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RISK MANAGEMENT PLAN FOR BERM INVESTIGATION FOR WASTE PITS 3 & 5 AND THE CLEARWELL JULY 1991

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RMP NO. RMP-0U1P011-791

RISK MANAGEMENT PLAN

for

BERM INVESTIGATION FOR WASTE PITS 3 & 5 AND THE CLEARWELL

prepared by

J. T. Witzeman

for

U.S. DEPARTMENT OF ENERGY/FERNALD SITE OFFICE

July 29, 1991

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RISK MANAGEMENT PLAN

for

RMP NO. RMP-OU1P011-791

BERM INVESTIGATION FOR WASTE PITS
3 & 5 AND THE CLEARWELL

Author: _____ 8/19/91
J. T. Witzeman, Project Engineer Date

APPROVALS:

_____ 8/19/91
for J. L. Click, Manager, Nuclear, Fire & System Safety Date

_____ 8/21/91
J. L. Trujillo, Manager, Sitewide Quality Assurance Date

_____ 8/22/91
R. L. Gardner, Manager, Facilities and Warehousing Date

_____ 8-20-91
P. A. Polus, Manager, Centralized Training Date

_____ 8/22/91
P. C. Weddle, Vice President, Project Management & Acquisition Date

RISK MANAGEMENT PLAN
FOR
BERM INVESTIGATION FOR WASTE PITS 3 & 5 AND THE CLEARWELL

I Introduction

Project Synopsis - This Risk Management Plan (herein referred to as the "Plan") is intended to describe specific actions and responsibilities to mitigate or eliminate the consequences of failure or concerns identified in the Risk Assessment Report, titled "Berm Investigation for Waste Pits 3 & 5 and the Clearwell," dated July 29, 1991 and approved for this project.

II Summary

This plan, titled "Berm Investigation for Waste Pits 3 & 5 and the Clearwell," involves three (3) potential failures or concerns that merit special management attention due to the severity of their unmitigated consequences.

These consequences can be managed, minimized or eliminated by close adherence to the risk control measures identified. Specific control measures directed by management and implemented by pertinent personnel provide the effective risk control required. This plan specifies the controls for the management of risk associated with this effort.

III Risks Requiring Inclusion in the Plan

The Risk Assessment Report (RAR) identifies three (3) potential failures or concerns (risks) associated with the "Berm Investigation for Waste Pits 3 & 5 and the Clearwell" effort. One of the risks is identified as Quality Level 2 and two as Quality Level 3.

A. Quality Level 2

1) Personnel falling into waste pit and drowning

- Working near edge of waste pit allows for numerous opportunities to fall into pit.

B. Quality Level 3

1) Failure of berm due to structural degradation

2) Skin contamination due to contact with contaminated soil or water

IV Description of Control Measures and Requirements

A. General Risk Controls, Mitigators and Requirements

All field activities shall be performed in a manner consistent with the FEMP Site Health and Safety Plan and the FEMP RI/FS QAPP.

B. Job - Specific Risk Controls, Mitigators and Requirements

Specific guidance, procedures and regulations for addressing the risks identified in Section III of this document are listed below.

Quality Level 2 Event

1) Personnel falling into waste pit (RAR item 3)

- Life preservers shall be worn when personnel approach within 5 feet of the edge of the waste pit (Project Specific Health and Safety Plan).

Quality Level 3 Events

1) Failure of berm due to structural degradation

- Design A/E firm has determined that berm failure during investigation activities is not likely assuming the absence of natural phenomena hazards

2) Risk of skin contamination due to contact with contaminated water or soil (RAR item 2)

- Protective clothing, gloves, showers and self-monitoring as required will prevent or control personnel contamination.

V Training

All personnel engaged in drilling operations on the project shall complete the following:

1) Documented review of the Health and Safety Plan for this work including site specified hazards and procedures

2) WEMCO Radiation Safety Training

3) WEMCO annual respiratory training and quantitative fit test or equivalent approved by WEMCO Industrial Hygiene

4) Site Nuclear Criticality Training

5) 40-hour OSHA training

6) 8-hour annual refresher training, as necessary

7) 8-hour supervisory training (for supervisors)

8) 24-hour supervised field experience (general site workers) or supervised field experience (occasional site workers)

9) FEMP site orientation video.

The completion of this training shall be documented by Site Training.

VI Attachments

1) Risk Assessment Report

2) Health and Safety Plan for the Dike Stability Investigation of Waste Pits 3 & 5 and the Clearwell.

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Attachment

HEALTH AND SAFETY PLAN

FOR THE

DIKE STABILITY INVESTIGATION

OF WASTE PITS 3 AND 5

AND THE CLEARWELL

AT THE

FEED MATERIALS PRODUCTION CENTER

FERNALD, OHIO

MAY 1991

Prepared By:

PARSONS
Fairfield Executive Center
6120 South Gilmore
Fairfield, OH 45014

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DOE Contract No. DE-AC05-900R21951

5474

HEALTH AND SAFETY PLAN
FOR THE
DIKE STABILITY INVESTIGATION
OF WASTE PITS 3 AND 5
AND THE CLEARWELL

PARSONS

Prepared by: _____ 5-17-91
Health and Safety Coordinator — Date

Approved by: _____ 5-17-91
Operable Unit 1 Manager — Date

WESTINGHOUSE MATERIALS CO. OF OHIO

Reviewed by: _____ 5/17/91
Project Engineer — Date

Recommended for Approval by: _____ 5-17-91
Operable Unit 1 Manager — Date

Approved by: _____ 5/23/91
For Vice President - Industrial, Radiological, Safety and Training — Date

U.S. DEPARTMENT OF ENERGY

Approved by: _____ 5/17/91
Operable Unit 1 Manager — Date

Approved by: Ray Hanson for 5/23/91
Project Manager — Date

HEALTH AND SAFETY PLAN
FOR THE
DIKE STABILITY INVESTIGATION
OF WASTE PITS 3 AND 5
AND THE CLEARWELL

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SECTION 1

TASKS TO BE PERFORMED[1]

This task-specific Health and Safety Plan was prepared as a supplement to the formal Health and Safety program at the FMPC. This Health and Safety Plan will be used by WMCO in conducting field activities as described herein. The tasks covered by this Health and Safety Plan consist of soil boring, collection of subsurface soil samples, drilling and construction of piezometric wells, and abandonment of bore holes and piezometric wells in the dikes surrounding Waste Pits 3 and 5 and the Clearwell at the FMPC. The purpose of these tasks is to evaluate the structural integrity of the waste pit dikes and to determine the potential threat of dike failure and the resulting release of waste pit and Clearwell contents to Paddy's Run.

Prior to the drilling and sampling activities in these areas, a series of survey target and control monuments will be installed to allow periodic monitoring of the dikes. The management and preparation of a Health and Safety Plan for the installation of these monuments is being conducted by WMCO.

Approximately sixteen (16) soil borings will be made in the dikes surrounding Waste Pits 3 and 5 and the Clearwell. Borings will be made at the toe as well as at the top of the dike along the perimeter of each waste pit. Drilling technicians will use split-barrel and, at selected sampling locations, thin-walled (shelby) tubes to collect subsurface soil samples during the construction of the borings. Soil borings are not expected to exceed a depth of approximately 35 feet. Following sample collection, a variety of laboratory tests, i.e., moisture contents, permeability, triaxial shear, etc., will be performed on the soils.

Piezometric wells will be installed along the dikes based on conditions encountered in the field. Well casing and screen material will be installed in each well. The static water level in each piezometric well will be monitored by WMCO personnel on a periodic schedule.

The drilling subcontractor will abandon the soil boring holes without piezometric wells by grouting the holes subsequent to the completion of the dike stability evaluation. WMCO will abandon the soil boring holes with piezometric wells.

Listed in Subsections 1.1 through 1.5 are several of the major dike stability investigation activities and a checklist of standard actions that may or may not occur for each activity.

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[1]The plan is consistent with 29 CFR 1910.120 and the FMPC Site Health and Safety Plan.

1.1 Effects of Conducting Soil Borings on the Dikes Surrounding Waste Pits 3 and 5 and the Clearwell

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.2 Effects of Collecting Subsurface Soil Samples

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.3 Effects of Drilling and Constructing Piezometric Wells

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.4 Effects of Monitoring the Piezometric Wells

No	Disturb Surface Soil	No	Sample Surface Water
No	Disturb Subsurface Soil	No	Sample Lagoons
No	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.5 Effects of Abandoning Bore Holes and Piezometric Wells

Yes	Disturb Surface Soil	No	Sample Surface Water
No	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

SECTION 2

SITE HISTORY

Since the beginning of uranium production operations at FMPC in 1952, an on-site area has been used for the storage of low-level radioactive wastes generated by the various chemical and metallurgical processes at the facility. The waste storage area, which consists of six waste pits, the Clearwell, and the burn pit, is located in the northwestern corner of the FMPC Site (Figure 2-1). The tasks addressed by this Health and Safety Plan are specifically related to Waste Pit 3, Waste Pit 5, and the Clearwell.

Waste Pit 3 was constructed in 1959 and was excavated to a depth of 27 feet. A minimum of 12 inches of compacted clay was used to line the inner slopes of the walls. In 1965, the pit capacity was expanded by adding 2 feet of additional material to the top of the pit walls. The pit consisted of a large settling basin with a concrete spillway overflowing into the clay-lined Clearwell. This was the first "wet" pit built for the purpose of settling solids from wet waste streams. The pit was operated as a settling basin from 1959 to 1968; it received wet waste streams consisting of lime-neutralized radioactive raffinate concentrate from the Recovery Plant and the general sump. The principal waste contained in Pit 3 is lime-neutralized, radioactive raffinate concentrate. Beginning in December 1958, lime sludge from the Water Treatment Plant was added to supplement the lime used for raffinate neutralization. During the late 1960s, large quantities of radioactive slag leach residues were pumped to Pit 3. After October 1968, Pit 5 was used as the settling basin. From 1975 to 1977, solid wastes (filter cake and fly ash) were used to complete the filling of the pit. Waste Pit 3 contains an estimated 227,000 cu yd of wastes, including 129,000 kg of uranium and 400 kg of thorium. The pit was closed in 1977, and clean fill was placed over the waste.

Waste Pit 5 was constructed in 1968 and operated from 1968 to 1983. The pit was lined with a 60-mil-thick elastometric membrane. As with Waste Pit 3, this waste pit received liquid waste slurries from the Refinery and the Recovery Plant, including neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge. The waste volume consists of approximately 102,500 cu yd, which contains 50,309 kg of uranium and 17,000 kg of thorium. From 1983 to February 1987, when it was taken out of service, Pit 5 received only clear decant from the general sump, filtrate from the recovery plant, or nonradioactive slurries, such as blowdown from the Boiler Plant and Water Treatment Plant. The surface of Waste Pit 5 is open and has not been covered with any type of fill material.

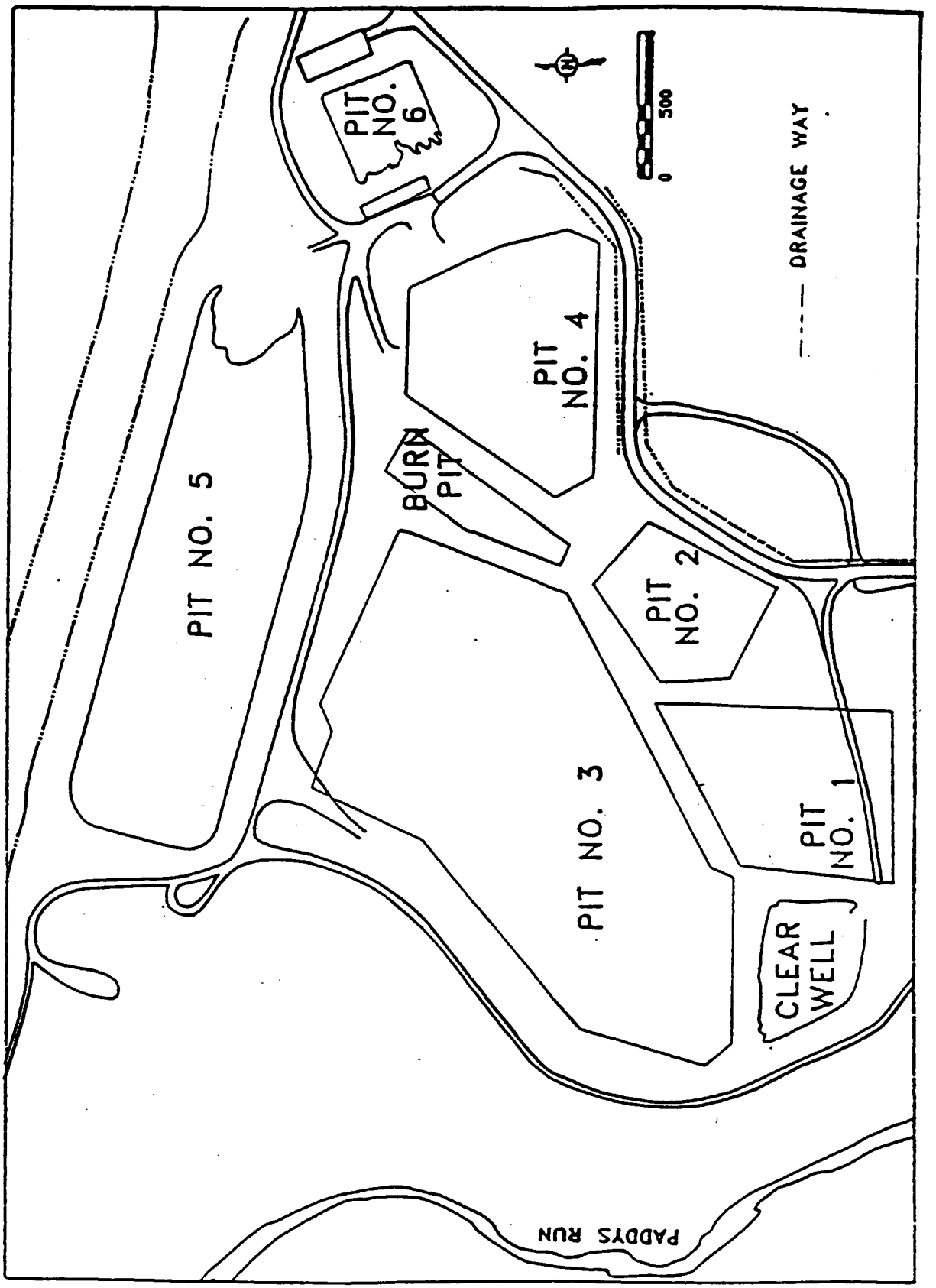

Figure 2-1 - FMPC Waste Storage Areas

The Clearwell served as a settling basin for process water and storm water runoff from the waste pits. The Clearwell was used as a final settling basin for process water that passed through Waste Pit 5 prior to its discharge into the Great Miami River. This use was terminated in March 1987 when Waste Pit 5 was removed from the process water treatment system. The Clearwell currently receives surface water runoff from the majority of the surfaces of Waste Pits 1, 2, and 3, and from the entire surface of Waste Pit 5. Water of varying depth remains in the Clearwell at all times. The depth of sediments in the Clearwell is unknown.

SECTION 3

TASK SPECIFIC HAZARD ASSESSMENTS

3.1 Hazard Assessment

An evaluation of the tasks to be conducted during the dike stability investigation indicates that physical, radiological, and chemical hazards will be present. Table 3-1 lists the anticipated hazards associated with each of the five major work tasks identified in Section 1.

Table 3-1
Hazards Associated With Dike Stability Investigation For Waste Pits 3 and Clearwell

TASK	PHYSICAL HAZARDS	CHEMICAL HAZARDS	RADIOLOGICAL HAZARDS
Soil Borings on Waste Pit and Clearwell Dikes	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Collection of Samples	Slip, trip, fall, vehicle traffic, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Installation of Piezometric Wells	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Monitoring the Piezometric Wells	Slip, trip, fall, heat/cold stress, drowning	Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Abandonment of Boreholes and Wells	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Portland cement, Bentonite, Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates

NOTES:

1: Previous sampling of Waste Pits 3 and 5 contents indicated the presence of several organic and inorganic contaminants, i.e., barium, acetone, methylene chloride. These chemicals may have migrated into the dikes surrounding the waste pits; however, no sampling data exists to support this possibility.

3.2 Chemical and Radiological Hazards

Table 3-2 lists the primary hazard, exposure limit, and action level for the chemicals and radionuclides that will likely be encountered during the dike stability investigation. Based on surface and subsurface soil sampling conducted during the Remedial Investigation (1990), several radionuclides (radium, thorium, and uranium) were identified at levels above background in the soil on the perimeter of the waste pits and the Clearwell. During the Remedial Investigation, ten (10) surface soil samples were collected from the perimeter of these areas. Radium-226, -228, thorium-228, -230, -232, uranium-234, and -238 were consistently detected in the soil samples. The concentration ranges for these radionuclides in pCi/g were: <0.3 to 1.2 for radium-226, <0.5 to 1.8 for radium-228, <0.6 to 13.6 for thorium-228, 0.8 to 6.1 for thorium-230, <0.6 to 1.4 for thorium-232, <0.6 to 5.3 for uranium-234, and <0.6 to 16.1 for uranium-238. Also during the Remedial Investigation, a total of twenty-six (26) subsurface soil samples were collected from various depths of twenty wells that had been drilled in the waste pits area. The same seven radionuclides that had been consistently detected in the surface soil samples were also consistently detected in the subsurface soil samples. Of the subsurface soil samples collected adjacent to the dikes of Waste Pits 3 and 5 and the Clearwell, the highest concentration for any of the seven consistently detected radionuclides was 89.4 pCi/g for uranium-238. All other radiounuclides were generally observed in concentrations less than 10 pCi/g.

Previous radiation measurements (Radiological and Chemical Characterization of the Waste Pits, CIS, Volume 2, Weston, 1987)) indicated that radioactive material is widely distributed as well as located in isolated small deposits in the waste pit area. During the 1987 Weston study of the waste pits at FMPC, a variety of organic and inorganic chemical constituents were identified in the contents of Waste Pits 3 and 5 and the Clearwell. Volatile and semi-volatile organic chemicals in the contents of these three pits were observed at concentrations of 4.5 ppm or less. Inorganic chemicals in the pit contents were generally observed at concentrations comparable to soils found throughout the eastern United States. Because the drilling activity will occur in the dikes surrounding the waste pits and the Clearwell, it is unlikely that drilling personnel will encounter the chemicals from the waste pit contents. The chemicals of concern are bentonite and Portland cement. These items, which pose a respiratory hazard because of their powder nature, will be used as a grout mixture to seal the boring and piezometer well holes.

Table 3-2
Chemical And Radiological Hazard Table

POTENTIAL CONTAMINANT	PRIMARY HAZARD	EXPOSURE[1] LIMIT	ACTION LIMIT	ACTION
Radium-226	Ingestion/Inhalation	3×10^{-10} µCi/ml[2]	-	-
Radium-228	Ingestion/Inhalation	5×10^{-10} µCi/ml[2]	-	-
Thorium-228	Ingestion/Inhalation	4×10^{-12} µCi/ml[2]	-	-
Thorium-230	Ingestion/Inhalation	3×10^{-12} µCi/ml[2]	-	-
Thorium-232	Ingestion/Inhalation	5×10^{-13} µCi/ml[2]	-	-
Uranium-234	Ingestion/Inhalation	2×10^{-11} µCi/ml[2]	-	-
Uranium-238	Ingestion/Inhalation	2×10^{-11} µCi/ml[2]	-	-
Bentonite (Crystalline silica as respirable dust, quartz standard)	Ingestion/Inhalation	0.1 mg/m^3	0.05 mg/m^3	[3]
Portland Cement (Respiratory standard)	Ingestion/Inhalation	5.0 mg/m^3	2.5 mg/m^3	[3]

NOTES:

[1] The Exposure Limit values are given for individual radionuclides. For known mixtures of radionuclides, the sum of the ratio of the observed concentration of a particular radionuclide and its corresponding limit for all radionuclides in the mixture must not exceed 1.0.

[2] This is the Derived Air Concentration (DAC).

[3] Full-face air purifying respirators with high efficiency/radionuclide filter cartridges.

SOURCES:

DOE Order 5480.11, "Radiation Protection For Occupational Workers," U.S. Department of Energy, July 20, 1989.

NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1990 (Bentonite and Portland Cement).

3.3 Physical Hazards

The terrain surrounding Waste Pits 3 and 5 and the Clearwell varies from steep to level. The outer sides of the earthen dike surrounding Waste Pit 5 slope at an angle of 34° (1-foot rise to 1.5-foot run) and range in height from 10-25 feet. The width of the top of the dike ranges from 8-15 feet. Waste Pit 5 remains an open pit. The pit liner is visible along the entire perimeter of Waste Pit 5. With the exception of the eastern end of the pit, water covers the entire surface of Waste Pit 5; the eastern end of the pit is covered with sediments and sludges.

The dike surrounding Waste Pit 3 is only visible on the western side of the waste pit; the outer dike surface is approximately 15-20 feet high and slopes at an angle similar to the dike surrounding Waste Pit 5. Waste Pit 3 has been covered with clean fill material and was graded to a slightly crowned surface. The entire Waste Pit 3 surface is now grass-covered. The Clearwell is also an open pit whose surface is covered with water. The dike surrounding the Clearwell is only visible along the western and southern sides of the pit.

Due to the variable terrain and proximity to open and liquid and sludge-filled pits, a variety of physical hazards are present during the dike stability investigation field work. Slipping, tripping, and falling by field workers and the movement and use of drilling rigs and related equipment along the pit and dike edges represent the most immediate physical hazards. Of particular note are physical hazards associated with the operation of the drilling rigs: falling or breaking machinery parts, rotating parts, cables under tension, and obstructed views by the operator. In addition, workers may be exposed to high levels of noise and to heat/cold stress during drilling and sampling activities. The potential for drowning exists for those personnel who may accidentally fall into Waste Pit 5 or the Clearwell during work activities.

SECTION 4

MONITORING

4.1 Goals

Prior to any task being performed on the waste pit and Clearwell dikes, air monitoring will be conducted by WMCO Radiological Safety and Environmental Monitoring personnel, as required at the time of work permit(s) issuance, to ensure that exposure limits are not exceeded. Radioactive contamination monitoring will be performed when soil media is disturbed in order to ensure that the spread of contamination is minimized.

4.2 Monitoring Equipment And Frequency of Monitoring

4.2.1 Airborne Radioactive Particulates

A representative air sample in the immediate breathing zone or general area of a worker actively involved in drilling operations will be collected to determine the concentration of long-lived airborne radioactive particulates to which workers are exposed. The sample will be collected using portable, battery-powered air pumps with 37 mm diameter membrane filters. The air sample filter will be checked for gross radioactivity to verify the adequacy of respiratory protection. A daily air sample which indicates that personnel may have been exposed to greater than 40 Derived Air Concentration (DAC)-hours in one week without respiratory protection will trigger dose assessment by WMCO Radiological Safety, Dosimetry Subsection.

4.2.2 Radioactive Surface Contamination

When personnel are working on the waste pit dikes, daily surveys of removable radioactive surface contamination will be performed by WMCO Radiological Safety personnel in the work area. Direct reading instruments and/or field swipe surveys will be used on drilling and sampling equipment. Alpha, beta, and gamma detectors will be used by a WMCO Radiation Technician to monitor each soil boring sample collected during the drilling operation.

4.2.3 Radiation Surveys

Prior radiation surveys will be used by WMCO Radiological Safety to establish general area radiation levels. Radiation surveys will be conducted by WMCO Radiological Safety personnel periodically during field activities. Portable radiation monitoring devices will be calibrated and maintained in accordance with WMCO Standard Operating Procedure SP-P-35-028, "Inspection and Performance Testing of Portable Radiation Survey Instruments."

4.2.4 Chemical Hazards

Exposure to significant chemical vapor concentrations are not expected during the dike stability investigation tasks. However, a photoionization detector (HNu) will be used by WMCO Environmental Monitoring personnel to monitor the air near the breathing zone of the drilling technicians during actual drilling operations. The HNu will also be used to monitor each soil boring sample for evidence of organic chemical contaminants.

4.2.5 Thermoluminescent Dosimetry

Thermoluminescent dosimeters (TLDs) will be worn by all field personnel during all aspects of dike stability investigation field activities.

4.2.6 Physical Hazards

Based on the range of average daily maximum air temperatures expected during field activities (76-84 degrees F), heat stress monitoring of personnel may be required. When the temperature is 85 degrees F or above, attention must be given to the possibility of heat stress. Heat stress monitoring of personnel will be directed by the RUST Project Engineer. Attachment A provides guidance for heat stress monitoring and prevention. Personnel should be aware that "cool vests" are available if needed. The RUST Project Engineer will check with WMCO Security each day prior to drilling activities in order to receive a weather forecast. If severe weather is forecast, frequent contact will be made with WMCO Security for updated weather reports.

All drill rig personnel will be required to wear hearing protection while the drill rig is in operation.

Each drill rig will be inspected by the drilling operator on a daily basis. Broken or worn parts will be replaced and safety features or interlocks will be tested to ensure that they are functional.

Underground and overhead utilities, i.e., electricity, natural gas, storm sewers, and telephone lines, will be identified and marked by WMCO utility engineers prior to any drilling activity.

All personnel who work within five feet of the edge of a waste pit which contains liquid are required to wear a personal flotation device.

4.3 Field Action Limit Guidelines

Table 4-1 presents the field action limit guidelines for radiological and chemical contaminants that may be encountered in the work environment during field activities.

Table 4-1
Field Action Limit Guidelines

INSTRUMENT	INTERVAL	LIMIT	ACTION
Alpha Probe[2/]	Pre-Job and Intermittent[1/]	500 cpm[3/] >25,000 cpm	APR[4/] Withdraw
Beta/Gamma Probe[2/]	Pre-Job and Intermittent[1/]	5,000 cpm[3/] >250,000 cpm	APR[4/] Withdraw
Hnu Meter	Intermittent[1/]	Detection to 10 ppm[5/] 10-25 ppm >25 ppm	APR[4/] SAR[6/] Withdraw

1/ "Intermittent is as deemed necessary by the WMCO Radiological Safety and/or Environmental Monitoring, or at a minimum of once a day.

2/ "Frisking" for alpha contamination and beta/gamma contamination using hand held alpha scintillator and Geiger Mueller detectors respectively.

3/ Above background.

4/ Full-face purifying respirators with HEPA or organic vapor, acid gas, fume cartridges (H.P. Review). Disposable protective clothing, such as Saranax coveralls and a step-off decontamination will also be required at any time APR are used.

5/ 1 ppm above background.

6/ Supplied Air Respirator.

Radiation levels in the work environment are expected to be less than 0.5 penetrating mrem/hr. These levels will be used to evaluate stay times on the Radiation Work Permit.

SECTION 5

PERSONAL PROTECTIVE EQUIPMENT

The specific personal protective equipment (PPE) required for each task will be determined at the time the FMPC Work Permit(s) is/are issued. The following type of personal protective gear is or may be required during each field activity of the dike stability investigation.

ITEM	NEED	JUSTIFICATION
Hard Hat	Yes	Head injury protection
Hearing Protection	Yes/No	As specified by IRS&T based on the noise level of drilling operations
Safety Glasses	Yes	Minimum requirement, but may be satisfied by full-face respirator
Safety Goggles/ Face Shield	Yes	Eye splash protection where full-face respirator is not used
Steel-Toed Shoes	Yes	Minimum requirement
Shoe Covers	Yes	Minimum requirement
Rubber/Latex Boots	Yes/No[1]	Additional protection against liquid contact
Inner Gloves	Yes/No[1]	Used beneath leather-palm gloves
Leather-Palm Gloves	Yes/No[1]	Physical protection of hands during drilling and sample handling
Rubber/Nitrite Gloves	Yes/No[1]	Additional protection against liquid contact
Controlled Area Coveralls	Yes	Minimum requirement for work in exclusion area
Cloth Hood	Yes/No	Additional splash protection
Full-face air purifying respirator	Yes/No	Respiratory protection
Dust filters	Yes	Respiratory protection when working with bentonite and Portland cement
Safety Belt and Line	Yes/No	Required by workers who may be working 4 feet or higher above the drill rig bed
Supplied Air Respirator	Yes/No	Respiratory protection
Personal Flotation Device	Yes/No	Required by workers conducting activities within 5 feet of waste pit edge

[1] Equipment item will be required if the WMCO Radiological Safety Technician determines that its use is necessary.

SECTION 6

WORK SITE SAFETY REQUIREMENTS

6.1 Equipment Safety

Drill rigs used for the dike stability investigation must be of a size adequate to accomplish the required project work without placing undue strain on the rig or mast and without endangering any person at the drill sites. All rotating shafts, pulleys, or chains must be covered with protective guards. Only rotating cathead drums will not be covered with a guard. Drill rigs must be maintained in good mechanical operating condition. All drill rigs must be equipped with an emergency kill switch readily accessible to crew personnel at the rear of the drill rig. Only authorized and qualified personnel will be allowed to operate the drill rig.

If a steam cleaner or power sprayer is used to clean/decontaminate drilling equipment, the cleaning must be conducted in a manner that directs the flow of high-pressure water or steam away from persons not involved in the cleaning. Hearing protection may be required if the cleaning device exceeds the OSHA noise standard of 90 decibels during operations. The use of a steam cleaner or power sprayer will likely be conducted at the FMPC Site Decontamination Facility.

All utility vehicles and trailers must be maintained in good condition for hauling loads to and from the drill sites. When parked at the drill site, all utility vehicles must be secured by wheel chocks or any other device to prevent accidental rolling or movement. Acceptable wheel chocks are those constructed of reinforced rubber or wood. Pickup trucks and other vehicles used primarily for personnel transportation do not require wheel chocks.

6.2 Drilling Area Safety

As soon as the drill rig is driven into position for drilling, a rope barricade must be erected around the entire drilling area. The barricade must extend outward from the rig far enough to contain any equipment that might fall from the rig. Signs which indicate the required safety equipment must be attached or posted on the barricade. The rope barricade must be maintained in position as long as the drill rig is on site.

6.3 Drill Rig Operations Safety

All required equipment and materials should be placed around the work site in a neat and orderly manner. Particular attention should be given at this time to potential safety hazards from objects which could fall from the bed of the drill rig or roll off a utility trailer. Drilling operations should not begin until all equipment is in place and the crew is ready to devote full attention to the required work. A minimum of two (2) persons must be present at the drill rig at all times of operation.

Drill rods and drill bit stabilizers must be transported to a work site either in a rack designed to hold such equipment on the drill rig or water truck, or on a utility trailer. If transported on a utility trailer, the drill rods and/or bit stabilizers must be held securely in place so that they will not roll form side to side. In addition, metal stakes must be in place on the sides of the trailer to prevent any loose rods from falling off.

At a work site, drill rods and drill bit stabilizers should be set out so that they can be picked up and laid down in a safe manner. They may be laid on crossties on the ground, on steel support racks, or left on the utility trailer. However, regardless of where they are placed, they must be secure from rolling and/or falling. Any support racks used to hold drill rods or stabilizers must have adequate strength to hold this equipment without collapsing. Drill rods and drill bit stabilizers placed directly on the ground must be chocked to prevent rolling.

All wire cabled on a drill rig are to be inspected by the rig operator before the start of work each day. Rig cables must be free of broken strands or weak spots. All wire cable that has broken strands must be replaced immediately. Under no circumstances should a drill rig operator exceed the rated cable load strength. Operators should also avoid putting excessive strain on the mast of the drill rig. In the event a drill rod string becomes stuck in the hole, the operator must attempt to work the equipment loose without endangering anyone by breaking a wire cable.

Certain minimum clearances apply to high-voltage power lines. Should the rig mast come within the minimum clearance as given below, the line must be de-energized, grounded, and locked out, or the work will not be done.

Line Voltage	Minimum Clearance
50 kV or less	10 feet
50 kV to 345 kV	20 feet
345 kV to 750 kV	34 feet

When setting up a drill rig on a hole location close to an overhead power line, the rig should be parked parallel to the line. This will avoid any possibility of the rig rolling into the line. Wheel chocks must be placed under the rig at all times when parked in the vicinity of an overhead power line. When working near power lines, care should be exercised to avoid breaking wire cables, which could then make contact with the line. The drill rig operator should avoid excessive strain on any cable while working in such a location. Any wire cable that is in marginal condition should be replaced before beginning work near a power line. In addition, drill rods are not to be leaned against the mast of the rig while working near an overhead power line.

Due to the construction of a drill rig, with the metal mast up in the air and the drill rods grounded in a hole full of mud and water, the mast can act as a very efficient lightning rod. For this reason, whenever a thunderstorm with visible lightning approaches a drilling work site, all work shall stop. The crew, including the operator, must move away from the drill rig and take cover in other vehicles or shelter. No one shall remain on or anywhere near the drill rig while a thunderstorm with lightning is in the area. The crew may return to the rig and resume work only when the thunderstorm has moved away from the area.

6.4 Sample Handling and Transportation Safety

Soil samples collected during the dike stability investigation will be preserved, packaged, and transported according to the specifications listed in ASTM-D 4220-83, "Standard Practices for Preserving and Transporting Soil Samples." Samples will be screened with direct reading radiation and chemical detection instruments before being taken from the drilling area. Containers into which soil samples are placed, will be surveyed and cleaned to ensure that no radiological contamination is transported off-site. If soil samples are transported off-site for analysis, DOE/FMPC and Department of Transportation (DOT) packaging, labelling, and transportation requirements will be met.

6.5 Borehole Abandonment Safety

During abandonment of the boreholes, bentonite and Portland cement will be combined to produce a grout mixture. Dust filters must be worn by personnel who open and mix these two products.

SECTION 7

SITE CONTROL

7.1 Access

The activities associated with the dike stability investigation will occur entirely within a Controlled Area of the FMPC. The Controlled Areas of the FMPC are controlled in accordance with the Radiological Controls Manual (FMPC-2084) which provides requirements for the following:

1) The wearing of dosimetry
2) Radiation safety training
3) Limitations on entry for personnel with open wounds or recent medical tests with radionuclides
4) Radiological area postings
5) Protective clothing
6) Limitations on food, beverages, and tobacco
7) General rules for work
8) Contamination control
9) Monitoring and showering requirements upon exiting from the Controlled Area and Radiological Areas.

A Radiation Work Permit with the specifications of this task-specific health and safety plan will be required for work in the area.

Per the requirements of 29 CFR Part 1910.120, an exclusion zone (defined by a barricade rope) will be established around the immediate drilling/soil sampling area. The exclusion zone is an area of high potential hazard due to physical, chemical, and/or radiological dangers. Access to the exclusion zone will be restricted to trained and certified personnel who are required to enter to perform their job duties. Due to the nature of the drilling activity, the exclusion zone location and boundaries may vary for each drilling site. Radiological Safety will establish controls consisting of step-off pads at the Controlled Area exit point. This area will be used for monitoring at the step-off pad, removal of disposable personal protective equipment. Only limited equipment decontamination will be allowed at the work site.

7.1.1 Radiological Postings

Radiological areas will be posted in accordance with FMPC Radiation Control Manual (FMPC-2084). Table 7-1 provides a brief summary of posting requirements applicable to radionuclides likely to be encountered during drilling and sampling activities. Radium-226 and thorium 230 are the radionuclides of concern, unless otherwise determined by WMCO Radiological Safety.

7.2 Bioassay Samples

Site personnel involved in this project are required to participate in a routine periodic urine assay program. Any suspected exposure to hazardous substances shall be reported and require additional sampling. If air sample analyses indicate that thorium levels in air were sufficient to deliver more than eight DAC-hours to an individual, in-vivo monitoring and/or other bioassay measurements will be performed on that individual as deemed appropriate by the WMCO Dosimetry Subsection. Air samples, which indicate that personnel may have been exposed to greater than 40 DAC-hours in one week, will trigger dose assessment by WMCO Dosimetry Subsection.

Table 7-1
Posting Requirements

Regulated Area	Contamination Level
(Ra-226, Ra-228, Th-228, and Th-230)	> 20 dpm/100 cm^2 removable > 300 dpm/100 cm^2 fixed and removable
(Beta-gamma emitters)	> 1,000 dpm/100 cm^2 removable > 5,000 dpm/100 cm^2 fixed and removable
Contaminated Area	
(Ra-226, Ra-228, Th-228, and Th-230)	> 200 dpm/100 cm^2 removable > 3,000 dpm/100 cm^2 fixed and removable
(Beta-gamma emitters)	> 10,000 dpm/100 cm^2 removable > 50,000 dpm/100 cm^2 fixed and removable
Airborne Radioactivity Area	Potential for 0.8 DAC hours per shift or > 50,000 dpm/100 cm^2 alpha surface contamination
Respirator Area	> 8.0 DAC hours in a single shift or > 2 DAC hours per shift averaged over one calendar quarter
Radiation Area	> 2.5 mrem/hr and < 100 mrem/hr
SOURCE: FMPC Radiation Control Manual (FMPC-2084), December 31, 1990.	

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7.3 Medical Monitoring

In accordance with 29 CFR 1910.120 requirements, all personnel are required to participate in a medical monitoring program which consists of the following items:

1) A baseline medical examination
2) Annual medical examination
3) Medical examinations may be required after potential exposures
4) WMCO respirator clearance for users.

Each individual shall be subject to a medical surveillance approval by the WMCO Director, Medical Services. The approval statement shall certify that each individual is medically qualified to perform the work and is physically fit to wear PPE.

7.4 Training Requirements

All personnel assigned to the tasks will, as a minimum, meet the following training requirements:

1) Documented review of the health and safety plan for this work including site specified hazards and procedures.
2) WMCO radiation safety training
3) WMCO annual respiratory training and quantitative fit test or equivalent approved by WMCO Industrial Hygiene
4) Site nuclear criticality training
5) 40-hour OSHA training
6) 8-hour annual refresher training, as necessary
7) 8-hour supervisory training (for supervisors)
8) 24-hour supervised field experience (general site workers) or 8-hour supervised field experience (occasional site workers)
9) FMPC site orientation video.

The completion of this training shall be documented by the site training personnel.

7.5 Safety Meetings

A safety meeting, which must be documented, shall be conducted prior to the start of each day's work. These safety meetings will cover the following applicable subjects:

1) Work operations
2) Personal protective equipment
3) All monitoring data
4) Hazard communications
5) Monitoring tests and results
6) Decontamination
7) Task organization
8) Physical stress
9) Emergency procedures
10) Communications
11) General safety
12) Housekeeping.

SECTION 8

EXPOSURE SYMPTOMS

Exposure to low levels of radiation does not produce acute exposure symptoms. Such exposures may cause delayed effects such as cancer. Since any radiation exposure may involve some degree of risk, exposures are to be kept as low as reasonably achievable (ALARA). Personnel radiation exposures will be monitored by thermoluminescent dosimeters.

SECTION 9

SITE ENTRY PROCEDURES

Prior to the initiation of the overall project and/or the beginning of daily work activities, the RUST Project Engineer will ensure that the following procedures have been conducted:

1) Procure the necessary work permits (radiation, excavation and penetration, and chemical/hazardous material) for drill rig operations.
2) Conduct safety inspection of all heavy equipment.
3) Establish radio contact, location, and start and stop times with FMPC Control Center.
4) Conduct pre-work plan and safety meeting prior to each day's work activities; exclusion zone, contamination reduction zone, and break areas will be identified.
5) Discuss alternate communication signals (if applicable).
6) Perform respirator check-out and inspection prior to use.
7) Inspect and calibrate all devices to be used for monitoring volatile organic compounds.
8) Assign all personnel who will be working in the exclusion zone (per 29 CFR 1910.120 requirements) to a buddy system.
9) Test and maintain clean liquid in eyewash station.
10) Verify location and operation of all emergency equipment. A list of emergency equipment is shown in Section 12.5.

Entrance to the exclusion zone will be controlled by the RUST Project Engineer (or designee).

SECTION 10

DECONTAMINATION

An exclusion zone will be established around each drilling location in order to control the potential spread of contamination from work activities. As stated in Section 7.1, a contamination reduction zone will be established for removal of disposable personal protective clothing and limited cleaning of contaminated equipment. Personnel will enter and exit the posted work area through a step-off pad. Upon exit, personnel will remove any disposable protective clothing and monitor themselves and any outgoing equipment for contamination. Additionally, decontamination of drilling equipment may be required between borings, or while advancing a boring, to minimize the potential for spread of contamination. All personnel and outgoing equipment will be monitored for contamination in accordance with WMCO Radiation Safety procedures. Action limits on equipment of 20 dpm/100 cm^2 alpha fixed plus removable, 1,000 dpm/100 cm^2 beta/gamma removable, and 5,000 dpm/100 cm^2 beta/gamma fixed plus removable will initiate decontamination activities. Any detectable alpha contamination and greater than 100 cpm beta-gamma contamination on any personnel will be reported to WMCO Radiological Safety, who will assist in decontamination in accordance with WMCO Radiation Safety procedures. The majority of equipment associated with drilling operations will be decontaminated at the FMPC Site Decontamination Facility. Only sampling equipment, i.e., pans, trowels, and other limited drilling equipment, as specified by WMCO, will be decontaminated at the work site. If the equipment cannot be decontaminated to acceptable levels, it will be disposed as radioactive waste.

SECTION 11

WASTES

Waste that is expected to be generated during work activities includes soil borings and cuttings, drilling fluids, disposable personal protective clothing, decontamination solution and material, and contaminated well casings. Potentially contaminated waste material will be collected, segregated, and placed in drums or other containers. Disposable protective clothing will be placed in plastic bags and disposed as compactible, potentially contaminated waste. Liquid waste collected from drilling and decontamination efforts will be transferred to the appropriate FMPC storage location.

Waste drums or containers shall meet the requirements of 49 CFR Parts 171-178, 40 CFR Parts 265-265 and 300, and OSHA. Hazard warning labels will immediately be applied to all drums as specified by WMCO Transportation and Solid Waste Compliance.

SECTION 12

CONTINGENCY PLANS

The plans shall be consistent with FMPC-2046, "FMPC Emergency Plan."

12.1 Incidents or Injuries Involving Possible Intake of Radiological or Chemical Substances by Employees

Incidents or injuries involving potential intake of uranium or other hazardous substances shall be reported to the RUST Project Engineer and the WMCO Medical Section by the involved employee, and an Incident Investigation Report shall be completed by the involved employee. Incident urine samples shall be submitted at the end of the shift and at the start of the next shift if exposure involves uranium.

12.2 Pre-Emergency Planning

During the training and pre-work safety meetings, employees involved in this task shall be trained and reminded of the provisions of the plant emergency procedure, alarm signals and communications, evacuation routes, emergency reporting, and the importance of maintaining continual communications with FMPC Emergency Preparedness personnel via two-way radio or cellular phone.

12.3 Lines of Authority

The RUST Project Engineer or his designated representative, has the primary responsibility for the prevention of and the initial response to emergency conditions. The RUST Project Engineer will direct emergency response actions at the work site until relieved by the WMCO Assistant Emergency Duty Officer (AEDO), or the Emergency Response Team. In the event an emergency does occur, the individual involved in or observing the condition shall immediately notify the following personnel in order of availability: the RUST Project Engineer; the communications center; the AEDO; the WMCO Health and Safety Officer; the Project Engineer/Operable Unit Manager.

The AEDO is responsible for ensuring that corrective actions have been implemented, the appropriate personnel notified, and reports completed as required. Personnel observing unsafe conditions at the work site shall report same to the RUST Project Engineer or to the WMCO Health and Safety Officer, who will stop work activity in the affected area until the hazardous condition can be remedied.

12.4 Evacuation

In the event an evacuation of the waste pit and Clearwell area is required, the RUST Project Engineer will be responsible for notifying all personnel involved. All personnel will proceed to the rally point as designated by the RUST Project Engineer. The FMPC-designated rally points within the DOE property are shown on Figure 12-1. The designated location for the waste pits area is Rally Point 6. This rally point is situated adjacent to the water tower and Plant 1. When the RUST Project Engineer is informed that an all-clear condition has been achieved, personnel will be released from the rally point.

In the event of an emergency which necessitates an evacuation of the Exclusion Area, the 2-2, 2-2 alarm signal shall be sounded over the plant alarm system; a voice message will follow over the Emergency Message System (EMS) instructing employees to go to their designated rally points. Personnel shall immediately proceed to the rally point. Personnel will follow instructions given by the rally point coordinator and participate in the accountability process. When an all-clear condition has been achieved, personnel will be released from the rally point. It is conceivable that the plant alarm signal or EMS will not be audible in certain remote locations of the work area. For this reason, communications with the FMPC communications control center via two-way radio or cellular phone will be maintained at all times by the RUST Project Engineer.

12.5 Emergency Equipment

The following safety equipment will be available for employee usage:

1) Fire extinguisher
2) Portable eyewash
3) Absorbent
4) Telephone
5) Spill drums
6) Two-way radio
7) Respirators
8) Clean-up materials
9) Local evacuation alarm
10) Life ring or ring buoy and attached rope.

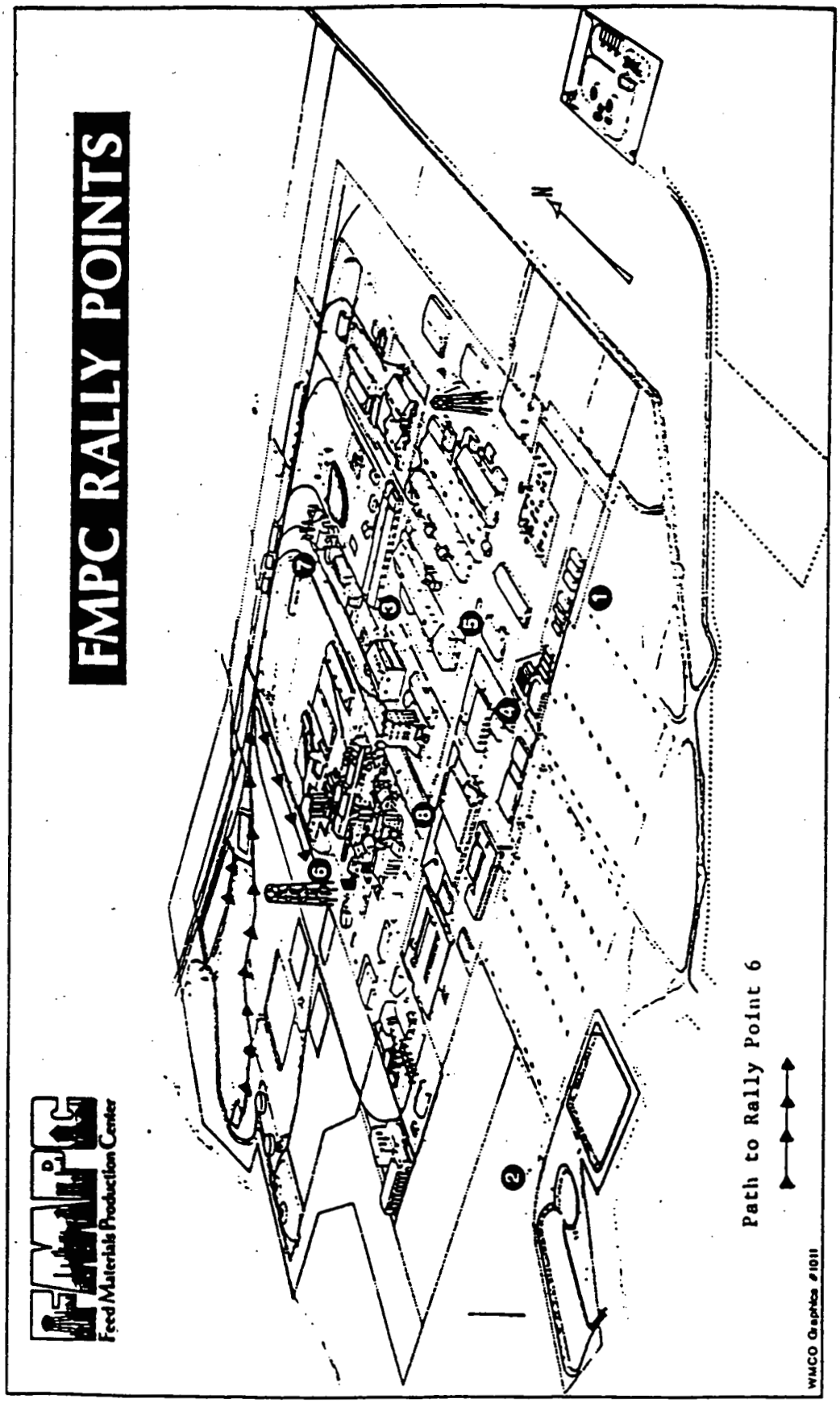

Figure 12-1 - FMPC Rally Points

12.6 Emergency Notification

All emergencies, including spills, leaks, or dike failure shall be reported immediately. Emergencies can be reported by telephone dialing x6511 or by contacting the communications center via two-way radio. Any additional information pertaining to an emergency shall be reported to the responding personnel to assist in defining appropriate response to the emergency.

12.7 Fire, Explosion, or Medical Emergency

In the event of a fire, explosion, or medical emergency, the communication center shall be notified immediately by two-way radio, by manual fire alarm, or by calling x6511. The communication center operator will activate the emergency response team and dispatch them to the emergency location. If a fire is in the incipient stage and perceived controllable without endangering oneself, personnel may use available fire extinguishers. If it is not in the incipient stage, personnel in the immediate area shall evacuate to a safe position and await instructions.

If medical attention is required, and the nature of the injury or illness is minor the affected personnel shall be taken to the FMPC Medical Department Facility located as shown on Figure 12-2. The path from the waste pits and Clearwell area is also indicated on Figure 12.2. The FMPC ambulance will be called to transport individuals who have suffered major injury or illness.

12.8 Spill Control Contingency Plan

Spills, regardless of their size or the classification of the liquid, shall be reported immediately. Emergencies can be reported by telephone by dialing x6511 or by contacting the communications center via two-way radio. The Emergency Response Team and AEDO will respond to the spill according to the FMPC Spill Control Contingency Plan.

12.9 Additional Information

12.9.1 Hospitals

The FMPC Medical Department Facility (Building 53) is the primary choice for on-site injuries. The FMPC ambulance will transport the injured workers to the nearest hospital, if necessary. FMPC maintains an emergency response capability that includes an ambulance and Emergency Medical Technicians.

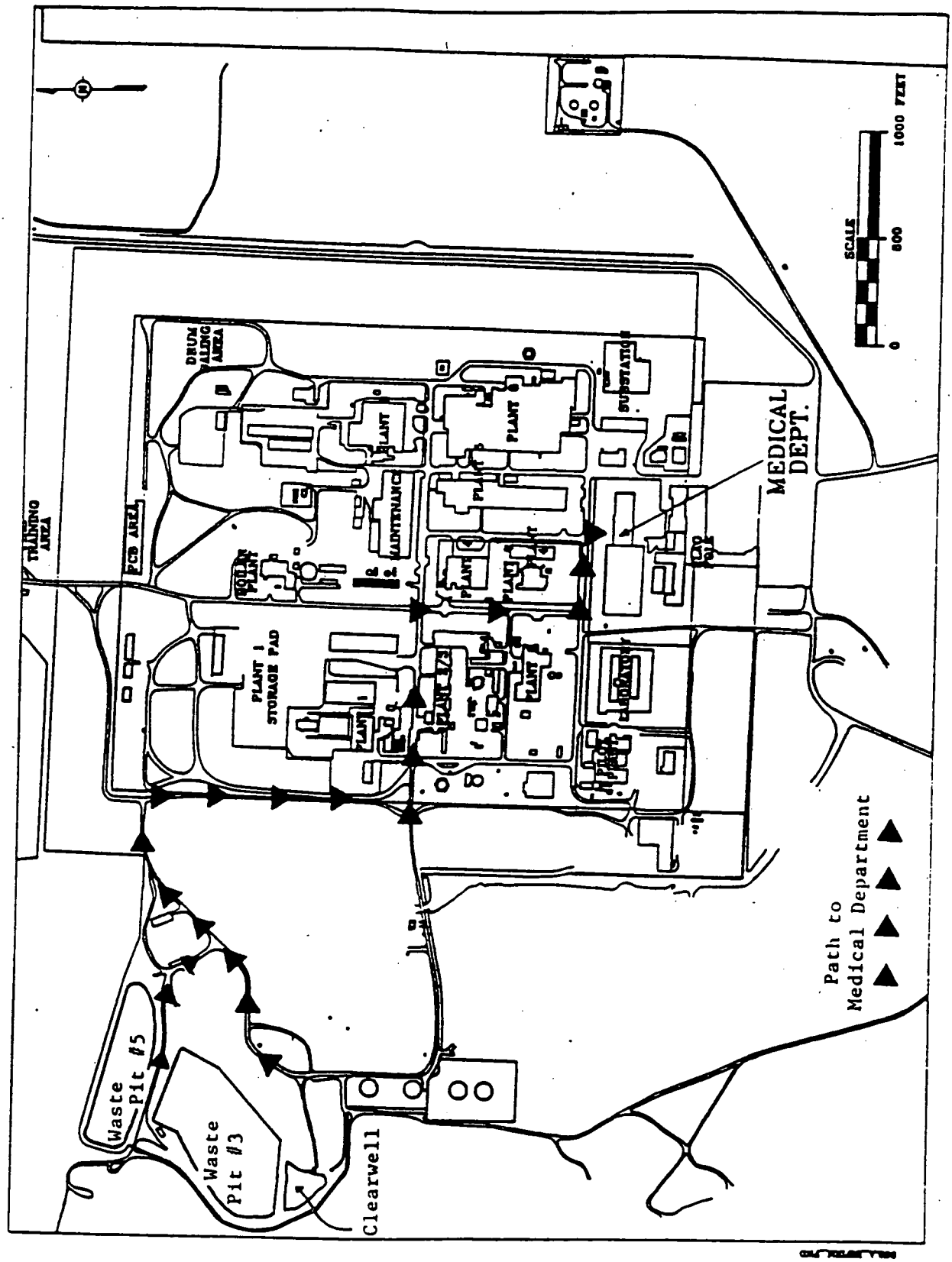

Figure 12-2 - Location of FMPC Medical Department Facility

12.9.2 Emergency Telephone Numbers

			Radio Frequency
EMERGENCY RESPONSE	738-6511	Control	
Industrial Hygiene	738-6207	357	F2
Radiation Safety	738-6889	355	F2
Fire and Safety	738-6235	303	F2
(Safety and Health Officer)	738-6231		
Assistant Emergency Duty	738-6431	202	F2
Officer (AEDO)	or 738-6295		
RUST Project Engineer	738-6310		F6
(J.P. McCormack)			
RUST Safety and Health Officer	738-6820		F6
(Larry Welton)			
Ambulance	738-6511		
Hospital	738-6511		
Fire	738-6511		

SECTION 13

CONFINED SPACE ENTRY

A Confined Space Entry permit will not be required because there will not be any entries into confined spaces during the dike stability investigation.

SECTION 14

APPROVAL AND COMPLIANCE STATEMENT

14.1 Provisions

This site-specific Health and Safety Plan was produced for the FMPC and addresses safety-related aspects of all work related to the dike stability investigation on Waste Pits 3 and 5 and the Clearwell. Personnel who perform the tasks listed in Section 1 must read, understand, and agree to abide by the procedures set forth in both this Health and Safety Plan and any subsequent amendments. Site workers are required to sign the attached approval and compliance acknowledgement form.

14.2 Amendments to Plan

This Health and Safety Plan is based on information available at the time of preparation. Unexpected conditions may arise which require reassessment of safety procedures. Unplanned activities and/or changes in the hazard status shall require a review of, and may result in changes to, this plan. Changes in the anticipated hazard status or unplanned activities are to be recorded as an amendment to this plan. Amendments must be approved by the plan author and WMCO IRS&T must be notified in writing of plan amendments.

Compliance with the provisions of this Health and Safety Plan may be audited through announced or unannounced site visits. All provisions of this Health and Safety Plan are to be implemented. Reasons for field actions/changes, when they are necessary, should be fully documented.

HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT FORM

I have been informed and understand and will abide by the procedures set forth in the Health and Safety Plan and Amendments for the Dike Stability Investigation of Waste Pits 3 and 5 and the Clearwell at the FMPC site.

Printed Name	Signature	Representing	Date

ATTACHMENT A

HEAT STRESS PROCEDURES

Heat Stress and Other Physiological Factors

Wearing PPE puts a hazardous waste worker at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, regular monitoring and other preventive precautions are vital.

Individuals vary in their susceptibility to heat stress. Factors that may predispose someone to heat stress include:

- Lack of physical fitness.
- Lack of acclimatization.
- Age.
- Dehydration.
- Obesity.
- Alcohol and drug use.
- Infection.
- Sunburn.
- Diarrhea.
- Chronic disease.

Reduced work tolerance and the increased risk of excessive heat stress is directly influenced by the amount and type of PPE worn. PPE adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. Therefore, when selecting PPE, each item's benefit should be carefully evaluated in relation to its potential for increasing the risk of heat stress. Once PPE is selected, the safe duration of work/rest periods should be determined based on the:

- Anticipated work rate.
- Ambient temperature and other environmental factors.
- Type of protective ensemble.
- Individual worker characteristics and fitness.

Monitoring

Because the incidence of heat stress depends on a variety of factors, all workers, even those not wearing protective equipment, should be monitored.

- For workers wearing permeable clothing (e.g., standard cotton or synthetic work clothes), follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values for Heat Stress [11]. If the actual clothing worn differs from the ACGIH standard ensemble in insulation value and/or wind and vapor permeability, change the monitoring requirements and work/rest schedules accordingly [12].

Source:

NIOSH/OSHA/USCG/EPA Occupational Safety And Health Guidance Manual for Hazardous Waste Site Activities, October 1985.

- For workers wearing semipermeable or impermeable[1] encapsulating ensembles, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C) [6].

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

  If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third [12].

- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

  If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

  If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third [12].

  Do *not* permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C)[12].

- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. *The body water loss should not exceed 1.5 percent total body weight loss in a work day* [12].

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see Table 8-10). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Prevention

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat injuries. To avoid heat stress, management should take the following steps:

- Adjust work schedules:

  Modify work/rest schedules according to monitoring requirements.

  Mandate work slowdowns as needed.

  Rotate personnel: alternate job functions to minimize overstress or overexertion at one task.

  Add additional personnel to work teams.

  Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.

- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.

- Maintain workers' body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat [14]. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:

  Maintain water temperature at 50° to 60°F (10° to 15.6°C).

  Provide small disposable cups that hold about 4 ounces (0.1 liter).

  Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.

  Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.

  Weigh workers before and after work to determine if fluid replacement is adequate.

- Encourage workers to maintain an optimal level of physical fitness:

  Where indicated, acclimatize workers to site work conditions: temperature, protective clothing, and workload (see *Level of Acclimatization* at the end of this chapter).

  Urge workers to maintain normal weight levels.

- Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure. Cooling devices include:

  Field showers or hose-down areas to reduce body temperature and/or to cool off protective clothing.

  Cooling jackets, vests, or suits (see Table 8-5 for details).

- Train workers to recognize and treat heat stress. As part of training, identify the signs and symptoms of heat stress (see Table 8-11).

Other Factors

PPE decreases worker performance as compared to an unequipped individual. The magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. This section discusses the demonstrated physiological responses to PPE, the individual human characteristics that play a factor in these

[1]Although no protective ensemble is "completely" impermeable, for practical purposes an outfit may be considered impermeable when calculating heat stress risk.

Table 8-10. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK ENSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8° - 32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5° - 87.5°F (28.1° - 30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5° - 82.5°F (25.3° - 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5° - 77.5°F (22.5° - 25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13].

[a]For work levels of 250 kilocalories/hour.

[b]Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 × % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

[c]A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Table 8-11. Signs and Symptoms of Heat Stress[a]

- Heat rash may result from continuous exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen
- Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting
- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

[a]Source: Reference [6].

responses, and some of the precautionary and training measures that need to be taken to avoid PPE-induced injury.

The physiological factors may affect worker ability to function using PPE include:

- Physical condition.
- Level of acclimatization.
- Age.
- Gender.
- Weight.

Physical Condition

Physical fitness is a major factor influencing a person's ability to perform work under heat stress. The more fit someone is, the more work they can safely perform. At a given level of work, a fit person, relative to an unfit person, will have [5,8,15,16]:

- Less physiological strain.
- A lower heart rate.
- A lower body temperature, which indicates less retained body heat (a rise in internal temperature precipitates heat injury).
- A more efficient sweating mechanism.
- Slightly lower oxygen consumption.
- Slightly lower carbon dioxide production.

Level of Acclimatization

The degree to which a worker's body has physiologically adjusted or acclimatized to working under hot conditions affects his or her ability to do work. Acclimatized individuals generally have lower heart rates and body temperatures than unacclimatized individuals [17], and sweat sooner and more profusely. This enables them to maintain lower skin and body temperatures at a given level of environmental heat and work loads than unacclimatized workers [18]. Sweat composition also becomes more dilute with acclimatization, which reduces salt loss [8].

Acclimatization can occur after just a few days of exposure to a hot environment [15,16]. NIOSH recommends a progressive 6-day acclimatization period for the unacclimatized worker before allowing him/her to do full work on a hot job [16]. Under this regimen, the first day of work on site is begun using only 50 percent of the anticipated workload and exposure time, and 10 percent is added each day through day 6 [16]. With fit or trained individuals, the acclimatization period may be shortened 2 or 3 days. However, workers can lose acclimitization in a matter of days, and work regimens should be adjusted to account for this.

When enclosed in an impermeable suit, fit acclimatized individuals sweat more profusely than unfit or unacclimatized individuals and may therefore actually face a greater danger of heat exhaustion due to rapid dehydration. This can be prevented by consuming adequate quantities of water. See previous section on *Prevention* for additional information.

Age

Generally, maximum work capacity declines with increasing age, but this is not always the case. Active, well-conditioned seniors often have performance capabilities equal to or greater than young sedentary individuals. However, there is some evidence, indicated by lower sweat rates and higher body core temperatures, that older individuals are less effective in compensating for a given level of environmental heat and work loads [19]. At moderate thermal loads, however, the physiological responses of "young" and "old" are similar and performance is not affected [19].

Age should not be the sole criterion for judging whether or not an individual should be subjected to moderate heat stress. Fitness level is a more important factor.

Gender

The literature indicates that females tolerate heat stress at least as well as their male counterparts [20]. Generally, a female's work capacity averages 10 to 30 percent less than that of a male [8]. The primary reasons for this are the greater oxygen-carrying capacity and the stronger heart in the male [15]. However, a similar situation exists as with aging: not all males have greater work capacities than all females.

Weight

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). Heat loss (dissipation) is a function of surface area and heat production is dependent on mass. Therefore, heat balance is described by the ratio of the two.

Since overweight individuals (those with a low ratio) produce more heat per unit of surface area than thin individuals (those with a high ratio), overweight individuals should be given special consideration in heat stress situations. However, when wearing impermeable clothing, the weight of an individual is not a critical factor in determining the ability to dissipate excess heat.

FMPC

RISK ASSESSMENT REPORT

Page 1 of 1 Risk Assessment Report Number RAR-OU1P011-791 DEPT SECTION SEQ

Risk Management Plan Number to be assigned — DEPT SECTION SEQ

Title: Berm Investigation of Waste Pits 3&5 and the Clearwell Location: Waste Pit Area Date: July 29, 1991 Revision No.: 0

POSSIBLE FAILURE/CONCERN	SERIOUSNESS (circle one for each case) Negligible / Low / Moderate / High / Very High	SERIOUSNESS RATIONALE	POSSIBLE CAUSE OF FAILURE/CONCERN (complete if seriousness other than negligible)	EFFECT OF FAILURE/CONCERN	NORMAL STANDARDS OR PROCEDURES TO ELIMINATE OR MINIMIZE A FAILURE/CONCERN	PROBABILITY (circle one for each case) Negligible / Low / Moderate / High / Very High	QUALITY LEVEL (circle one for each case)
1) Failure of berm due to structural degradation	1 2 3 4 **(5)**	Failure of berm would allow the release of pit materials to Patty's Run (National media coverage)	Failure of berm due to loss of structural integrity caused by berm study activities	Release of contaminated potentially hazardous wastes to Patty's Run	Design A/E firm has determined that berm failure during investigation activities is not likely assuming the absence of natural phenomena hazards	1 **(2)** 3 4 5	1 2 **(3)** 4
2) Risk of skin contamination	1 **(2)** 3 4 5	Skin contamination will require on-site personnel decontamination	Skin contact with contaminated soil or water	Personnel skin contamination and on-site decontamination	Process clothing gloves and showering upon exiting the process area are required to prevent and control personnel contamination	1 2 3 4 **(5)**	1 2 **(3)** 4
3) Personnel falling into waste pit and drowning	1 2 3 4 **(5)**	Falling into pit could result in drowning i.e., death	Working near edge of waste pit allows for numerous opportunities to fall into pit	Drowning i.e., death	Project Specific Health and Safety Plan requires the donning of life preservers if working within 5 feet of edge of waste pit	1 2 **(3)** 4 5	1 **(2)** 3 4
	1 2 3 4 5					1 2 3 4 5	1 2 3 4

PREPARER FACILITY OWNER OPERATIONS SAFETY AND HEALTH QUALITY ASSURANCE APPROVAL

8/19/91 For JLC 8/19/91 8/21/91 8/22

FMPC-T-2501 (REV. 3/30/89)

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