area because of the fixed nature of the materials counted.

23.6.2 Verification of Engineered Controls Function

The ES&H Department will conduct weekly inspections of each fume hood for operability and will make monthly measurements of face velocity on each hood to verify sash-position markings and filter condition. Hoods failing to maintain required sash velocity will be removed from service until repairs are made and testing demonstrates the hoods to be adequate.

23.6.3 Verification of Installed Safety Equipment

Safety equipment in each laboratory consists of A-B-C type fire extinguishers, safety shower/eye wash combinations, and first aid kits. The locations of safety shower/eye wash stations will be identified by signs consistent with those in use at ORNL. Barricades, signs, labels, and other equipment will be installed as hazards are identified.

The ES&H Department will test safety shower/eye wash combinations weekly and record the test on the form attached to each unit.

Fire extinguishers will be inspected monthly by the ES&H Department and serviced annually by the ORNL Fire Department.

First aid kits will be inspected at least monthly by the ES&H Department.

23.7 LABORATORY WORKER INFORMATION AND TRAINING

23.7.1 General Training Requirements

Laboratory workers will be trained as Level I access personnel and will receive 40 hours of basic health and safety training. Three days of on-the-job training will be conducted under the supervision of the CSL Supervisor. These workers will also be trained by the CSL Supervisor in the specific requirements of each technique or method to be used.

Laboratory workers will be trained initially and annually regarding the project's hazard communication program.

23.7.2 Job-Specific Chemical Agent and Technique Training

As techniques and hazardous chemical usage change in the laboratory facility, the Laboratory Supervisor and the FHSS will provide additional training as needed and appropriate. This training will include (but not be limited to)

- PELs, RELs, and TLVs for chemicals in the work area;
- signs and symptoms associated with exposure to chemicals in the work area;
- location and availability of known reference material regarding the safe handling, storage, and disposal of hazardous chemicals found in the laboratory, including MSDSs;
- physical and health hazards associated with chemicals in the work area;
- methods and observations that can be used to detect the presence or release of a hazardous chemical; and
- worker protective measures, including protective devices and emergency measures to be used in the event of a release of hazardous chemicals in the work area.

Training will be documented as specified in PP 1210, "ES&H Training."

23.7.3 Information Available to Workers

Laboratory workers will have access to MSDSs through the project's hazard communication program. If needed and upon written request, the ES&H Department will provide MSDSs and additional data concerning specific chemicals that may be handled in the CSL.

23.8 MEDICAL SURVEILLANCE

All laboratory workers will participate in the project's medical surveillance program. The details of this program are contained in PP 1205, "Medical Surveillance."

23.9 PERSONAL PROTECTIVE EQUIPMENT

PPE for each laboratory operation will be specified by the HWP controlling individual laboratory spaces. All laboratory workers will be required to use at least PPE Level 1, as discussed in PP 1230, "Personal Protective Equipment."

23.10 INDIVIDUAL RESPONSIBILITIES

23.10.1 Program Manager

The RI/FS Program Manager is responsible for overall implementation of the project's plans and procedures. The Program Manager provides continuous support to the project's chemical hygiene plan.

23.10.2 Environmental, Safety, and Health Manager

The RI/FS ES&H Manager is responsible for implementing the health and safety aspects of this plan. The ES&H Manager is responsible for work area and worker exposure monitoring, engineering controls evaluations and approvals, laboratory procedure review and concurrence, and industrial hygiene and health physics services to the laboratories. The ES&H Manager functions as the Chemical Hygiene Officer for the project. The ES&H Manager may delegate tasks associated with chemical hygiene to members of the ES&H professional staff and may seek guidance and assistance from the Bechtel corporate Safety and Health Organization as necessary.

23.10.3 Technical Support Lead

The Technical Support Lead is responsible for ensuring that the CSL Supervisor develops and implements laboratory operating procedures, specifies laboratory equipment and materials, and ensures compliance by the laboratory staff with all applicable project ES&H procedures and the provisions of this plan.

23.10.4 Field Support Lead

The FSL is responsible for providing maintenance and facility resources to the CSL complex in support of this plan.

23.10.5 Close Support Laboratory Supervisor

The CSL Supervisor is responsible for the daily implementation of this plan within the CSL complex. The CSL Supervisor is responsible for training the individuals under his charge in safe laboratory techniques and ensuring compliance in the laboratory with the provisions of HWP's and this plan.

23.10.6 Field Health and Safety Supervisor

The FHSS is responsible for day-to-day on-site ES&H support to the CSL complex. In this capacity, the FHSS is responsible for ES&H training on applicable plans, procedures, and regulations; work area and worker monitoring; issuance of HWP's associated with laboratory work; and coordination with the CSL Supervisor on ES&H matters associated with laboratory operations. The FHSS will designate a Health and Safety Specialist who is familiar with and able to respond to the potential hazards of field activities when the FHSS is off site. (The Project Health Physicist or Industrial Hygienist will possess command authority.)

23.10.7 Laboratory Workers

Laboratory workers are responsible for the safe conduct of laboratory operations, including strict adherence to laboratory procedures and HWP provisions. Laboratory workers are responsible for maintaining housekeeping in their respective laboratory spaces, for being knowledgeable about the hazardous chemicals and agents used in job performance, and for obtaining information related to their safe use.

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APPENDIX A
INVENTORIES OF RADIONUCLIDE CONSTITUENTS IN WAG 10

Inventories of Radionuclide Constituents in Wag 10

Location	Waste form	Major contaminants	Inventory (Ci)	Volume (L) ^a
Leak site-OHF observation well	Soil	⁹⁰ Sr	0.72	Unknown
Leak site-OHF grout release	Soil	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ¹⁰⁶ Ru	Unknown	Unknown
ILLW/LLW transfer line	Soil	Unknown	Unknown	Unknown
	Groundwater	Unknown	Unknown	Unknown
OHF impoundment	Surface water	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ¹³⁴ Cs	0.071	245,000
	Sediment	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ¹³⁴ Cs	150	55,000
	Soil	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ¹³⁴ Cs	11.7	Unknown
OHF surface facilities				
Waste pits	Liquid	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ²³⁹ Pu ²³⁸ Pu, ²⁴¹ Am, ²⁴⁴ Cm	0.1	20,000
	Grout	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ²³⁹ Pu ²³⁸ Pu, ²⁴¹ Am, ²⁴⁴ Cm	Unknown	62 ^b
NHF surface facilities				
Emergency waste storage tank	Liquid	Unknown	Unknown	Unknown
	Sludge	Unknown	Unknown	Unknown
Pilot sluicing tank	Liquid	Unknown	Unknown	Unknown
	Sludge	Unknown	Unknown	Unknown
Tank T1	Liquid; sludge	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	1,000	32,710;4,200
Tank T2	Liquid; sludge	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	1,000	33,280;4,200
Tank T3	Liquid; sludge	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	1,000	2,200;4,900
Tank T4	Liquid; sludge	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	1,000	31,060;4,900
Tank T9	Liquid; sludge	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	600	5,670;2,200
Process Waste Sludge Basin	Surface water	Unknown	Unknown	Unknown
	Sediment	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	20-30	824 ^b
	Soil	Unknown	Unknown	Unknown

^aVolume: 1 L = 0.26 gal.

^bThis volume is reported in m³ (1 m³ = 35.31 ft³).

Appendix C (continued)

Sources: Francis, C. W. and L. K. Hyder 1987. *Investigations for Contamination in Cores of Bedrock Taken Under Two Waste Impoundments at Oak Ridge National Laboratory*, ORNL/RAP/LTR-87/21, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

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APPENDIX B

RADIOLOGICAL SURFACE CONTAMINANTS AND LEVELS FOR W/AG 10

Radiological Surface Contaminants and Levels for WAG 10

Location*	Major contaminants	Level		
		Direct (mrad/h)	Smearable (per 100 cm ²)	
			(dpm)	(mrad/h)
OHF surface facilities				
Building 7852	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	0-4000	0-102	0.85-35*
Building 7853	Unknown	Unknown	Unknown	Unknown
Pump house	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	0-8000	< 20	0.5-16*
Waste pits	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ²³⁹ Pu	10-40	Unknown	Unknown
T-5 water tank	Unknown	Unknown	Unknown	Unknown
Pump house	Unknown	Unknown	Unknown	Unknown
NHF surface facilities				
Building 7860	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, TRU	5-2000	Unknown	Unknown
Building 7863	Unknown	Unknown	Unknown	Unknown

Source: Huang, S. F. et al. 1984. *Preliminary Radiological Characterization of the Old Hydrofracture Facility at Oak Ridge National Laboratory*, ORNL/CF-84/202, Oak Ridge, Tenn.

*See Huang et al. (1984) for locations and individual readings per building and/or structure.

APPENDIX C
CHEMICAL CONTAMINANTS, INVENTORIES, FORMS,
AND VOLUMES FOR WAG 10

**Chemical Contaminants, Inventories, Forms,
and Volumes for WAG 10**

Location	Waste form	TCL contaminants	Inventory (kg) ^a	Volume (L) ^b
OHF Impoundment	Surface water	Sb	< 74	245,000
		As	< 1	
		Ba	132	
		Be	1	245,000
		Cd	< 1	
		Ca	6,444	
		Cr	5	
		Cu	< 5	
		Cu	< 5	
		Fe	2,266	
		Pb	< 1	
		Mg	2,203	
		Mn	49	
		Hg	< 1	
		Ni	< 15	
		K	1,593	
		Se	4	
		Ag	< 17	
		Na	< 123	
		V	< 7	
		Zn	33	
		Phenols	< 0.1	
		Endrin	< 0.1	
		Methoxychlor	< 0.1	
		Toxaphene	< 0.5	
		PCBs	< 0.1	
	Sediments	Sb	< 4	55,000
		As	< 2	
		Ba	6	
		Cd	< 0.1	
		Cr	7	

Location	Waste form	TCL contaminants	Inventory (kg) ^a	Volume (L) ^b
OHF Impoundment (continued)		Co	0.4	
		Cu	3	
		Fe	403	
		Pb	<3	
		Mn	7	
		Ni	3	
		Se	<5	
		Ag	<1	
		V	2	
		Zn	3	
		PCBs	0.5	
Tank T1	Liquid	Unknown	Unknown	32,710
	Sludge	Unknown	Unknown	4,200
Tank T2	Liquid	Unknown	Unknown	33,280
	Sludge	Unknown	Unknown	4,200
Tank T3	Liquid	Unknown	Unknown	2,200
	Sludge	Unknown	Unknown	2,900
Tank T4	Liquid	Unknown	Unknown	31,060
	Sludge	Unknown	Unknown	4,900
Tank T9	Liquid	Unknown	Unknown	5,670
Process Waste Sludge Basin	Surface water	Unknown	Unknown	Unknown
	Sediments	Unknown	Unknown	Unknown
	Soil	Unknown	Unknown	Unknown

^aInventory: 1 kg = 2.20 lb.

^bVolume is reported in liters unless otherwise noted (1 L = 0.26 gal).

Sources: Francis, C. W. and O. M. Sealand 1987. *Concentrations of Radionuclides in ORNL Waste Pond Sediments and Their Leaching Characteristics*. ORNL/RAP/LTR-87/70, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

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APPENDIX D
GENERAL SAFETY PRINCIPLES FOR LABORATORY PRACTICE

GENERAL SAFETY PRINCIPLES FOR LABORATORY PRACTICE

The following constitute the general safety rules for operations conducted in the CSL complex. Additional provisions, restrictions, and requirements can be found in the HWP controlling area operations and the individual laboratory procedures. These principles are in addition to other established safety work rules currently in force.

Avoidance of "Routine" Exposures

- Eating, drinking, and use of tobacco or cosmetics are not permitted in any laboratory space. Food, cosmetics, and beverages will not be stored in laboratory spaces.
- Spills of chemicals or sample materials are to be reported to the FHSS immediately. Upon notification, the FHSS will contact the ES&H Manager and the ORNL Laboratory Shift Supervisor. In the event of a spill of hazardous chemicals or radioactive materials, the laboratory is to be evacuated and ES&H notified. If possible, the spill should be stopped and contained.
- Chemicals are not to be smelled or tasted. Any apparatus that discharges toxic vapors or gases is to be operated in a fume hood or vented to a hood sash.
- Pipetting or starting a siphon will not be performed by mouth.
- Fume hoods (where installed) are to be operated whenever the laboratory spaces are occupied or when they are used to store uncontained hazardous materials.
- Continuous air monitors (where installed) are to be operated whenever radioactive materials are present in the laboratory spaces.

Selection of Chemicals and Methods

- Procedures will be developed so that chemicals of lowest hazard are used where practicable.
- Laboratory procedures, equipment, and instruments will be selected, procured, or developed so that hazardous chemical discharge and safety hazards are minimized.

Equipment and Glassware

- Damaged glassware and equipment are not to be used.
- Evacuated glassware (such as dewar flasks) is to be handled with care. Dewars not equipped with fragmentation protection (armor) are not to be used in the CSL.

- All used glassware is to be considered contaminated with hazardous agents until decontaminated.
- Under no circumstances will laboratory glassware be used for the preparation or consumption of foodstuffs or beverages.

Personal Protective Equipment

- Level 1 PPE is to be used by all workers in the laboratory complex. Use of basic eye protection is required at all times. Use of safety shoes is mandatory.
- Appropriate gloves are to be used whenever chemicals or samples are being handled. Gloves will be inspected and tested before each use.
- Contact lenses are forbidden in laboratory spaces.
- Additional PPE specified in the controlling HWP is mandatory.

Housekeeping

- Work areas are to be kept clean and uncluttered. Work areas are to be clean and orderly at the completion of each day's operation.
- All chemicals and apparatus are to be clearly and properly labeled.

Unattended Operations

- Only automatic or computer-supervised systems that are fail-safe will be permitted to operate unattended.

Use of Fume Hoods

- Fume-hood use is mandatory at any time that work is conducted with unknown materials or with chemicals with a PEL or TLV of 50 ppm or less.
- Fume-hood use is mandatory for any operation that might release toxic vapors, fumes, mists, dusts, or gases.
- Ready stocks of hazardous chemicals will be kept in fume hoods or in specified cabinets.
- When not in use, hoods will be on and sashes closed while the laboratory space is occupied.

Eyewash Facility

- Eyewash stations will be installed and maintained in the laboratory.
- Laboratory personnel will be trained in the use of the eyewash.

Waste Materials and Waste Management

- No waste material containing toxic materials, explosive or reactive materials, or concentrated acids or bases will be discharged into the laboratory drains. These materials are to be collected separately and handled in accordance with PP 1401, "Waste Categorization for Solid Waste," and PP 1402, "Waste Handling."
- Spills, accidents, and emergencies will be responded to in accordance with PP 1406, "Management of RCRA Hazardous Waste Accumulation Areas."
- All spills will be reported to the ORNL Emergency Response Center.

APPENDIX E

TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS

TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS

Historical Overview of Site

This appendix expands on the hazards and methods to protect personnel from those hazards as identified in previous site work or background information. This assessment was conducted with the EPA computer program HASP (1992). For a thorough overview of historical information concerning the site, see the following documents:

Preliminary assessment:

Huang, S. F. et al. 1984. *Preliminary Radiological Characterization of the Old Hydrofracture Facility at Oak Ridge National Laboratory*. ORNL/CF-84/202. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Site inspection report:

Records of site inspections done under the current scope of work being done by the Bechtel Team were used to provide background information. The site inspections pertinent to WAG 10 were done in 1988, 1989, and 1992.

Task by Task Risk Analysis

The evaluation of hazards is based on the knowledge of site background presented in earlier chapters and anticipated risks posed by the specific operation.

The following subsections describe each task/operation in terms of the specific hazards associated with it.

The following table provides a summary of task analysis and chemical hazards for each task at the site.

Task Analysis Chemical Hazards of Concern

Contaminant	TLV/IDLH	Postulated source/concentration (ppa.)	Routes of exposure
Site Walk-through			
Polychlorinated biphenyls	TLV: 0.5 mg/m ³ for chlorodiphenyl (54% chlorine). Skin. [(C) ACGIH, 1986] IDLH: Not applicable, potential human carcinogen. (NIOSH, 1987)	Groundwater: 350 to 1500 Lagoons: 350 to 1500	Inhalation Ingestion Contact Absorption
Site Survey			
Polychlorinated biphenyls	TLV: 0.5 mg/m ³ for chlorodiphenyl (54% chlorine). Skin. [(C) ACGIH, 1986] IDLH: Not applicable, potential human carcinogen. (NIOSH, 1987)	Groundwater: 350 to 1500 Lagoons: 350 to 1500	Inhalation Ingestion Contact Absorption
Perimeter Monitoring			
Polychlorinated biphenyls	TLV: 0.5 mg/m ³ for chlorodiphenyl (54% chlorine). Skin. [(C) ACGIH, 1986] IDLH: Not applicable, potential human carcinogen. (NIOSH, 1987).	Groundwater: 350 to 1500 Lagoons: 350 to 1500	Inhalation Ingestion Contact Absorption
Groundwater Well Installation			
Barium	TLV: 0.5 mg/m ³ [(C) ACGIH, 1986] IDLH: 250 mg/M ³ (NIOSH, 1987)	Lagoons: 1 to 5000 Surface Soil: 1 to 10000 Subsurface Soil: 1 to 10000 Tanks: 1 to 5000 Groundwater: 1 to 10000	Inhalation Ingestion Contact
Groundwater Sampling			
Methyl ethyl ketone	TLV: 200 PPM IDLH: 2000 PPM	Groundwater: 0 to 1	Inhalation Ingestion Contact
1,1,1-Trichloroethane	TLV: 350 PPM IDLH: 1000 PPM (NIOSH, 1987)	Groundwater: 0 to 1	Inhalation Ingestion Contact
Arsenic, solid	TLV: 0.2 mg/m ³ for arsenic [(C) ACGIH, 1986] IDLH: Not applicable, potential human carcinogen (NIOSH, 1987).	Groundwater: 1 to 30	Inhalation Ingestion Contact Absorption

Contaminant	TLV/IDLH	Postulated source/concentration (ppm)	Routes of exposure
Groundwater Sampling (cont.)			
Barium	TLV: 0.5 mg/m ³ [(C) ACGIH, 1986] IDLH: 250 mg/m ³ (NIOSH, 1987).	Groundwater: 1 to 5	Inhalation Ingestion Contact
Polychlorinated biphenyls	TLV: 0.5 mg/m ³ for chlorodiphenyl (54% chlorine) Skin. [(C) ACGIH, 1986] IDLH: Not applicable, potential human carcinogen. (NIOSH, 1987)	Groundwater: 0 to 350	Inhalation Ingestion Contact Absorption
Aethane	TLV: 750 PPM [(C) ACGIH, 1986] IDLH: 20000 PPM	Groundwater: 0 to 1	Inhalation Ingestion Contact
Remote Opening			
Barium	TLV: 0.5 mg/m ³ [(C) ACGIH, 1986] IDLH: 250 mg/m ³ (NIOSH, 1987).	Groundwater: 0 to 1	Inhalation Ingestion Contact
Hydrogen sulfide	TLV: 10 PPM IDLH: 300 PPM (NIOSH, 1987).	Air: 0 to 1 Groundwater: 0 to 0	Inhalation Ingestion Contact
Polychlorinated biphenyls	TLV: 0.5 mg/m ³ for chlorodiphenyl (54% chlorine) Skin. [(C) ACGIH, 1986]. IDLH: Not applicable, potential human carcinogen. (NIOSH, 1987).	Groundwater: 350 to 1500	Inhalation Ingestion Contact Absorption.

TASK HAZARD DESCRIPTIONS**1. SITE WALK-THROUGH AND SITE SURVEY**

General hazards associated with site walk-throughs, site surveys, and sampling grid layout include the following:

- Exposure to irritant and toxic plants such as poison ivy and sticker bushes may cause allergic reactions to personnel.
- Surfaces covered with heavy vegetation and undergrowth create a tripping hazard.
- Back strain due to carrying instruments.
- Native wildlife (e.g., rodents, ticks, and snakes) present the possibility of insect bites and associated diseases such as Lyme disease.
- Driving vehicles on uneven or unsafe surfaces can result in accidents (e.g., overturned vehicles or flat tires).
- Electrical hazard due to fallen lines.
- Heat stress/cold stress exposure.
- On-site chemical hazards depending on contaminant location and contact or disturbances of contaminated areas.

Hazard Prevention

- Wear long sleeved clothing and slacks to minimize contact with irritant and toxic plants and to protect against insect bites. Appropriate first aid for personnel' known allergic reactions.
- Be alert and observe terrain while walking to minimize slips and falls. steel-toed boots provide additional support and stability.
- Use proper lifting techniques to prevent back strain.
- Avoid wildlife when possible. In case of an animal bite, perform first aid and capture the animal, if possible, for rabies testing. Perform a tick check after leaving a wooded or vegetated area.
- Ensure all maintenance is performed on vehicles before going to the field. A site surveillance on foot might be required to choose clear driving paths.
- Ensure fallen power lines are not energized.

- Avoid buildings which are not structurally sound.
- Implement heat stress management techniques such as shifting work hours, fluid intake, and monitoring employees, especially workers in high-risk areas.

2. PERIMETER MONITORING

These site boundaries clearly mark off the "clean" off-site areas, from the "contaminated" on-site areas, and so chemical contamination from the site should not be a hazard associated with perimeter and off-site monitoring.

Perimeter monitoring and off-site monitoring are performed once the site boundaries have been established. Hazards specific to perimeter and off-site monitoring include encounters with residents and non-project personnel. This is a unique hazard, in the untrained personnel prove to be a risk when performing any type of site work.

Hazard Prevention

- The most effective preventative measure is to inform all interested parties. Notifying state and local police, the fire department, and any local/state governmental officials of the projects purpose and scope will allow those authorities to answer questions posed to them by local residents and the media by preparing statement son the projects purpose or by informing the public where to call for further information. This will alleviate the problem of work stoppage due to field personnel answering questions.

3. GROUNDWATER SAMPLING

Hazards generally encountered during groundwater sampling include the following:

- Exposure to vapors of volatile organics when the well head is initially opened.
- Back strain due to lifting bailers or pumps from down-well depths and moving equipment (generators) to well locations.
- Slipping on wet, muddy surfaces created by spilled water.
- Electrical hazards associated with use of electrical equipment around water or wet surfaces.
- Possible water splashing in eyes during sampling.

Hazard Prevention

- To minimize exposure to volatile when the well head is initially opened, a monitoring instrument (HNU, OVA) should be placed near the opening to monitor organic levels. The breathing zone should also be monitored. The action levels on the instruments should be chosen before site

work begins, and should be outlined in the safety plan. To prevent contact with contaminated groundwater, or product material, provide adequate protective equipment.

- Back strain can be prevented by employing proper lifting and bailing techniques. Heavy equipment, such as pumps and generators, should be only lifted with the legs, preferably using two or three personnel.
- Slipping on wet surfaces can be prevented by placing all purged water in drums for removal. Also, if the area is wet wear boots with good treads and be alert of where personnel are walking to decrease the chance of slipping.
- Ground fault interrupter should be used in the absence of properly grounded circuitry or when pumps are used around wet conditions.
- Electrical extension cords should be protected or guarded from damage (i.e., cuts from other machinery) and be maintained in good condition.
- Eye protection should be worn as appropriate to prevent water splashing into eyes.

4. REMOTE OPENING OF PRESSURIZED WELLS

Anticipated hazards will potentially include

- Spray or jet of high pressure well liquids
- Rupture of pressure boundary resulting in sprays, jets, or missiles
- Hydrogen sulfur present in wellhead space gas
- High pressure injection of well liquids through unprotected skin
- Failure of engineered controls

Hazard Prevention

The risk from these hazards has been reduced by engineered controls such as high-pressure well tapping saddles, self-contained drilling machine, air release filter pathway (including desiccant, carbon, and HEPA filters), an encompassing glovebag, and field monitoring for radiological and chemical hazards.

CHEMICAL HAZARDS

Polychlorinated biphenyls

Polychlorinated biphenyls are colorless to light-colored liquids. They are used as coolants in transformers and in electrical capacitors. They are insoluble in water. They are non-

volatile and non-combustible. They are extremely persistent in the environment. ((C)AAR, 1986)

Arsenic, Solid

Arsenic, solid is a grayish metallic solid turning black on the exposure to air. It is insoluble in water. It is toxic by ingestion. ((C)AAR, 1986)

Methyl Ethyl Ketone

Methyl ethyl ketone, also called ethyl methyl ketone, is a colorless fairly volatile liquid with a pleasant pungent odor like acetone or lacquer thinner. It is used as a solvent, for making other chemicals, and for production of wax from petroleum. It is moderately soluble in water. Because it is lighter than water, it may be expected to float while rapidly dissolving. Its flash point of 20 deg F indicates that the product is easily ignited under a wide range of ambient temperature conditions. Vapors may be heavier than air and may travel some distance to a source of ignition and flash back. Accumulations of vapor in confined spaces, such as buildings or sewers, may explode if ignited. Methyl ethyl ketone does not react with water or many common materials and is stable in normal transportation. It is reactive with strong oxidizing materials, and will dissolve or soften some plastics. Toxicity is low to moderate via the various potential routes of exposure. Vapors are irritating to nose, eyes, and throat. Products of combustion may include toxic constituents. ((C)AAR, 1986)

1,1,1-Trichloroethane

1,1,1-Trichloroethane is a colorless liquid with a sweet, chloroform-like odor. It is used as a solvent for fats, oils, waxes, resins and other products it may be irritating to skin, eyes and mucous membranes; and in high concentrations the vapors may have a narcotic effect. It is moderately flammable at high temperatures and, when involved in fire, may emit highly toxic and irritating fumes. (NOAA, 1987)

Acetone

Acetone is a clear, colorless liquid with a pleasant odor. It is used to make other chemicals, in paint and nail polish removers, as a solvent, and for other uses. It is quite volatile and has a flash point of 0 deg F. It is lighter than water and soluble in water. Its vapors are heavier than air. ((C)AAR, 1986)

Hydrogen Sulfide

Hydrogen sulfide is a colorless gas having the odor of rotten eggs. It is shipped as a liquefied gas under its own vapor pressure. One's sense of smell becomes rapidly fatigued in atmospheres containing hydrogen sulfide and hence cannot be counted on to warn of the continued presence of the gas. Contact with the liquid can cause frostbite. The gas is heavier than air and flame can flash back to the source of leak very easily. Under fire

conditions cylinders and tank cars may violently rupture and rocket. It is soluble in water. ((C)AAR, 1986)

HEALTH HAZARDS

Polychlorinated Biphenyls

Liquid or Solid: Irritating to skin and eyes. (USCG, 195)

Arsenic, Solid

Poisonous if swallowed. Inhalation of dust poisonous. Fire may produce irritating or poisonous gases. Runoff from fire control or dilution water may cause pollution. (DOT < 1984)

Barium

If inhaled, may be harmful. Contact may cause burns to skin and eyes. Fire may produce irritating or poisonous gases. (DOT, 1984)

Methyl Ethyl Ketone

Vapor: Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness. Liquid: Will burn eyes. Harmful if swallowed. (USCG, 1985)

1,1,1-Trichloroethane

Vapor: Irritating to eyes, nose and throat. If inhaled, will cause dizziness or difficult breathing. Liquid: Irritating to skin and eyes. If swallowed, may produce nausea. (USCG, 1985)

Acetone

Vapor: Irritating to eyes, nose and throat. If inhaled, may cause difficult breathing or loss of consciousness.

Liquid: Irritating to eyes. Not irritating to skin. (USCG, 1985)

Hydrogen Sulfide

Exposure to very high concentrations causes immediate death. Also death or permanent injury may occur after very short exposure to small quantities. It acts directly upon the nervous system resulting in paralysis of respiratory centers. Signs and Symptoms of Exposure: Contact with eyes causes painful conjunctivitis, sensitivity to light, tearing, and clouding of vision. Inhalation of low concentrations causes a runny nose with a loss of smelling sense, labored breathing, and shortness of breath. Direct contact with skin causes

pain and redness. Other symptoms of exposure include profuse salivation, nausea, vomiting, diarrhea, giddiness, headache, dizziness, confusion, rapid breathing, rapid heart rate, sweating, weakness, sudden collapse, unconsciousness and death due to respiratory paralysis. (EPA, 1986)

FIRE/EXPLOSION HAZARDS

Polychlorinated Biphenyls

Combustible. Irritating gases are generated in fires. (USCG, 1985)

Arsenic, Solid

Some of these materials may burn but none of them ignite readily. (DOT, 1984)

Barium

May ignite itself if exposed to air. May re-ignite after fire is extinguished. May ignite to presence of moisture. Violent reaction with water produces flammable gas. Runoff to sewer may create fire or explosion hazard. (DOT, 1984)

Methyl Ethyl Ketone

Flammable. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. (USCG, 1985)

1,1,1-Trichloroethane

Combustible. POISONOUS GASES ARE PRODUCED IN FIRE. Toxic and irritating gases are generated in fires. (USCG, 1985)

Acetone

Flammable. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. (USCG, 1985)

Hydrogen Sulfide

A very flammable gas. Compound is heavier than air and may travel a considerable distance to source of ignition and flash back. It forms explosive mixtures with air over a wide range. Also reacts explosively with bromine pentafluoride, chlorine trifluoride, nitrogen triiodide, nitrogen trichloride, oxygen difluoride, and phenyl diazonium chloride. Avoid physical damage to containers; sources of ignition; storage near nitric acid, strong oxidizing materials, and corrosive liquids or gases. Incompatible with metals. When heated to decomposition, it emits highly toxic fumes of oxides of sulfur. (EPA, 1986)

FIRE FIGHTING**Polychlorinated Biphenyls**

Extinguish fire using agent suitable for type of surrounding fire (material itself does not burn or burns with difficulty). ((C)AAR, 1986)

Arsenic, Solid

Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty). Use water in flooding quantities as fog. Use foam, carbon dioxide or dry chemical. ((C)AAR, 1986)

Barium

DO NOT USE WATER OR FOAM. SMALL FIRES: Dry chemical, soda ash or lime. **LARGE FIRES:** Withdraw from area and let fire burn. **MAGNESIUM FIRES:** Use dry sand, Met-L-X powder or G-1 graphite powder. **DO NOT USE WATER.** Move container from fire area if you can do it without risk. (DOT, 1984)

Methyl Ethyl Ketone

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, carbon dioxide or dry chemical. ((C)AAR, 1986)

1,1,1-Trichloroethane

Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Extinguish fire using agent suitable for type of surrounding fire (material itself does not burn or burns with difficulty). Keep run-off water out of sewers and water sources. ((C)AAR, 1986)

Acetone

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, carbon dioxide or dry chemical. ((C)AAR, 1986)

Hydrogen Sulfide

For small fires let burn unless leak can be stopped immediately. For large fires, use water spray, fog or foam. Stop flow of gas. Use water to keep fire-exposed containers cool and to protect men effecting the shut-off. Move container from fire area. Stay away from ends of tanks. Withdraw immediately in case of rising sound from venting safety device or any

discoloration on tank due to fire. Cool containers with water using unmanned device until well after fire is out. (EPA, 1986)

NON-FIRE RESPONSE

Polychlorinated Biphenyls

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Water spill: Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material at bottom. If dissolved, apply activated carbon at ten times the spilled amount in region of 10 ppm or greater concentration. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. ((C)AAR, 1986)

Arsenic, Solid

Keep material out of water sources and sewers. ((C)AAR, 1986)

Barium

Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do it without risk. No water on spilled materials; do not get water inside container. SMALL DRY SPILLS: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. LARGE SPILLS: Dike spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. (DOT, 1984)

Methyl Ethyl Ketone

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents. Water spill: Use natural barriers or oil spill control booms to limit spill motion. Remove trapped material with suction hoses. Air spill: Apply water spray or mist to knock down vapors. ((C)AAR, 1986)

1,1,1-Trichloroethane

Keep material out of water sources and sewers. Attempt to stop leak if without hazard. Use water spray to knock-down vapors. Land spill: dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents. Water spill. Use natural barriers or oil spill control

booms to limit spill motion. Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material at bottom. Remove trapped material with suction hoses. ((C)AAR, 1986)

Acetone

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without hazard. Use water spray to disperse vapors and dilute standing pools of liquid. ((C)AAR, 1986)

Hydrogen Sulfide

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if without hazard. Use water spray to knock-down vapors. Land spill: dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. Water spill: Neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. Air spill: Apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. ((C)AAR, 1986)

FIRST AID

Polychlorinated Biphenyls

If this chemical comes in contact with the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical. If this chemical comes in contact with the skin, immediately wash the contaminated skin with soap and water. If this chemical penetrates through the clothing, immediately remove the clothing, wash the skin with soap and water, get medical attention promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible. If this chemical has been swallowed, get medical attention immediately. (NIOSH < 1987)

Arsenic, Solid

If this chemical comes in contact with the eyes, immediately wash the eyes with large amounts of water and continue flushing for 15 minutes, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical. If this chemical comes in contact with the skin, immediately wash the contaminated skin with soap and water. If this chemical penetrates through the clothing, immediately remove the clothing, wash the skin with soap and water, get medical attention promptly. If this chemical has been swallowed, get medical attention immediately. (NIOSH, 1987)

Barium

If this chemical comes in contact with the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical. If this chemical comes in contact with the skin, immediately flush the contaminated skin with water. If this chemical penetrates the clothing, immediately remove the clothing and flush the skin with water. Get medical attention promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible. If this chemical has been swallowed, get medical attention immediately. (NIOSH, 1987)

Methyl Ethyl Ketone

If this chemical comes in contact with the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical. If this chemical comes in contact with the skin, immediately wash the contaminated skin with water. If this chemical penetrates the clothing, immediately remove the clothing and wash the skin with water. If symptoms occur after washing, get medical attention immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once. Other measures are usually unnecessary. If this chemical has been swallowed, get medical attention immediately. (NIOSH, 1987)

1,1,1-Trichloroethane

If this chemical comes in contact with the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical. If this chemical comes in contact with the skin, promptly wash the contaminated skin with soap and water. If this chemical penetrates through the clothing, promptly remove the clothing and wash the skin with soap and water. Get medical attention promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible. If this chemical has been swallowed, get medical attention immediately. (NIOSH, 1987)

Hydrogen Sulfide

Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. (EPA, 1986)

STANDING ORDERS FOR DONNING/DOFFING PERSONAL PROTECTIVE EQUIPMENT

INSPECTION

Proper inspection of PPE features several sequences of inspection depending upon specific articles of PPE and frequency of use. The different levels of inspection are as follows:

- Inspection and operational testing of equipment received from the factory or distributor.
- Inspection of equipment as it is issued to workers.
- Inspection after use or training and prior to maintenance.
- Periodic inspection of stored equipment.
- Periodic inspection when a question arises concerning the appropriateness of the selected equipment, or when problems with similar equipment arise.

The primary inspection of PPE in use for activities at the site will occur immediately prior to use and will be conducted by the user. This ensures that the specific device or article has been checked out by a user that who is familiar with its use.

CLOTHING

Before Use

- Determine that the clothing material is correct for the specified task at hand.
- Visually inspect for
 - imperfect seams
 - nonuniform coatings
 - tears
 - malfunctioning closures
- Hold up to light and check for pinholes.
- Flex product
 - observe for cracks
 - observe for other signs of shelf deterioration

- If the product has been used previously, inspect inside and out for signs of chemical attack:

- discoloration
- swelling
- stiffness

During the Work Task

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

GLOVES

Before Use

- Visually inspect for
 - imperfect seams
 - tears
 - nonuniform coating
 - pressurize glove with air; listen for pin-hole leaks.

LEVEL 2 DOFFING STEPS

- Step 1 Tape removal
- Step 2 Boots and outer gloves removal
- Step 3 Coveralls removal
- Step 4 Inner gloves removal
- Step 5 Frisk

Note: *Donning* consists of Steps 4 through 1 in reverse order.

LEVEL 3 DOFFING STEPS

- Step 1 Segregated equipment drop
- Step 2 Tape removal
- Step 3 Boot cover removal
- Step 4 Outer glove removal
- Step 5 Safety boot removal
- Step 6 Suite removal
- Step 7 Face piece removal
- Step 8 Inner glove removal
- Step 9 Frisk
- Step 10 Redress

Note: *Donning* consists of Steps 8, 7, 6, 5, 4, 3, 2 in reverse order. Dressout will be supervised by ES&H

LEVEL 4 DOFFING STEPS

- Step 1 Segregated equipment drop
- Step 2 Boot cover and glove wash
- Step 3 Boot cover and glove rinse
- Step 4 Tape removal - outer glove and boot
- Step 5 Boot cover removal
- Step 6 Outer glove removal
- Step 7 Suit/safety boot wash
- Step 8 Suit/SCBA/boot/glove rinse
- Step 9 Safety boot removal
- Step 10 SCBA backpack removal
- Step 11 Splash suit removal
- Step 12 Inner glove wash
- Step 13 Inner glove rinse
- Step 14 Facepiece removal
- Step 15 Inner glove removal
- Step 16 Inner clothing removal
- Step 17 Field wash
- Step 18 Frisk
- Step 19 Redress

NOTE: *Donning* consists of Steps 16, 15, 14, 11, 10, 9, 6, 5, 4 in reverse order. Dressout will be assisted and supervised by ES&H.

LEVEL 5 DOFFING STEPS

- Step 1 Segregated equipment drop
- Step 2 Boot cover and glove wash
- Step 3 Boot cover and glove rinse
- Step 4 Tape removal - boot and glove
- Step 5 Boot cover removal
- Step 6 Outer glove removal
- Step 7 Suit/safety boot wash
- Step 8 Suit/safety boot rinse
- Step 9 Safety boot removal
- Step 10 Fully encapsulating suit and hard hat removal
- Step 11 SCBA backpack removal
- Step 12 Inner glove wash
- Step 13 Inner glove rinse
- Step 14 Face piece removal
- Step 15 Inner glove removal
- Step 16 Inner clothing removal
- Step 17 Field wash of skin
- Step 18 Frisk
- Step 19 Redress

Note: *Donning* consists of Steps 16, 15, 14, 11, 10, 9, 6, 5, 4 in reverse order. Dressout will be assisted and supervised by ES&H.

SPECIFIC LEVELS OF PROTECTION PLANNED FOR THE SITE

The following levels of protection will be utilized during activities at the site:

- **Level 4**

Release of groundwater H₂S possible but not probable; a spray event will result in mist, not gas. Skin and primary respiratory protection necessary for escape and recovery post release. Level 5 only for termination of release.

- **Level 3 Modified**

No airborne levels of these chemicals were detected during previous investigations. Radiological hazard and contact hazard with high pH brine justify Level 3 with an escape bottle. Level 3 outer and glove/boot ensemble to protect against organic contact, radionuclides, and high pH brine. Face shield and beta goggles required. Level 3 modified for skin route only.

- **Level 2**

No detectable air or surface contaminants in prior monitoring and survey.

- **Level 2 Modified**

Level 5 Tasks

- None: Emergency release termination only by ES&H.

Level 5 Tasks (modified)

- None

Level 4 Tasks

- Remote opening of pressurized wells

Level 4 Tasks (modified)

- OHF cubicle entry (initial)

Level 3 Tasks

- OHF cubicle entry

Level 3 Tasks (modified)

- Groundwater sampling

Level 3 Tasks

- Site survey
- Perimeter monitoring

Level 2 Tasks (modified)

- Site walk-through

STANDING ORDERS FOR WAG 10 AREA CAAs

- No smoking, eating, or drinking in this zone
- No horseplay
- No matches or lighters in this zone
- Check in on entrance to this zone
- Check out on exit from this zone
- Implement the communications system
- Line of sight must be in position
- Wear the appropriate level of protection as defined in the HWP

STANDING ORDERS FOR WAG 10 AREAS OUTSIDE OF CAAs

- **No smoking, eating, or drinking in this zone**
- **No horseplay**
- **No matches or lighters in this zone**
- **Wear the appropriate level of protection**

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