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EPA ID No. IN5 170 023 498

# RCRA FACILITY INVESTIGATION PHASE II RELEASE ASSESSMENT DRAFT WORK PLAN FOR SOLID WASTE MANAGEMENT UNITS #15/06, #14/00, #16/16 NAVAL SURFACE WARFARE CENTER, CRANE DIVISION CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Southern Division
Environmental Branch, Code 186ND
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29411-0068

Submitted by:
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Contract No. N62472-90-D-1298
Contract Task Order 0078

May 1993

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Admin. Records
Code 095

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA 47522-5000

IN REPLY REFER TO:

5090
Ser 095/309/H11.9
11 JUN 1993

U.S. Environmental Protection Agency, Region V
Region V Waste Management Division
Attn: Ms. Carol Witt-Smith (HRP-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Ms. Witt-Smith:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV) submits two copies of the Draft Part 2 RFI Phase III Soils Work Plan for the Ammunition Burning Grounds, Solid Waste Management Unit (SWMU) 03/10, as enclosure (1). Two copies of the Draft RFI Release Assessment Work Plan for Roads and Grounds, Sanitary Landfill and Lithium Battery, and Building 146 (SWMUs 15/06, 14/00, and 16/16 respectively). Enclosure (3) is the required Certification Statement.

NAVSURFWARCENDIV Crane point of contact is Mr. Thomas J. Brent, Code 09510, telephone 812-854-1132.

Sincerely,

G. K. HILL
Deputy Director, Public Works Directorate
By direction of the Commander

Encl:
(1) Draft Part 2 RFI Phase III Soils Work Plan for the Ammunition Burning Grounds
(2) Draft RFI Release Assessment Work Plan
(3) Certification Statement

Copy to: (w/o encl)
SOUTHNAVFACENGCOM, (CODE 185ND)
COMNAVSEASYSCOM (SEA 654E)
USAE-WES, BILL MURPHY (GG-YH)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Deputy Director,
Public Works Directorate

11 JUN 1993

TITLE DATE

Enclosure (3)

RUST ENVIRONMENT & INFRASTRUCTURE

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May 27, 1993
DNSB/93-0042

Mr. Jim Hunsicker
Environmental Protection Branch Manager
Naval Weapons Support Center
Crane, IN 47522-5009

Re: Contract No. N62472-90-D-1298 "CLEAN"
Draft Work Plan Submittal
CTO #0078, RFI Phase II Release Assessment
Naval Surface Warfare Center Crane Division
RUST Project No. 20617

Dear Mr. Hunsicker:

Enclosed for your review are eight copies of the Draft RCRA Facility Investigation Phase II Release Assessment Work Plan for Solid Waste Management Units #15/06, #14/00, and #16/16 for Naval Surface Warfare Center, Crane Division, Indiana. Copies of this document have been distributed to all other Technical Review Committee members according to the enclosed Distribution List.

Sincerely,

Jeffrey D. Maletzke

Jeffrey D. Maletzke
Project Manager

enc: As Noted

cc: Roger Boucher, NORTHDIV (letter only)
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L/L/BK6/BK8

# PREFACE

This preface is to inform the reader of a name change which occurred at Naval Weapons Support Center Crane (NWSCC) in 1992. The new name for the facility is Naval Surface Warfare Center, Crane Division (NAVSURFWARCENDIV). The former facility title of NWSCC may appear on Navy-modified figures or as a referenced information source. However, the work plan text correctly identifies the facility as NAVSURFWARCENDIV.

6/RP/78WPD/COVER

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## LIST OF ACRONYMS/ABBREVIATIONS

| | |
|---|---|
| ABG | Ammunition Burning Ground |
| ALPEC | Ammunition Loading Production Engineering Center |
| CAAA | Crane Army Ammunition Activity |
| CASCO | Central Ammunition Supply Control Office |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CHSM | Corporate Health and Safety Manager |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| CLP | Contract Laboratory Program |
| CMI | Corrective Measure Implementation |
| CMS | Corrective Measures Study |
| CTO | Contract Task Order |
| DOT | Department of Transportation |
| EMR | Phase I Environmental Monitoring Report |
| FDC | Field Data Coordinator |
| FTL | Field Team Leader |
| HASP | Health and Safety Plan |
| HMTC | Hazardous Material Technical Center |
| HMX | Cyclotetramethylene Tetranitramine |
| HSWA | Hazardous and Solid Waste Amendments |
| IAS | Initial Assessment Study |
| IDEM | Indiana Department of Environmental Management |
| IATA | International Air Transport Association |
| IRP | Installation Restoration Program |
| ISBH | Indiana State Bureau of Health |
| MCL | Maximum Concentration Level |
| MSL | Mean Sea Level |
| NACIP | Navy Assessment and Control of Installation Pollutants |
| NAD | Naval Ammunitions Depot |
| NAVFAC | Navy Facilities Engineering Command |
| NAVSURFWARCENDIV | Naval Surface Warfare Center, Crane Division |
| NEESA | Naval Energy and Environmental Support Activity |
| NEIC | National Enforcement Investigation Center |
| NGVD | National Geodetic Vertical Datum |
| NORTHDIV | Northern Division |
| NWSCC | Naval Weapons Support Center Crane |
| OTA | Ordnance Test Area |
| PAH | Polyaromatic Hydrocarbons |

## LIST OF ACRONYMS/ABBREVIATIONS (Continued)

| | |
|---|---|
| PEP | Propellants, Explosives, Pyrotechnics |
| PID | Photoionization Detector |
| PPE | Personal Protective Equipment |
| PWO | Public Works Office |
| QA/QC | Quality Assurance/Quality Control |
| QAPP | Quality Assurance Project Plan |
| RA | Release Assessment |
| RCRA | Resource Conservation and Recovery Act |
| RDX | Cyclotrimethylene Trinitramine = Hexahydro-1,3,5-trinitro-1,3,5-triazine |
| RFI | RCRA Facility Investigation |
| RI | Remedial Investigation |
| RPM | Remedial Project Manager |
| SCS | Soil Conservation Service |
| SHSO | Site Health and Safety Officer |
| SMCL | Secondary Maximum Concentration Level |
| SOP | Standard Operating Procedures |
| SOW | Statement of Work |
| SWMU | Solid Waste Management Unit |
| TNT | 2,4,6-Trinitrotoluene |
| TRC | Technical Review Committee |
| TSD | Treatment, Storage, or Disposal |
| USACE | United States Army Corps of Engineers |
| USCS | Unified Soil Classification System |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| UST | Underground Storage Tank |
| VOC | Volatile Organic Compounds |

6/RP/78WPD/TOC

# 1.0 INTRODUCTION

## 1.1 RCRA FACILITY INVESTIGATION OBJECTIVES

This Release Assessment (RA) Work Plan was completed as part of a Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation being conducted for Solid Waste Management Units (SWMUs) #15/06, #14/00, and #16/16 at the Naval Surface Warfare Center, Crane Division (NAVSURFWARCENDIV). This Work Plan is submitted to the Southern Division, Naval Facilities Engineering Command in response to Contract Task Order (CTO) No. 0078 under Comprehensive Long-Term Environmental Action Navy (CLEAN) Prime Contract No. N62472-90-D-1298 and Subcontract No. GCPP-91-001-1298.

The purpose of the RA is to demonstrate the absence or presence of hazardous waste or hazardous constituents released to the environment within the following SWMUs identified as posing potential threat to human health or the environment:

- SWMU #15/06: Roads and Grounds Area
- SWMU #14/00: Sanitary Landfill and Lithium Battery
- SWMU #16/16: Cast High Explosive Fill/Incinerator Building 146

The RA encompasses a multi-media study focused on verifying suspected releases of concern at each SWMU.

## 1.2 RCRA PERMIT REQUIREMENTS

On December 23, 1989, the U.S. Environmental Protection Agency (USEPA) issued the federal portion of the Final RCRA Permit for NAVSURFWARCENDIV to the U.S. Navy. This permit established the Hazardous and Solid Waste Amendments (HSWA) Corrective Action Requirements and Compliance Schedules obligating the U.S. Navy to perform RCRA Facility Investigations (RFIs) at 30 SWMUs, to conduct Corrective Measure Studies (CMSs), and implement Corrective Measures if needed. The federal portion of the RCRA Permit consists of Permit Conditions and Attachments. Permit Conditions contains the following sections: I. Standard Conditions, II. General Facility Conditions, III. Land Disposal Requirements, and IV. Corrective Action Requirements. The Permit Attachments include: I. Waste Analysis Plan, II. Dioxin Management Plan, and III. RCRA Corrective Action Plan and Activities. Section IV of the RCRA Permit Conditions identifies the Corrective Action Requirements including the compliance schedule for newly identified and previously delineated SWMUs. Attachment III describes the phases and scopes of RFIs, CMSs, and Corrective Measure Implementations (CMIs).

The RCRA Permit for NAVSURFWARCENDIV identifies SWMU-specific scopes for RFIs according to a phased approach defined as follows:

- RFI Phase I - Environmental Monitoring Report - Documents the past and present monitoring requirements under Federal, State, and local authorities, known releases of hazardous waste or hazardous constituents, and Corrective Measures taken.

- RFI Phase II - Release Assessment - Documents the absence or presence of hazardous waste or hazardous constitutents in specified media.

- RFI Phase III - Release Characterization - Determines the rate and extent of migration of hazardous waste or hazardous constituents and their concentrations in specified media.

The RCRA Permit for NAVSURFWARCENDIV requires that RFI Phase I Environmental Monitoring Reports (EMRs) be submitted for many of the SWMUs at NAVSURFWARCENDIV. An EMR addressing SWMUs #15/06, #14/00, and #16/16 was prepared and submitted in accordance with USEPA guidance documents, the RCRA Permit Section IV, and Attachment III in August 1992 (Halliburton NUS, 1992). Based on information and conclusions presented in the EMR, RFI Phase II Release Assessments for groundwater, surface water, and soil were recommended for each SWMU. This RA Work Plan to implement Phase II Release Assessments has been prepared in accordance with USEPA guidance documents and the RCRA Permit, based on recognition of the requirement for continuing the RFI Corrective Action process at the three SWMUs.

## 1.3 WORK PLAN ORGANIZATION

This Work Plan is a detailed plan that will lead to verification of hazardous waste or hazardous constituent release. This plan consists of a number of components presented in subsequent sections. Sections 2 and 3 include discussions of the scope of work and project management, respectively. Section 4 presents a description of current conditions and includes a discussion of facility history and background, physical setting, and SWMU characteristics. The sampling and analysis plan is detailed in Section 5, including sampling approach and rationale as well as a schedule for completion of field tasks. Sampling protocols presented in Section 5 incorporate a Standard Operating Procedure (SOP) format with SOPs included in Appendix A. Subsequent Work Plan sections include sample custody, handling, packaging, and shipment procedures as well as data

management and reporting procedures. Appendix B is bound separately and contains the Quality Assurance Project Plan (QAPP). Appendix C contains the Health and Safety Plan (HASP).

6/RP/78WPD/SECTION.1

# 2.0 RFI PHASE II RELEASE ASSESSMENT SCOPE OF WORK

The RFI Phase II Release Assessment for SWMUs #15/06, #14/00, and #16/16 will be implemented by performing tasks identified in the CTO #0078 Statement of Work, by completing field investigation tasks identified in this Work Plan, and subsequently by evaluating data and preparing a RA report. These tasks are summarized in the following sections.

## 2.1 PROJECT PLANNING

The project planning task includes activities from project initiation through completion of the project plans. The following project activities have been completed:

- A project scoping meeting involving Halliburton NUS Team technical specialists.
- A site visit.
- Collection and evaluation of existing information (as presented in the RFI Phase I EMR (Halliburton NUS, 1992)).
- Preparation of RA internal draft plans including the Work Plan, Quality Assurance Project Plan (Appendix B), and Health and Safety Plan (Appendix C).

## 2.2 FIELD INVESTIGATION

The field investigation involves implementing the activities specified in Section 5.0 and completing those investigation activities in accordance with the QAPP (Appendix B). The field investigation for this RFI Phase II Release Assessment includes surface soil sampling, surface water and sediment sampling, borehole drilling and subsurface soil sampling, groundwater sampling, landfill gas sampling, and in-situ hydraulic conductivity testing at each of the three SWMUs. Specific field activities to be completed and the procedures and quality assurance program for completing those activities are presented in Section 5.0 and the QAPP (Appendix B).

## 2.3 SAMPLE ANALYSIS AND DATA VALIDATION

This task includes laboratory analysis of samples collected during the field investigation and data validation. As indicated in this Work Plan and QAPP, samples collected during the field investigation will be analyzed through Naval Energy and Environmental Support Activity (NEESA) approved laboratories, and data validation will be performed by the Halliburton NUS Team according to the Halliburton NUS/NEESA Data Validation Template/Reference Book. Information from this task will be included in the RA report.

## 2.4 DATA EVALUATION

This task will include analysis of chemical and physical data after the data are verified to be of acceptable accuracy and precision. Data evaluation will be initiated upon receipt of validated analytical data from the field investigation and after sample analysis and data validation of laboratory parameters are performed. Data evaluation activities may include data reduction and tabulation, calculation of aquifer characteristics, statistical analysis, environmental fate and transport modeling, and mapping. The results of this task will be incorporated into the RA report.

## 2.5 RELEASE ASSESSMENT REPORT PREPARATION

A draft RA Report will be prepared which summarizes the activities performed, data collected, and conclusions drawn from on-site investigations. The report will include updated SWMU descriptions, results of field investigations and laboratory analyses, and discussions of potential routes of contaminant migration. The draft report will be submitted to the Navy and USEPA for review. Comments will be reviewed and addressed in completing the final RA report.

## 2.6 MEETINGS AND PRESENTATIONS

### 2.6.1 Meetings with Navy Representatives

The Halliburton NUS Team may attend up to three meetings with representatives of NAVSURFWARCENDIV or Southern Division (SOUTHDIV) to discuss comments on work plans, to prepare for meetings with USEPA or Indiana Department of Environmental Management (IDEM) on negotiations for the level of effort to be undertaken in any step of the Installation Restoration Program (IRP) Corrective Actions, and to provide oral presentations of various report elements to Navy representatives.

### 2.6.2 Meetings with Regulatory Agencies

The Halliburton NUS Team may attend one meeting with government representatives in any step of the IRP Corrective Actions.

### 2.6.3 Technical Review Committee Meetings

The Halliburton NUS Team will attend and participate in up to three Technical Review Committee (TRC) meetings or meetings with local government officials, including presentations of work plans or other topics related to work involving IRP Corrective Actions at NAVSURFWARCENDIV.

6/RP/78WPD/SECTION.2

# 3.0 PROJECT MANAGEMENT AND ORGANIZATION

## 3.1 PROJECT ORGANIZATION

The project organization chart shown on Figure 3-1 shows the lines of communication and responsibility which will be adhered to during the RA. The Navy will solicit USEPA's approval and input for the project.

The Navy Remedial Project Manager (RPM) is in direct contact with the EPA and the CLEAN Program Manager. The Project Manager is responsible for completing the RA scope of work, and for controlling the budget and schedule. The Project Manager will maintain day-to-day contact with the Navy RPM. The personnel responsible for quality assurance, health and safety, and project control report directly to the CLEAN Program Manager. The Field Team Leader (FTL) reports directly to the Project Manager. The Site Health and Safety Officer and Site Quality Assurance (QA) Manager report to the FTL and also report independently to the CLEAN Health and Safety Manager and QA Manager.

### 3.1.1 Navy Remedial Project Manager

The Navy Remedial Project Manager (RPM), Adrienne Wilson, will provide direction for the Halliburton NUS Team Project Manager through the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Manager at Halliburton NUS. The various management and QA responsibilities of key project personnel are shown on Figure 3-1 of the Work Plan and are described below.

### 3.1.2 CLEAN Program Manager

The CLEAN Program Manager, John Trepanowski, has overall responsibility for ensuring that the project meets the quality objectives and standards. In addition, the CLEAN Program Manager is responsible for technical QC and project oversight, and will provide the Project Manager with access to management at the Department of the Navy.

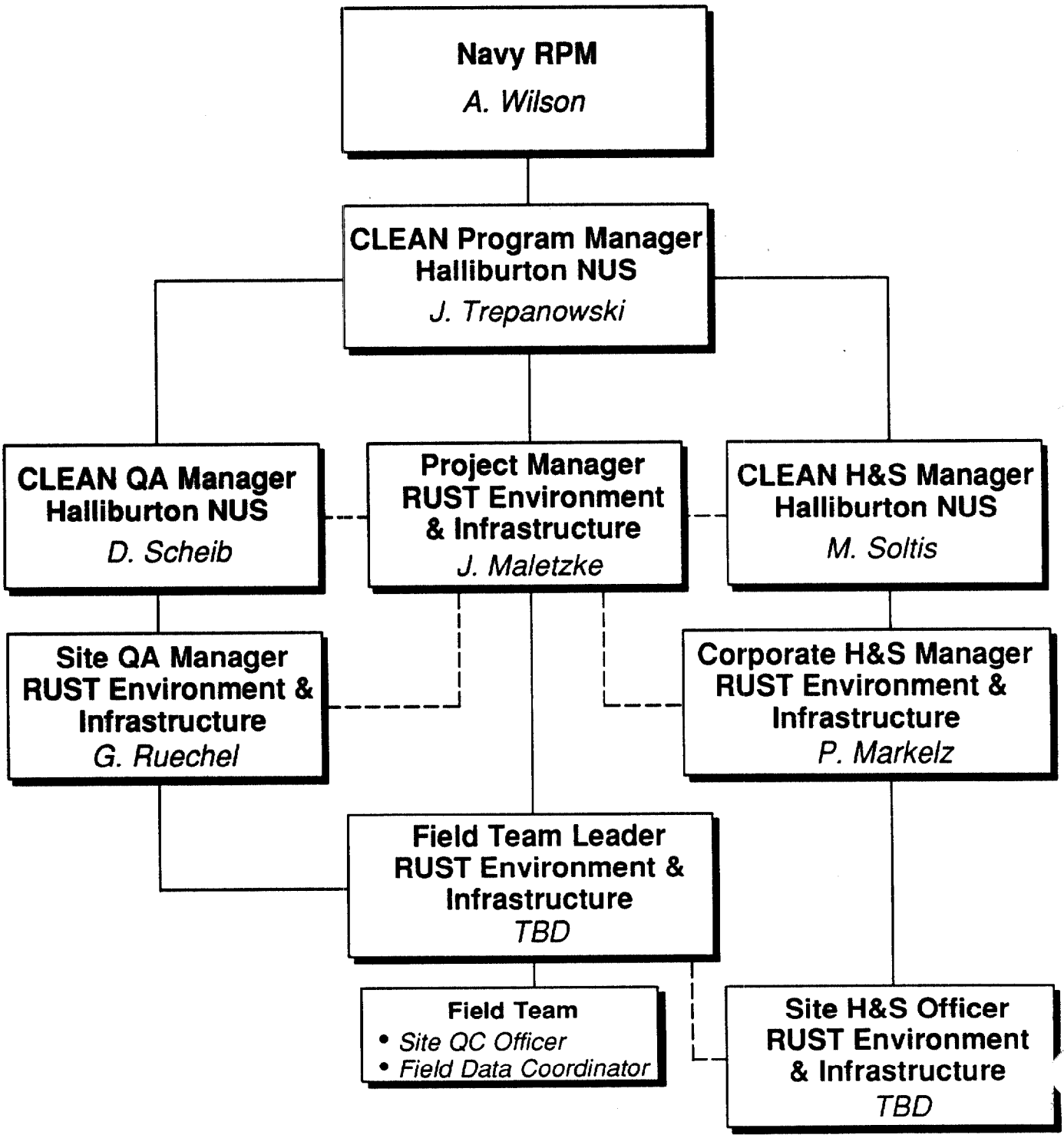
### 3.1.3 Project Manager

The Project Manager, Jeff Maletzke, is responsible for implementing the project, and has the authority to commit the resources necessary to meet project objectives and requirements. The Project Manager's primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. He will also be responsible for the preparation and quality of interim and final reports, including the cleanup/remediation specifications.

# FIGURE 3–1



## PROJECT ORGANIZATION CHART
## RFI PHASE II RELEASE ASSESSMENT
## NAVSURFWARCENDIV
## CRANE, INDIANA

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## 3.2 QUALITY ASSURANCE

Quality assurance is maintained from sample collection through laboratory analysis and data evaluation. The FTL is responsible for Quality Assurance/Quality Control (QA/QC) in the field. Field QC reviews are conducted on field documentation and through daily on-site QC checks. Laboratory QC is the responsibility of the contract laboratory as identified in the laboratory's QA Plan which is an attachment to the QAPP. The laboratory reports to the Site QA Manager and CLEAN QA Manager who track the QA process through data validation. The Site QA Manager is responsible for the evaluation of the field and laboratory QC measures for this project. The Site QA Manager acts as the liaison between on-site personnel, the CLEAN QA Manager, and laboratory QA personnel. The QAPP more fully explains field and laboratory QA/QC procedures.

### 3.2.1 CLEAN Quality Assurance Manager

The CLEAN QA Manager, Debra Scheib, is responsible for QA/QC monitoring at the program level, QA/QC monitoring of the subcontractors, QA/QC training, and updates to the CLEAN QC Management Plan. The CLEAN QA Manager will also assist the Program and Project Managers in resolution of issues related to quality that may occur in the field.

### 3.2.2 Quality Assurance Manager

The QA Manager, Greg Ruechel, in conjunction with the CLEAN QA Manager, will oversee implementation of the QAPP on the project. He will also be responsible for the evaluation of the field and laboratory QC measures for this project.

## 3.3 FIELD TEAM ORGANIZATION AND RESPONSIBILITIES

The Halliburton NUS Team and subcontractors will perform field sampling activities under the direction of the FTL. Field team members and their responsibilities follow.

### 3.3.1 Field Team Leader

The FTL will have overall responsibility for completion of field activities according to the Work Plan. The FTL is the overall coordinator of activities at the site and is the communication link between field team members, the Site QC Officer, the Field Data Coordinator (FDC), and the Project Manager. The FTL, in conjunction with the Project Manager, will assign specific field duties to team members. The FTL will be on-site during field activities and oversee operations. The FTL will be responsible for

mobilization and demobilization of equipment and the field team and subcontractors. The FTL will direct the activities of subcontractors on-site. Logistical problems hindering field activities such as equipment malfunctions or availability, personnel conflicts, or weather-dependent working conditions will be relayed to the FTL and resolved by the FTL.

Field team members will report directly to the FTL and provide daily verbal progress reports of field activities. The FTL is responsible for completing the Site Daily Logbook. The FTL is responsible for informing the Project Manager of daily activities. The FTL is responsible for supplying field team members with appropriate field notebooks and field documentation forms.

### 3.3.2 Field Team

Field team members will report directly to the FTL. Field team members will collect samples, advance soil borings, and install groundwater monitoring wells. Decontamination of sampling equipment will be accomplished by the field team under the direction of the FTL. Field team members will complete field documentation forms as indicated in the Work Plan. Field team members will submit personal Daily Activities Reports to the FTL for compilation into the Site Daily Logbook; the FTL will subsequently submit Daily Activities Reports to the Site QC Officer for review and filing. Field team members will submit field documentation forms to the Site QC Officer and will relinquish custody of field samples to the FDC. Field team members will assist in sample packaging and shipping as directed by the FDC. All field team members, subcontractors, and site visitors will comply with the provisions of the Site-Specific HASP.

### 3.3.3 Site Quality Control Officer

The Site QC Officer will check the completion of Chain of Custody Records, packaging and shipment of samples, Sample Logbook entries, and paperwork for accuracy and compliance with NEESA protocols and other specified procedures. The Site QC Officer will check Daily Activities Reports and field data forms for accuracy and compliance with the QAPP and Work Plan. The Site QC Officer is responsible for reviewing the calibration log sheets for field instruments. After review of these documents, the Site QC Officer is responsible for filing the field documentation. The Site QC Officer may be a member of the field team but cannot be the FDC.

### 3.3.4 Field Data Coordinator

The FDC will be responsible for maintaining an adequate supply of sample containers, preservatives, labels, and shipping materials in the field. The FDC will complete the

Chain of Custody Records, assign Site-Specific Sample Numbers, and contact the laboratories regarding the shipment and arrival of samples. The FDC will receive samples from the field team and package them for shipment. The FDC will ensure that custody seals are on shipping containers and that samples are shipped promptly. The FDC will file the shipping airbills in a secure area. The FDC will maintain sample collection, labeling, and shipment documentation in the Sample Logbook. The FDC will receive field documentation reviewed by the Site QC Officer, copy the documentation, forward the copies to the Project Manager, and file the original documentation in a secure area. The FDC may also be a member of the field team but cannot be the Site QC Officer.

### 3.3.5 Site Health and Safety Officer

The Site Health and Safety Officer (SHSO) will be present on-site during Level A, B, or C field operations and will be responsible for health and safety activities and the delegation of duties to the health and safety staff in the field. Because the Phase II RA activities are identified as low-hazard Level C or Level D, the SHSO may direct site health and safety efforts through an Assistant SHSO approved by the Corporate Health and Safety Manager (CHSM). The SHSO will be responsible for implementing the site-specific Health and Safety Plan. The SHSO may direct or participate in downrange activities as appropriate when this does not interfere with primary SHSO responsibilities. The SHSO has stop-work authorization which can be executed upon his/her determination of an imminent safety hazard, emergency condition, or other potentially dangerous situations, such as detrimental weather conditions. Authorization to proceed with work will be issued by the CHSM in conjunction with the Project Manager. The SHSO will initiate and execute contact with support facilities and personnel when this action is appropriate.

### 3.3.6 Assistant Health and Safety Officer

On low-hazard Level C or Level D sites, the Assistant SHSO may have collateral duties but must be qualified for the health and safety responsibility by the CHSM. At Level A, B, or specific Level C sites, the Assistant SHSO will be the downrange person who accompanies field sampling teams and will report to the SHSO. Additionally, he/she will be required to support the SHSO when multiple operations are conducted that require monitoring and SHSO surveillance. His/her primary responsibility is to provide appropriate monitoring to ensure the safe field operations. The number of Assistant SHSOs will be dependent upon the number of downrange operations occurring simultaneously, the designated level of protection, and the individual assignments made by the SHSO. The Assistant SHSO will also share responsibility with the FTL and the SHSO for ensuring that safety practices are followed by downrange teams.

# 4.0 DESCRIPTION OF CURRENT CONDITIONS

## 4.1 FACILITY LOCATION AND DESCRIPTION

### 4.1.1 Location

NAVSURFWARCENDIV is located in southwestern Indiana and occupies the northern half of Martin County (Figure 4-1). The site encompasses more than 100 square miles (62,463 acres) including 800-acre Lake Greenwood. NAVSURFWARCENDIV provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NAVSURFWARCENDIV supports the Crane Army Ammunition Activity (CAAA) including production and renovation of conventional ammunition, and storage, shipment, demilitarization, and disposal of conventional ammunition.

### 4.1.2 Legal Description

NAVSURFWARCENDIV occupies portions of Townships 4 North, 5 North, and 6 North and portions of Ranges 2 West, 3 West, and 4 West, Martin County, Indiana. Legal descriptions for each of the SWMUs covered in this report are given in subsequent SWMU-specific sections.

## 4.2 FACILITY HISTORY AND ACTIVITIES

### 4.2.1 History of Ownership and Operation

In 1940, Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana, and in late 1941 the Burns City Naval Ammunition Depot was commissioned. In 1943, NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet.

During World War II (WWII), NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created, the Ammunition Loading and Production Engineering Center (ALPEC) was transferred to Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam Conflicts. During the Southeast Asia crisis, the number of full-time employees at NAD Crane grew to 6,800.

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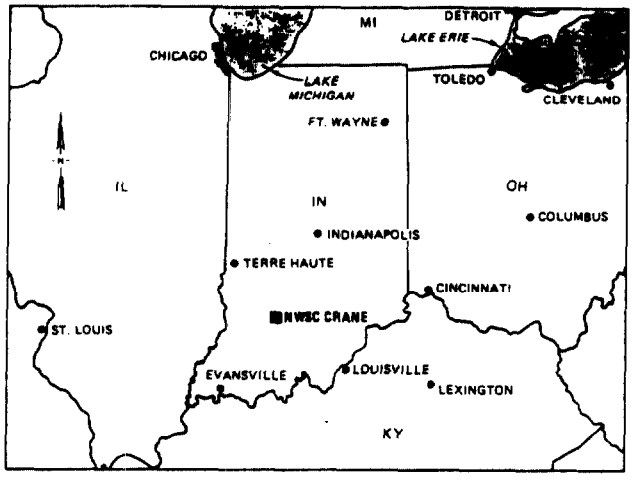
NAVSURFWARCENDIV RA WP
MAY 1993

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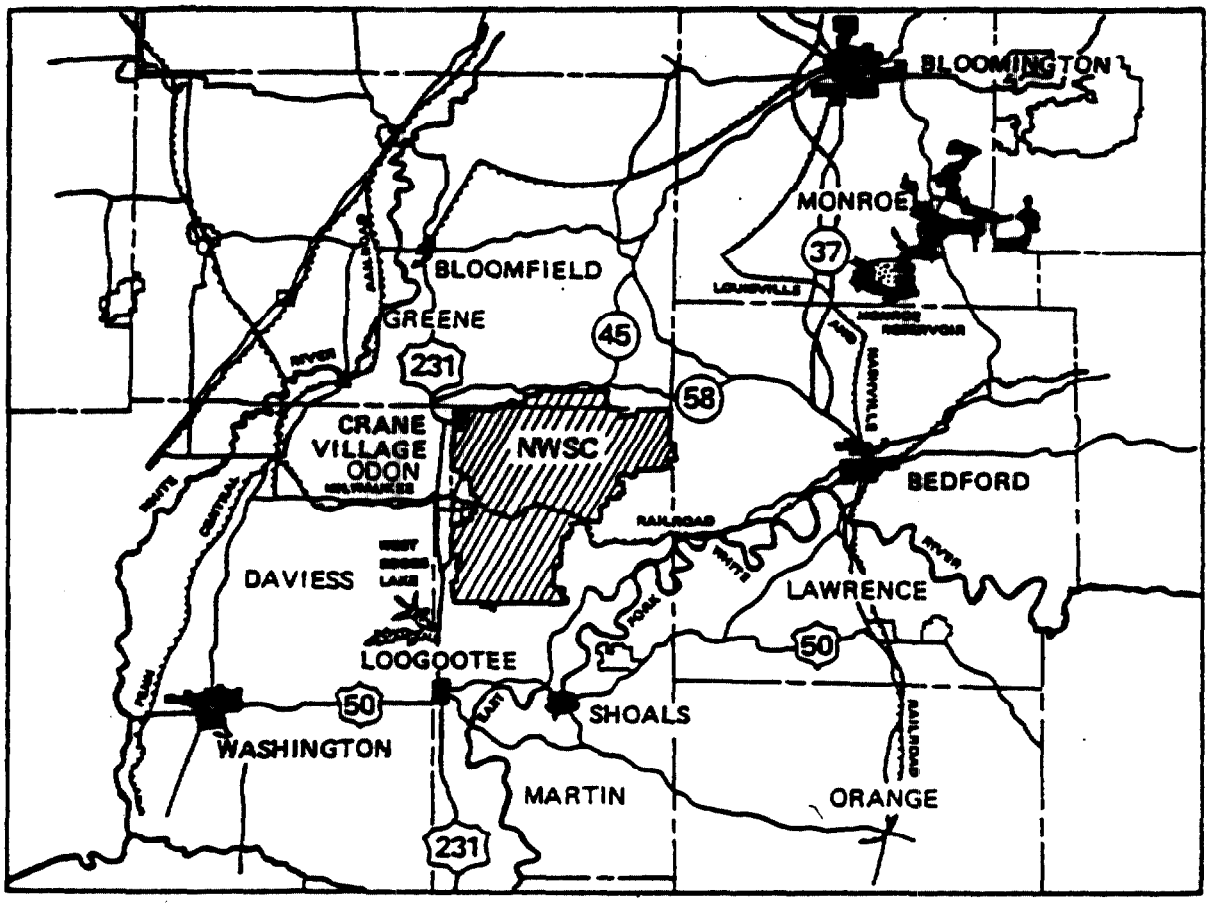


SOURCES: CHESAPEAKE DIVISION, NAVAL FACILITIES ENGINEERING COMMAND, 1979 AND NAVAL ENERGY AND ENVIRONMENTAL SUPPORT AGENCY, 1983.

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 4-1** 20617

**GENERAL LOCATION MAP**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

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L-11087

In 1976, NAD Crane was designated Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships and crafts equipment, shipboard weapons systems and assigned ordnance items, and to perform additional functions as directed.

In 1977, the Single Manager Concept was implemented. The CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained Navy, and currently the Navy retains ownership of all real estate and facilities at NWSCC. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NWSCC.

Until the late 1970s and early 1980s, a variety of liquid wastes from both ordnance and non-ordnance activities were disposed on-site without treatment. For example, ordnance-contaminated wastewaters were discharged into unlined ponds or into storm drains and ditches; wastewaters generated from cleaning operations were discharged into an unlined pond; oily waters, battery acid, paint thinner, acetone, boiler blowdown, and solvents were dumped behind buildings or into ravines; and waste hydraulic oil was spread on dirt roads. Since that time, treatment plants have been built, wastewater streams have been connected to the sanitary sewer, and oils and solvents have been collected, segregated, and either recycled, sold, or properly disposed.

Air pollution control devices were installed in the late 1970s. Therefore, ventilation systems at bomb loading facilities and the incinerator had no scrubber systems until the 1970s. Waste management activities included the burning of solid wastes and subsequent disposal of ash in unlined pits or gullies. Also, dye and dye-contaminated materials have been disposed in on-site trenches.

Operations specific to SWMUs #15/06, #14/00, and #16/16 are detailed within Sections 4.4.1.2, 4.4.2.2, and 4.4.3.2, respectively. Operations within these three SWMUs can be generalized as roads and grounds maintenance (SWMU #15/06), sanitary landfill (SWMU #14/00), and cast high explosives fill/incinerator area (SWMU #16/16).

Most recently in 1992, NWSCC was designated NAVSURFWARCENDIV.

### 4.2.2 History of Regulatory Actions

Following promulgation of the USEPA's RCRA hazardous waste regulatory program, NAVSURFWARCENDIV filed notification and application to operate as a treatment, storage, or disposal (TSD) facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards found in Title 40 Code of Federal Regulations, Part 265 (40 CFR, Part 265).

In April 1981, the Navy implemented the Navy Assessment and Control of Installation Pollutants (NACIP), subsequently known as the IRP. The purpose of the NAVSURFWARCENDIV IRP was to identify and control environmental contamination from past practices. As part of the IRP, an Initial Assessment Study (IAS) was conducted in April and May 1981, by a team from NEESA, the Ordnance Environmental Support Office, and the Army Corps of Engineers. Based on information from historical records, aerial photographs, field inspections, and personnel interviews, the IAS identified 17 potentially contaminated sites at NAVSURFWARCENDIV. Fourteen of the 17 sites were recommended for confirmation studies to include sampling and monitoring. Of the 14 sites identified in the IAS as warranting further investigation under NACIP, two (SWMU #15/06 and SWMU #16/16) are investigated in this Work Plan (SWMU #14/00 was not identified in the IAS). Prior to publication of the IAS in May 1983, confirmation studies were reportedly initiated by NAVSURFWARCENDIV (NEESA, 1983).

Pursuant to the RCRA regulations and the IRP, hydrogeologic investigations, including groundwater monitoring, were initiated at 10 sites in 1981. Eight of these 10 sites were later identified as warranting further investigation in the IAS.

In November 1984, the Naval Facilities Engineering Command - Northern Division (NORTHDIV) contracted the Hazardous Material Technical Center (HMTC) to perform confirmation studies at several sites at NAVSURFWARCENDIV.

Corrective actions programs established as part of the RCRA HSWA required NAVSURFWARCENDIV to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NAVSURFWARCENDIV submitted a Hazardous Waste Management Report to the USEPA in January 1985. The report listed the IAS-identified hazardous waste sites as SWMUs. Following the Hazardous Waste Management Report, a RCRA Facility Assessment (A.T. Kearney, Inc., 1987) was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs.

On December 23, 1989, the USEPA issued the federal portion of the Final RCRA Permit for NAVSURFWARCENDIV to the U.S. Navy. This permit established the HSWA Corrective Action Requirements and Compliance Schedules obligating the U.S. Navy to perform RFIs at 30 SWMUs, to conduct Corrective Measure Studies (CMSs), and to implement Corrective Measures if needed. The Federal RCRA permit for NAVSURFWARCENDIV requires that RFI Phase I EMRs be submitted for many of the SWMUs at NAVSURFWARCENDIV. Recommendations and conclusions presented in EMRs form the basis for continuing RFI corrective actions at respective SWMUs.

## 4.3 PHYSICAL CHARACTERISTICS

This section briefly describes the climate, topography, hydrology, soils, geology, hydrogeology, and biology of NAVSURFWARCENDIV. More detailed descriptions are included in the Final EMR (Halliburton NUS, 1992).

### 4.3.1 Climate

NAVSURFWARCENDIV is located in a temperate climate zone displaying a wide temperature range among seasons. The summers are warm and humid, and the winters are generally mild with short periods of very cold weather. The mean minimum temperature in January is 26*o*F and the mean maximum temperature in July is 89*o*F. The area receives an average of 44 inches of precipitation annually, with 42 inches of rainfall and 15 inches of snowfall (NEESA, 1983).

### 4.3.2 Topography

The topography at NAVSURFWARCENDIV consists of undulating terrain dissected by many small drainageways. The elevation of the site ranges from 470 feet above Mean Sea Level (MSL) at a southern drainageway to 860 feet MSL on a ridge in the west-central portion of the site. V-shaped drainageways in the north progress to 2,000-foot-wide floodplains in the south and rise to approximately 150 to 200 feet to the ridgelines (NEESA, 1983).

### 4.3.3 Hydrology

Six creeks accept drainage in five separate drainage basins at NAVSURFWARCENDIV (Figure 4-2). The six creeks are: Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, and Seed Tick Creek. Surface drainage from NAVSURFWARCENDIV eventually empties into the east fork of the White River, south of the facility. Situated within Crane are Lake Greenwood and several ponds. Lake Greenwood water is the main source of water at NAVSURFWARCENDIV and is also used for recreation (NEESA, 1983).

### 4.3.4 Soil

Four soil units have been mapped at NAVSURFWARCENDIV in the Soil Survey of Martin County, Indiana (McElrath, 1988), including Wellston-Gilpin, Wellston-Berks-Gilpin, Wellston-Berks-Ebal, and Wakeland-Wilbur-Haymond soils. These soils are primarily silt loams. Each soil unit is described in greater detail in the Final EMR (Halliburton NUS, 1992).

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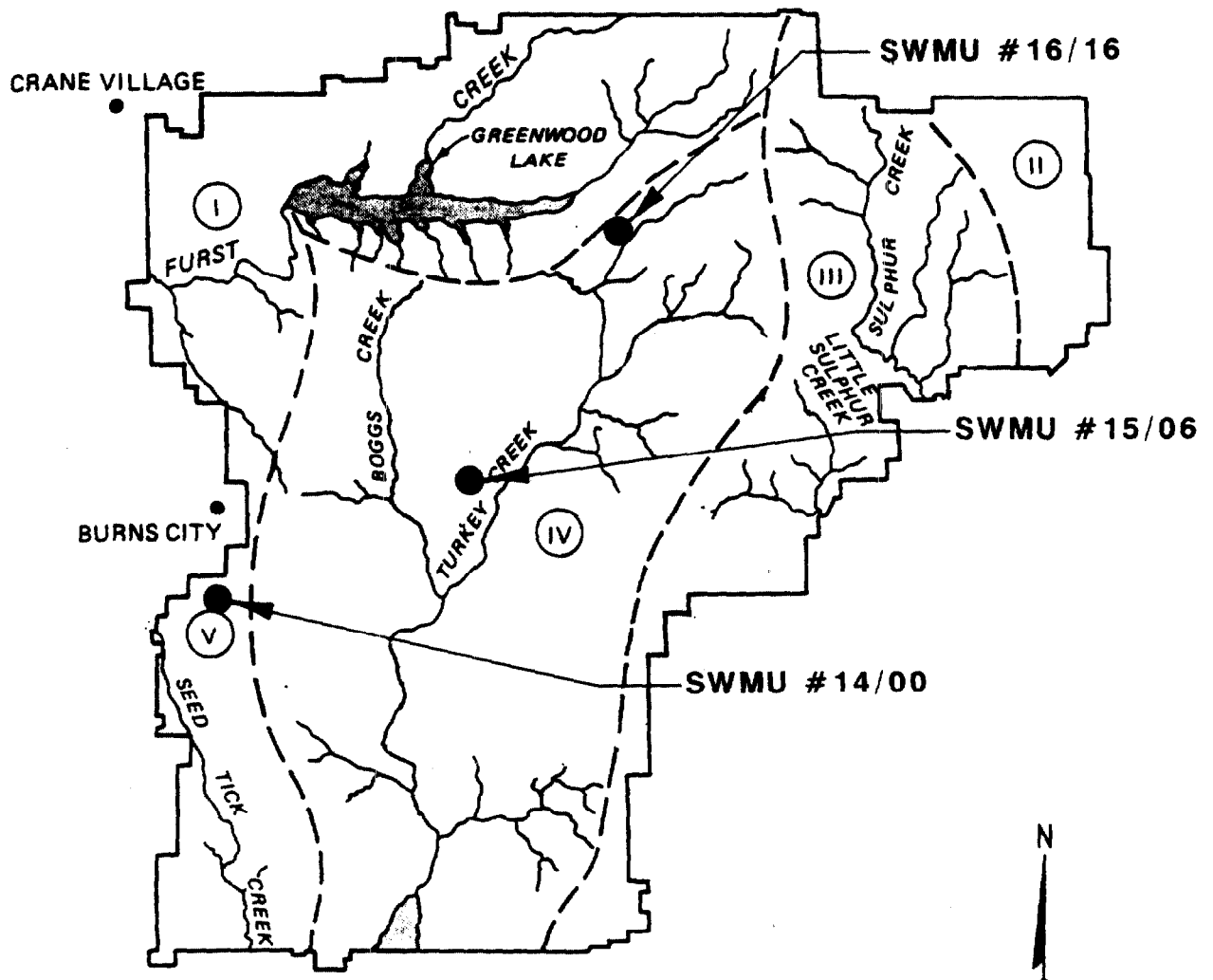


SWMU #16/16: CAST HIGH EXPLOSIVE FILL / INCINERATOR BUILDING 146
SWMU #15/06: ROADS AND GROUNDS AREA
SWMU #14/00: SANITARY LANDFILL AND LITHIUM BATTERY

N

SCALE

2 0 2 4 MI

SOURCE: CHESAPEAKE DIVISION NAVAL FACILITIES COMMAND, 1979

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 4-2** 20617

**SURFACE DRAINAGE BASINS**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

L-11086

### 4.3.5 Geology

NAVSURFWARCENDIV is located in the eastern flank Illinois Basin. Beneath unconsolidated colluvial and alluvial deposits, Paleozoic age sedimentary rocks underlying NAVSURFWARCENDIV have been deformed to yield a gentle dip of 50 feet per mile towards the west-southwest. Rock units in the basin are reported to exceed a thickness of 13,000 feet in some areas (Murphy et al., 1990). The distribution of the unconsolidated surficial deposits and bedrock units at NAVSURFWARCENDIV is presented in Figure 4-3.

The bedrock surface at NAVSURFWARCENDIV is made up of lower Pennsylvanian and upper Mississippian age sandstones, limestones, and shales. A generalized stratigraphic column of bedrock units in the NAVSURFWARCENDIV area is shown in Figure 4-4.

In general, Mississippian-age Chester Series sandstones, shales, and limestones are exposed in the valley walls of eastern portions of NAVSURFWARCENDIV and in the lower elevations of deep valleys in the western portions. Pennsylvanian-age Mansfield Formation sandstone, siltstones, claystones, and shale are found at the crests of hills and ridges in eastern portions of NAVSURFWARCENDIV and as the surficial bedrock unit further west. The contact between the Mississippian units and overlying Pennsylvanian units is an unconformity formed by long-term erosion of the Mississippian surface (Murphy et al., 1990).

### 4.3.6 Hydrogeology

Hunt (1988) discussed regional groundwater trends pertaining to the unglaciated southwest portion of Indiana. In general, groundwater is contained in joint openings of limestone and sandstone aquifers. Based on studies conducted in the eastern portion of NAVSURFWARCENDIV (Hunt, 1988; Murphy et al., 1990), rock units considered to be aquifers and aquicludes are presented in Figure 4-5. Although unit thicknesses may vary, the distribution of bedrock units at NAVSURFWARCENDIV (Figure 4-3) suggests similar aquifer characteristics throughout the facility. Surficial unconsolidated aquifers are thin and have limited potential as water supplies.

Aquifers beneath NAVSURFWARCENDIV are considered to be vertically isolated from each other by interlayered shale beds which act as aquitards. Groundwater recharge occurs where aquifer units outcrop. After entering an aquifer outcrop, groundwater flows by gravity down the dip of the aquifer unit. Since the regional dip of rock units is to the southwest, regional groundwater flow in all aquifers is directed towards the southwest.

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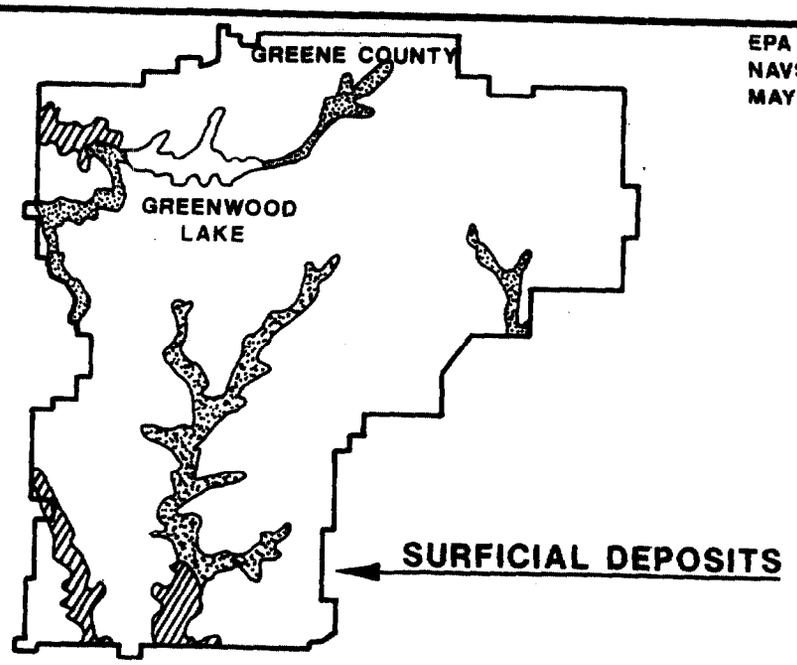
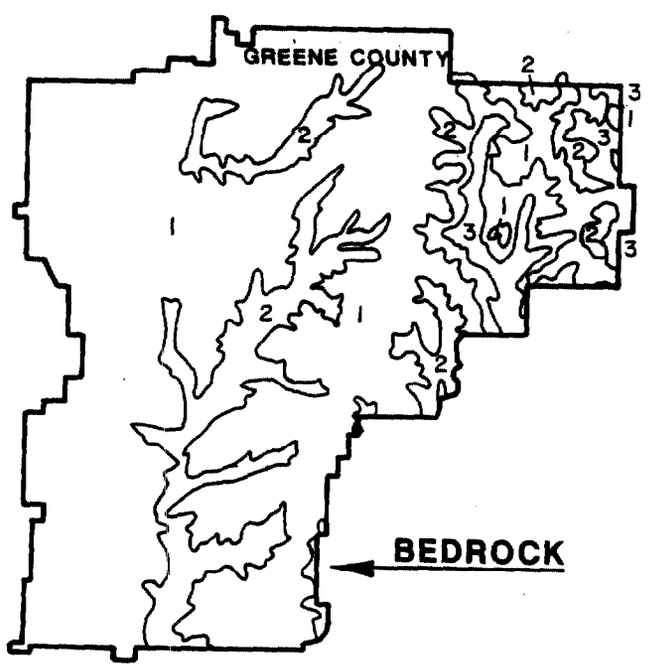
MAY 1993



SCALE: NTS.

## LEGEND

- QUARTERNARY SILT, SAND, AND GRAVEL MOSTLY ALLUVIUM BUT INCLUDES SOME COLLUVIAL AND PALUDAL DEPOSITS.
- QUATERNARY CLAY, SILT AND SAND. LACUSTRINE DEPOSITS.
- RESIDUAL CLAYS AND SILT FROM PENNSYLVANIAN RACCOON CREEK GROUP AND MISSISSIPPIAN STEPHENSPORT AND WEST BADEN GROUPS.

1. RACCOON CREEK GROUP
2. STEPHENSPORT GROUP
3. WEST BADEN GROUP

SOURCE: NAVAL ENERGY AND ENVIRONMENTAL SUPPORT AGENCY. 1983.

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

**FIGURE 4-3**

**SURFICIAL AND BEDROCK GEOLOGIC MAPS**

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CRANE, INDIANA

20617

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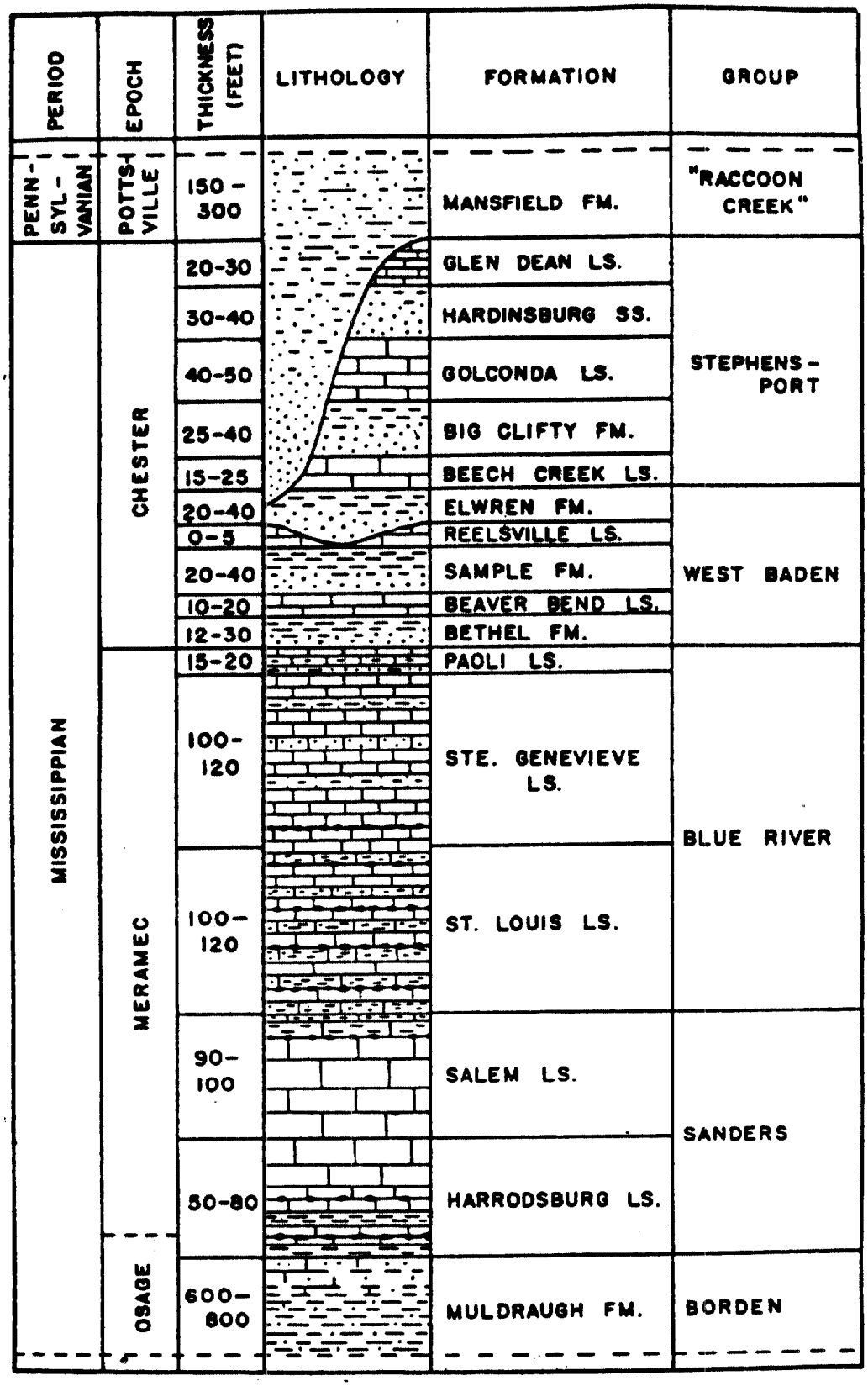


SOURCE: PALMER, 1969

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 4-4** 20617

**BEDROCK STRATIGRAPHIC COLUMN**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

| GEOLOGIC UNIT | THICKNESS (FEET) | HYDROGEOLOGIC UNIT TYPE |
|---|---|---|
| Golconda/Haney Formation | Few – 14 | Upper Aquifer |
| Big Clifty Formation – Indian Springs Shale | 20 | Aquiclude–Aquitard |
| Big Clifty Formation – Lower Member | 40 | Middle Aquifer |
| Beech Creek Formation | 18 – 22 | |
| Elwren Formation | 20 | Aquitard |
| Reelsville Formation | 10 | |
| Sample Formation | 40 – 45 | |
| Beaver Bend Formation | 10 – 12 | Lower Aquifer |

SOURCE: MURPHY ET AL., 1990 AND HUNT, 1988

NOTE:
REPORTED UNIT THICKNESS AND TYPE ARE BASED ON STUDIES COMPLETED IN THE EASTERN PORTION OF NWSCC. THE DISTRIBUTION OF BEDROCK UNITS AT NWSCC SUGGESTS SIMILAR AQUIFER CHARACTERISTICS THROUGHOUT NWSCC.

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RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 FIGURE 4-5 20617

HYDROSTRATIGRAPHIC UNITS

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

Local variations in bedding, dip, aquifer and aquitard, incision by surface drainage, and karstic conditions cause local groundwater movement at NAVSURFWARCENDIV to differ from regional trends. Where erosion resulting from surface drainage has cut through aquifer units, springs and seeps are produced which locally complicate groundwater flow. Springs and seeps are prevalent at contacts between aquicludes and overlying aquifers. Groundwater flowing from springs and seeps into surface water can potentially re-enter the groundwater system as recharge to a lower aquifer outcropping downstream.

In the eastern portion of NAVSURFWARCENDIV Hunt (1988) hypothesized that karstic conditions are present primarily in major drainage valleys where erosion has cut into permeable sandstones overlying easily dissolved limestone units. Rapid infiltration within the Big Clifty sandstone units has caused dissolution and weathering of the underlying Beech Creek Limestone. The result of this occurrence has been the creation of karst and collapse conditions along major drainageways within the eastern part of NAVSURFWARCENDIV.

### 4.3.7 Biology

NAVSURFWARCENDIV biological characterization is presented in the IAS (NEESA, 1983), and summarized in the Final EMR (Halliburton NUS, 1992). Listings of plants and animals found at NAVSURFWARCENDIV are also included in the Final EMR (Halliburton NUS, 1992).

## 4.4 SWMU CHARACTERISTICS

The following sections present background information specific to the three SWMUs as summarized from the Final EMR (Halliburton NUS, 1992). Where appropriate, sections of the Final EMR have been repeated.

### 4.4.1 SWMU #15/06, Roads and Grounds Area

#### 4.4.1.1 Location and Description

The Roads and Grounds Area is located in the northern half of NAVSURFWARCENDIV (Figure 4-6). This SWMU includes Building 2801 and an aboveground waste oil storage tank, Buildings 2716, 2717, 2718, 2774, an area occupied by a former asphalt batch plant, and a vegetated hillside south of Building 2801 (Figure 4-7). Buildings 2716, 2717, and 2718 are described as General Warehouses, while Building 2774 is listed as a Paint Locker (Naval Facilities Engineering Command (NAVFAC) Drawing No. 610328, 1962). The hillside area to the south of Building 2801 is characterized by assorted

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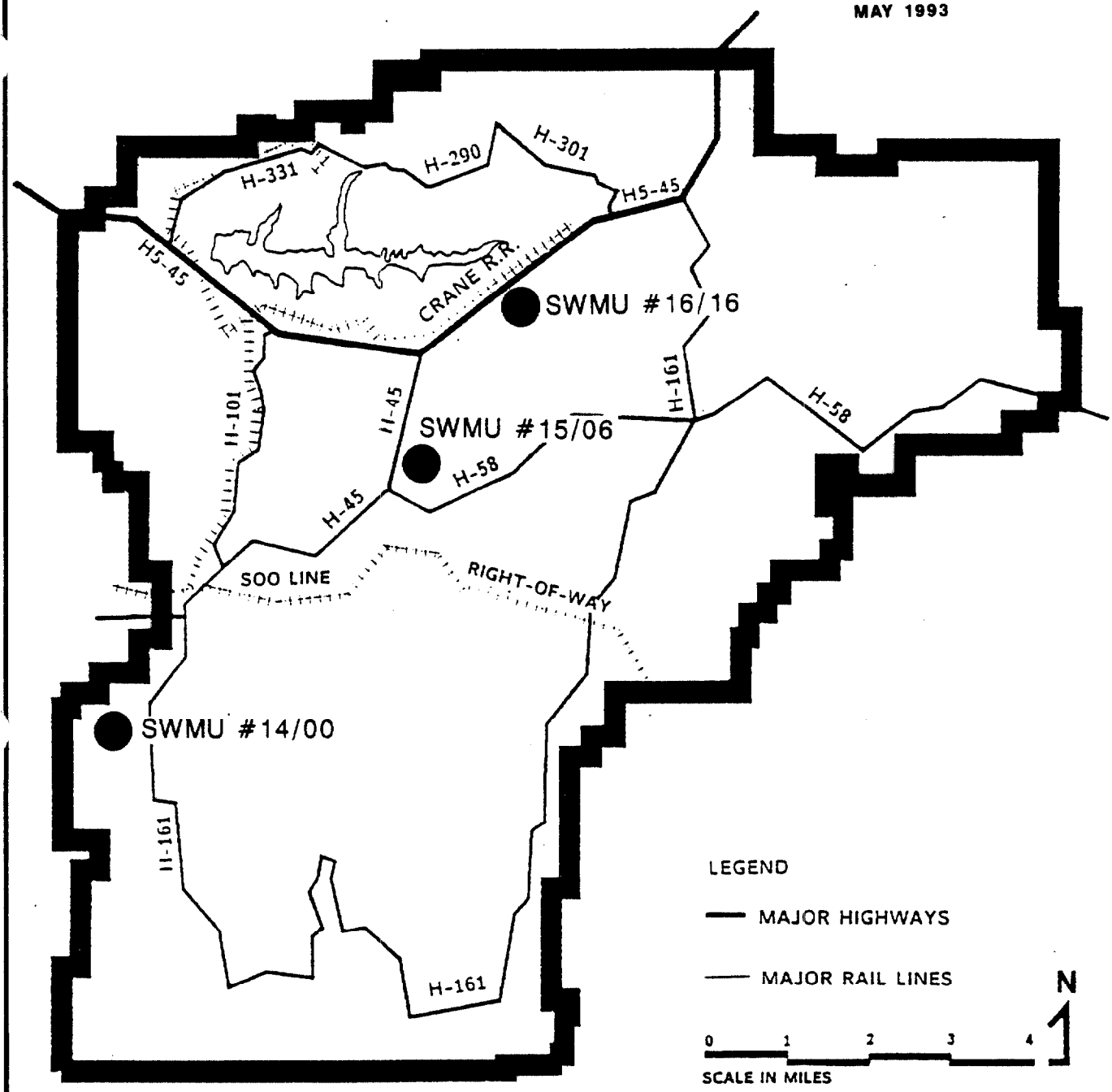


SWMU #16/16: CAST HIGH EXPLOSIVE FILL/INCINERATOR BLDG. 146
SWMU #15/06: ROADS AND GROUNDS AREA
SWMU #14/00: SANITARY LANDFILL AND LITHIUM BATTERY

SOURCE: NORTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND, NWSCC MASTER PLAN, 1986

DUNCAN-PARK ...IC. CHARLOTTE, NC 800-768-7788

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 4-6** 20617

**SWMU - LOCATION MAP**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

L-11082

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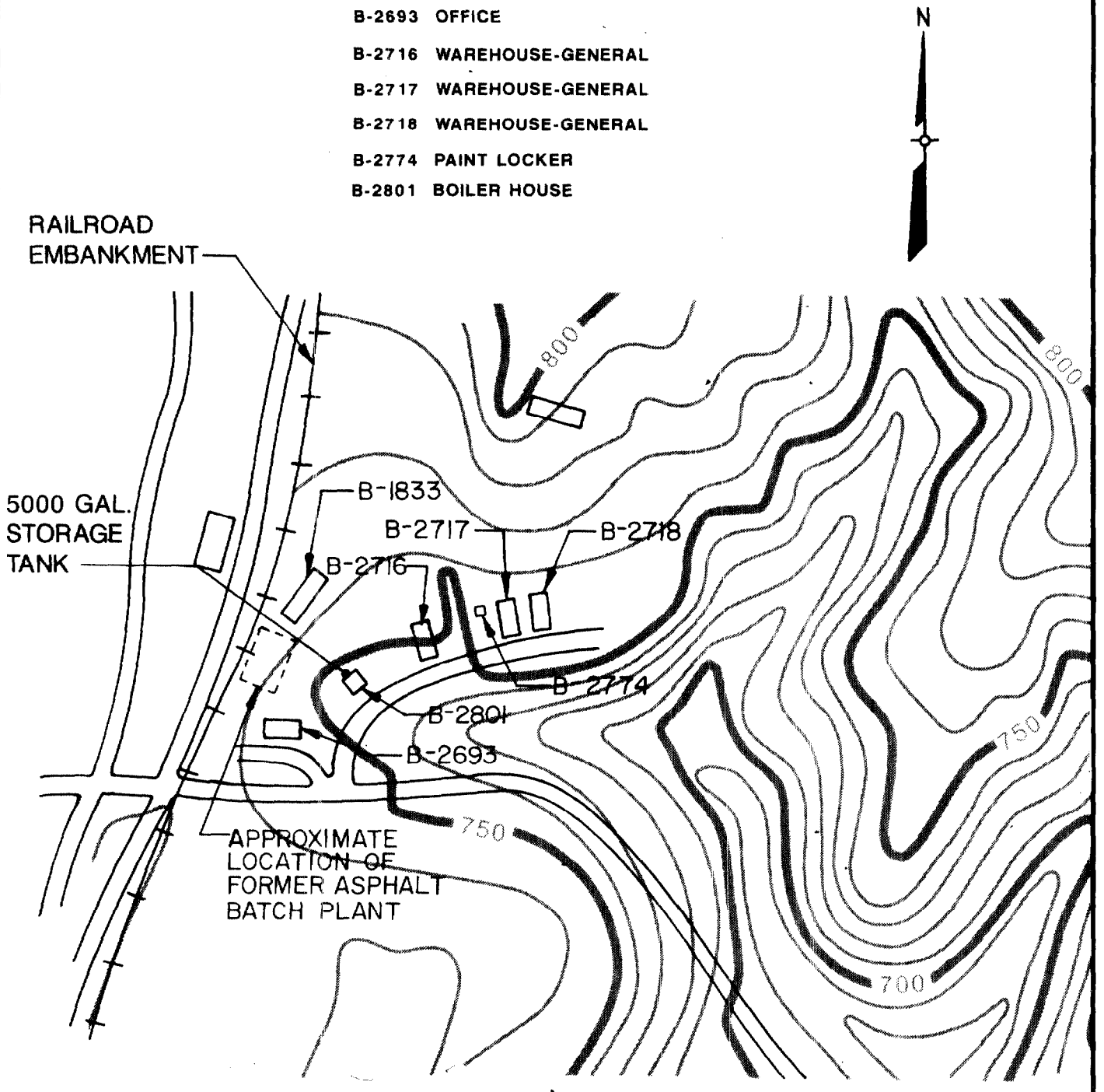
B-1833 STORAGE BUILDING
B-2693 OFFICE
B-2716 WAREHOUSE-GENERAL
B-2717 WAREHOUSE-GENERAL
B-2718 WAREHOUSE-GENERAL
B-2774 PAINT LOCKER
B-2801 BOILER HOUSE




SOURCE: U.S.G.S., 1978, INDIANA SPRINGS, INDIANA, 7.5 MIN. TOPOGRAPHIC QUADRANGLE.

APPROXIMATE SCALE: 1" = 400'
CONTOUR INTERVAL = 10'

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

**FIGURE 4-7**
**SWMU #15/16:**
**ROADS AND GROUNDS AREA**
RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

20617

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debris and a small intermittent stream at the base of the hill. These buildings are currently considered inert storage (NWSCC, 1991b). The Roads and Grounds Area is accessed via Highway 468.

#### 4.4.1.2 Operations

Building 2801 was previously used as a boiler house. A 5,000-gallon aboveground storage tank is located on the north side of this building. Approximately 10,000 gallons of waste oil are removed annually from this tank (NWSCC, 1992a). Building 2801 is currently used for general storage. No specific information concerning historical operations at Building 2801 was available. However, NAVSURFWARCENDIV staff indicated that Building 2801 operated as a boiler house for at least the last 18 years (NWSCC, 1991a).

An operations startup date for the former asphalt batch plant is not known, but is thought to have occurred early in NAVSURFWARCENDIV history. NAVSURFWARCENDIV staff stated that the batch plant was removed in 1972 or 1973 (NWSCC, 1991a). NAVSURFWARCENDIV staff (1991a) reported that during batching operations, tar was heated to a liquid and stored in tanks using steam-heated coils. Gravity fed liquid tar stored in underground storage tanks (USTs) to smaller aboveground storage tanks. Valves in the aboveground tanks allowed tar to be recovered for incorporation into the batching process (NWSCC, 1991a).

During the site inspection of the Roads and Grounds Area, a NAVSURFWARCENDIV Roads and Grounds Area employee stated that tar spills occurred at the asphalt batch plant formerly located in the Roads and Grounds Area (NWSCC, 1991a). Spills were attributed to boilovers and accidental discharge associated with the molten tar storage tanks at the batch plant. It was stated that one spill occurred as a result of a molten tar storage tank drain valve being left open overnight. The following morning tar was said to have flowed approximately 150 yards south down the drainageway between Buildings 2693 and 2801.

#### 4.4.1.3 Waste Descriptions

Types of wastes present at the Roads and Grounds Area have reportedly included waste oils, fuel oil, gasoline, asphalt, and pesticide and herbicide residues. Drums labelled waste oil, anti-freeze, and hydraulic fluid were observed during the site visit. Herbicides, pesticides, solvents, paints, and lubricants were also stored in the Roads and Grounds Area. General refuse such as drums, containers, and construction debris have been dumped on the hillside south of inert storage buildings (B-2716, 2717, 2718).

#### 4.4.1.4 Topography

The Roads and Grounds Area occupies an upland area south of Lake Greenwood. Elevations in the general area range from approximately 760 feet MSL to approximately 745 feet MSL. Topography adjacent to the Roads and Grounds Area drops off sharply southeast of the Roads and Grounds Area. The base of the valley southeast of the Roads and Grounds Area is at an approximate elevation of 700 feet MSL. The topographic high (elevation 800 feet MSL) in the vicinity of the Roads and Grounds Area is approximately 1,000 feet north of Building 2693.

#### 4.4.1.5 Physiography and Hydrology

Surface drainage from the Roads and Grounds Area enters intermittent drainageways to the south and southeast. These intermittent drainageways converge into a single intermittent drainageway which continues to flow towards the south-southeast under Highway 99. Surface flow continues towards the south while gaining volume from other intermittent sources until it enters Turkey Creek. Turkey Creek flows south-southwest to merge with Boggs Creek. Boggs Creek continues to flow south, exiting the southern boundary of NAVSURFWARCENDIV. South of NAVSURFWARCENDIV Boggs Creek eventually flows into the east fork of the White River.

#### 4.4.1.6 Geology

Soils

Soil information discussed below for the Roads and Grounds Area was obtained from the Soil Survey of Martin County, Indiana, which was published by the Soil Conservation Service (SCS) (McElrath, 1988).

Detailed soil mapping by the United States Department of Agriculture (USDA) shows soils in the Roads and Grounds Area to be of the Wellston-Gilpin complex. In the vicinity of the Roads and Grounds Area, these soils are strongly to steeply sloping (12 to 30 percent). Wellston-Gilpin soils are considered well-drained and are commonly found on hillsides in the upland areas. Wellston soil is generally considered to be deep where bedrock is generally present at depths greater than 5 feet. Gilpin soil is described as moderately deep, and bedrock is commonly found at a depth of 39 inches. Unified Soil Classification System (USCS) classifications of Wellston soil are silt (ML), clay (CL), clayey silt (CL-ML), at depth sandy clay (SC) and silty sand (SM). USCS classifications of Gilpin soil include gravelly clay (GC), sandy clay (SC), clay (CL), and clayey silt (CL-ML).

Hydraulic conductivity for both soils is considered moderate. Hydraulic conductivities reported by the USDA for the Wellston-Gilpin complex range from $4.2 \times 10^{-4}$ cm/sec to $1.4 \times 10^{-3}$ cm/sec. Surface runoff is medium for both soil types. The organic matter content of the surface layer is moderate, ranging from 1 to 4 percent. Soil pH ranges from 3.6 to 6.5 in Wellston-Gilpin soils.

Bedrock

The bedrock surface beneath the Roads and Grounds Area is composed of sandstone, shale, and limestone of the Pennsylvanian Age Raccoon Group (Department of the Army, 1978).

A lineation study (U.S. Army Corps of Engineers, undated) shows a north-south trending lineation to terminate just north of the Roads and Grounds Area. Lineations were interpreted from aerial photographs and indicate the potential presence of structural geologic controls. Structural geologic controls include features such as faults, joints, foliation, and bedding planes. Lineations mapped during the study were not field verified.

#### 4.4.1.7 Hydrogeology

The general hydrogeologic setting of NAVSURFWARCENDIV was described in Section 4.3.6. This regional hydrogeologic setting is considered representative of the hydrogeology in the Roads and Grounds Area. SWMU-specific hydrogeologic information for the Roads and Grounds Area is not presented due to the absence of soil borings and monitoring wells.

#### 4.4.1.8 Previous Investigations

Limited analytical data are available for the Roads and Grounds Area. The IAS (NEESA, 1983) recommended that four soil and sediment samples be collected near debris deposited at the bottom of the hill south of Building 2716 and analyzed by the EP Toxicity Test for heavy metals and pesticides. Accordingly, in 1985 four samples were collected and analyzed for the recommended parameters. The sample locations are not known. Analytical results for the four samples indicated that detectable levels of metals and pesticides were absent.

A Pilot Test Program (Kent et al., 1973) was conducted by the Navy to provide input for the development of a Navy-wide database. NAVSURFWARCENDIV was selected as the site of one of three such programs. The NAVSURFWARCENDIV tests were used to establish environmental baseline conditions at a typical Naval Ordnance Activity and to

provide data for pollution abatement projects. The test program included sampling ambient stations (wells, streams, and lakes), industrial discharges, and sewage treatment plant discharges over a 7-1/2-month period in 1972.

During the Pilot Test (Kent et al., 1973), a sample was collected in Turkey Creek downstream of the Roads and Grounds Area. The exact location of the sample is unknown, however, Kent et al. (1973) describes the location as 1,500 feet downstream from a sample collected from a plating shop (Building 1884) discharge pipe. The purpose of this sampling point was to assess the effects of discharge from the plating shop on the creek. The plating shop is located approximately 500 feet northwest of the Roads and Grounds Area. Analytical results reveal that the average concentrations of chromium, cadmium, lead, and cyanide present in the creek exceed drinking water Maximum Concentration Level (MCLs). In addition, concentrations of these same metals and copper detected during the pilot study exceed available Ambient Water Quality Criteria for the protection of Aquatic Life (USEPA, Clean Water Act). Parameters considered appropriate to the Roads and Grounds Area such as pesticides, oil and grease, Polyaromatic Hydrocarbons (PAHs), and Total Recoverable Petroleum Hydrocarbons (TRPHs) were not analyzed.

#### 4.4.1.9 Potential Contaminant Migration Pathways and Impacts

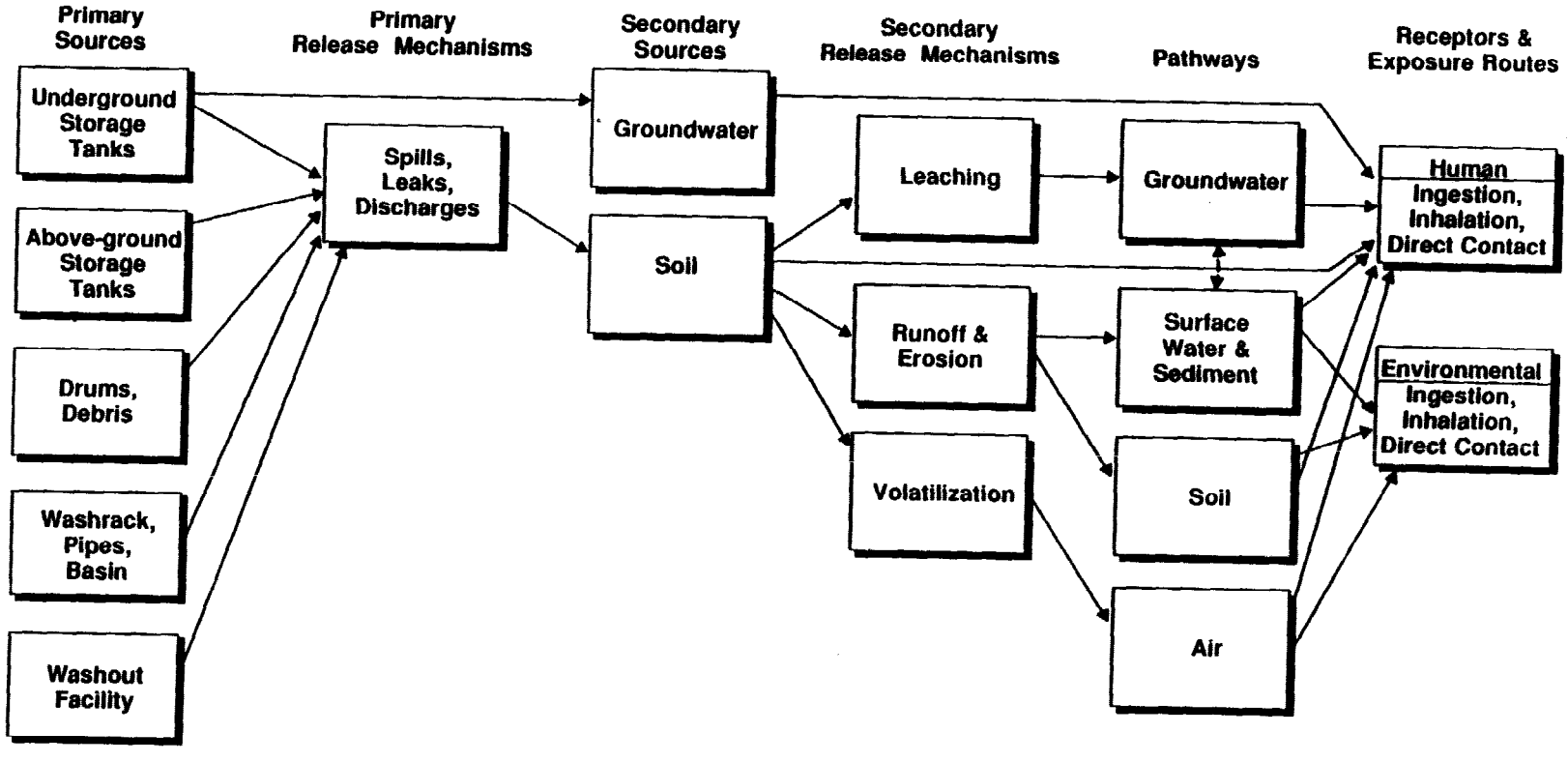
The interrelationships between contaminant sources, pathways, and receptors at the Roads and Grounds Area are presented as a Site Conceptual Model in Figure 4-8. The format and presentation of the model facilitates development of data quality objectives, sampling design, fate and transport evaluations, and performance of risk assessments. The primary potential migration pathways existing at the Roads and Grounds Area are surface water and groundwater. Reportedly, pesticides, drums, and other debris have been dumped on the hillside south of Buildings 2716, 2717, and 2718 (NEESA, 1983; A.T. Kearney, 1987). Depending upon the volume of pesticide and drum residues released down the hillside, compounds may have either directly entered the stream or infiltrated the surface soils. Compounds sorbed onto surface soils may be transported in suspension or solution down the hillside and into the stream by storm events. Also, as previously mentioned, tar has been released from storage tanks at the former asphalt batch plant. Tar spills flowed into drainageways in the Roads and Grounds Area and continued to flow into the stream.

Groundwater is the other major potential migration pathway. Waste oils were observed to have been released to soil in the Roads and Grounds Area. In addition, pesticide residues were reportedly released to soils and surface water (NEESA, 1983; A.T. Kearney, 1987). Other chemicals may have also been released from drums stored in the area or dumped down the hillside. Compounds released to soils may percolate

**FIGURE 4-8**

**SITE CONCEPTUAL MODEL
SWMU #15/16: ROADS AND GROUNDS AREA
PHASE II RELEASE ASSESSMENT, NAVSURFWARCENDIV
CRANE, INDIANA**





through the vadose zone by gravity or leaching and eventually reach the groundwater system. Chemicals entering surface waterways may eventually merge with surface water bodies outside NAVSURFWARCENDIV.

### 4.4.2 SWMU #14/00, Sanitary Landfill and Lithium Battery

#### 4.4.2.1 Location and Description

The Sanitary Landfill is located near the western boundary of NAVSURFWARCENDIV (Figure 4-6). The Sanitary Landfill is an active 65-acre landfill which began operations in 1972 and replaced the Old Burn Pit. The landfill currently receives trash and garbage from production operations and residential and food preparation areas. Special approval was granted by the Indiana State Bureau of Health (ISBH) in 1981 to 1982 to bury neutralized lithium batteries in the landfill. Figure 4-9 shows the Sanitary Landfill.

#### 4.4.2.2 Operations

The Navy-owned and operated Sanitary Landfill began accepting paper, wood, metal, and putrescible wastes in 1972. Landfilling was accomplished by the trench and fill method utilizing 23 disposal cells (Figure 4-9). Area fill waste disposal is currently employed in an area to the southeast of the filled trenches.

As previously mentioned, the Sanitary Landfill was opened in 1972 for disposal of paper, wood, metal, and putrescible materials. Landfilling progressed by trench and fill methods with each trench or cell having approximate dimensions of 100 feet wide, 300 to 500 feet long, and 8 feet deep. Within the bottom of each trench a shallow trench was dug, and a 4- to 6-inch perforated plastic pipe was buried and backfilled with fine gravel (Snell Environmental Group, Inc., 1977). The purpose of this drain was to remove rain water during cell excavation, and subsequently serve as a leachate drain. Leachate is conveyed to two fenced-in ponds at the northwest and south ends of the landfill. Each leachate collection pond is approximately 40 feet by 60 feet by 5 feet deep, with an estimated storage capacity of 40,000 to 50,000 gallons (Dames & Moore, 1992). Perforated laterals connect each cell to 8-inch collection pipes at a series of manholes. The leachate pond outfall was connected to the sanitary sewer in 1981 (NWSCC, 1992b).

The sequence of trench construction and filling is not entirely clear. The Installation Assessment Relook Program (Fox-Dial, 1985), identified the presence of three large trenches in 1974 as well as what appeared to be the western leachate collection pond. At the time of preparation of the Landfill Operational Plan (Snell Environmental Group, Inc., 1977), the first nine cells had been constructed, Cell No. 1 was being used as a hot pit (isolated burial of spontaneously combustible materials), and Cell No. 7 was being

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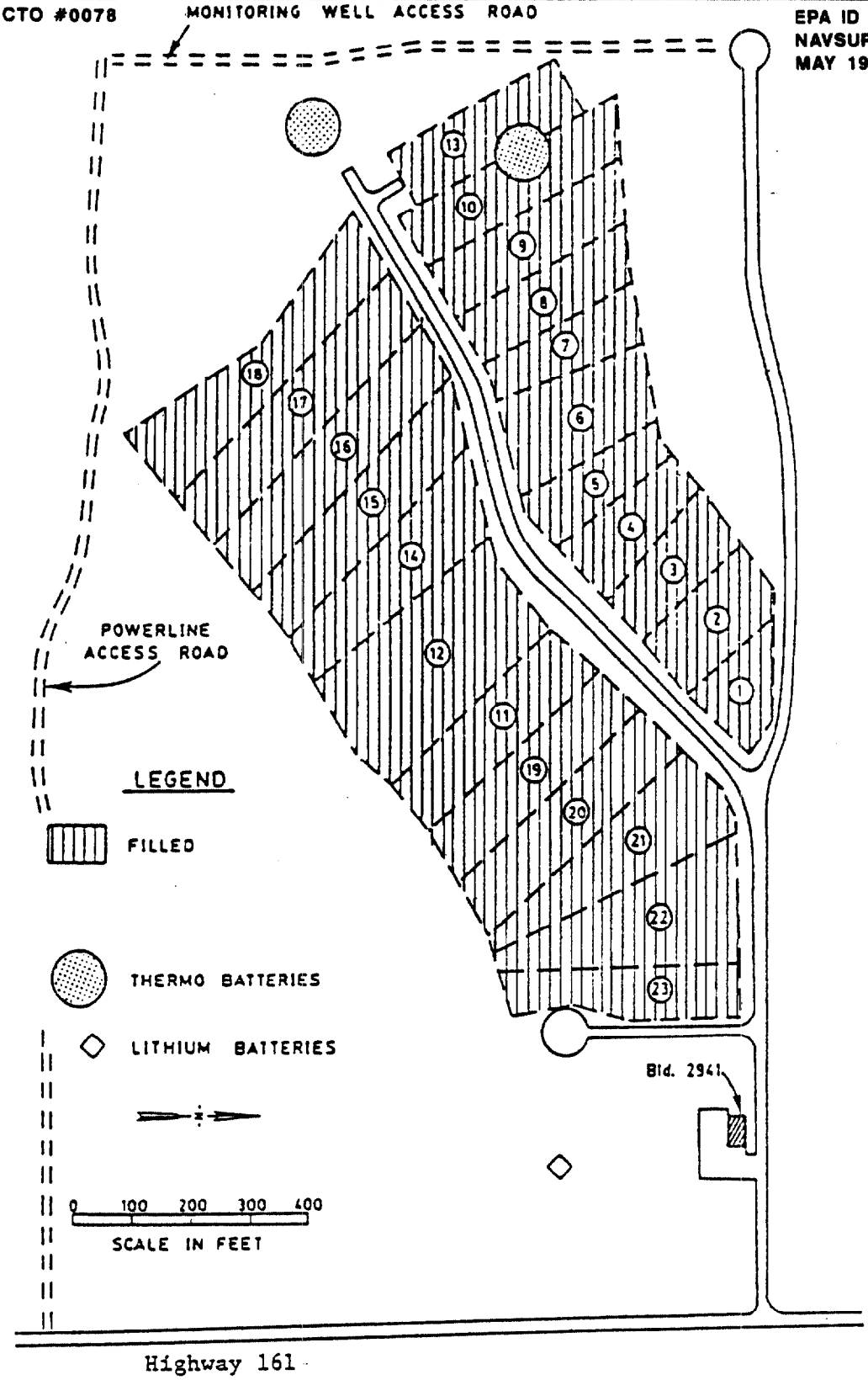



SOURCE: DUNBAR, APRIL 1984

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 20617

**FIGURE 4-9**
**SWMU #14/00 SANITARY LANDFILL AND LITHIUM BATTERY**
RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

L-11080

filled (Figure 4-2). The Crane Sanitary Landfill consolidated profiles (Public Works Office (PWO) Drawing No. 4638) indicate that the first 12 trenches were completed prior to 1980. PWO Drawing No. 4638 also indicates initiation dates for filling of Trench Nos. 13, 14, 15, and 17 as March 1980, March 1982, January 1985, and July 1983, respectively. Dunbar (1984a) reports filling of Trench Nos. 1 through 15, and Trench No. 17 as complete.

A 1987 Permit Amendment Application for the landfill (Reid, Quebe, Allison, Welcox & Associates, Inc., 1987) outlined plans to shift to area fill methods at the completion of trench and fill methods. Area fill was to be over the original landfill trenches (Nos. 1 through 9, 11, 12, 14, and 15 through 23).

It is not known if area fill was developed over the completed trench and fill area. Currently, area fill methods are employed in an approximately 37-acre area to the southeast of the completed trenches, with current fill encompassing approximately 10 acres (NWSCC, 1991c). It is believed that area fill was not placed over the completed trenches, but rather initiated in the area encompassing current operations.

#### 4.4.2.3 Waste Description

The landfill primarily receives trash and garbage from NAVSURFWARCENDIV production operations, residential areas, and food preparation areas. Estimates of material disposed daily are as follows:

- 1979: 40,000 lbs/day ("Land Disposal Site Information" memorandum).
- 1987: 35 cubic yards/day (compacted) (NWSCC Environmental Protection Division Reference File 5090/LF1.1).
- 1990: 28 cubic yards/day (NWSCC Environmental Protection Division Reference File 5090/LF1.0).

In addition to trash and garbage, other wastes have been buried in the Sanitary Landfill. In 1976, fire debris from a chemical warehouse fire were sent to the landfill (RCRA Facility Permit No. IN5170023498). The fire itself destroyed 70,000 pounds of pentachlorophenol, 50,000 gallons of paint, 500 pounds of fluorescent dye, 500 gallons of solvents, and other items (NEESA, 1983). In 1981 to 1982, special approval was granted by the ISBH to bury neutralized lithium batteries in the Sanitary Landfill. A plan map (PWO Drawing 4638, 1985; NAVFAC Code ID No. 80091) shows an approximate 25-foot square area in the northeast portion of the landfill used for lithium battery disposal. The same map also indicates two circular areas, where approximately 2,100 thermo batteries have been buried and a rectangular asbestos material disposal area. However, asbestos burial was

reportedly not confined to specific areas of the landfill (NWSCC, 1992a). The two circular thermo battery areas and the rectangular asbestos area are in the western portion of the landfill and were added to the base map in 1983.

The lithium batteries shown as buried in the northeast portion of the landfill (PWO Drawing 4638, 1985) are reportedly a type of thermo battery consisting of Li-Fe/$FeS_2$ cells separated by a pyrotechnic heat paper (NWSCC, 1992a). The cells are solid at room temperature. Activation of the batteries was accomplished by igniting the heat paper and melting the cells. Temperatures between 500 and 600$o$C were reached during this process (NWSCC, 1992a).

The thermo battery disposal areas designated in the western portion of the landfill (PWO Drawing 4638, 1985) are thought to consist of calcium chromate thermo batteries (NWSCC, 1992a). These thermo batteries consisted of Ca/$CaCrO_4$ J $2H_2O$ cells with asbestos insulators, and their use apparently preceded the lithium cells described above (NWSCC, 1992a).

According to the Installation Assessment of NWSCC (Department of the Army, 1978), certain areas of the Sanitary Landfill have been designated as "hot beds." Toxic or hazardous waste was placed in these hot bed areas within the trenches and a neutralizing agent was added before placement of the final cover. The quantities of contaminated wastes placed in these areas have been very small (Department of the Army, 1978). These materials were isolated from burnable papers because they were subject to spontaneous combustion (Snell Environmental Group, 1977). According to the Landfill Operational Plan, 16 of these "hot beds" existed in 1977 (Snell Environmental Group, 1977).

The Sanitary Landfill has also received special wastes that have been approved for disposal by the State. The majority of special waste is asbestos materials. Special waste disposal requests, approvals, expiration dates, and case numbers as well as monthly disposal summaries for special wastes are included in the Final EMR (Halliburton NUS, 1992).

Other miscellaneous wastes that have reportedly been disposed in the Sanitary Landfill include a 30-gallon trash can containing rags contaminated with grease and Petroleum Naptha (Environmental Protection Division File LF1.1), magnetic computer tapes stored in cardboard boxes, Purple K fire extinguishing fluid (NWSCC Telephone Record, 1983), 30,000 pounds of styrofoam packing material (NWSCC Environmental Protection Division File 5090/W4.0), fluorescent lamps (NWSCC Memorandum, 1982), 200 size "X" and 193 size "D" batteries (Environmental Protection Division File 11346/LF1.1), and empty containers utilized for shipping and handling bulk explosives (Allen, 1974).

#### 4.4.2.4 Topography

The Sanitary Landfill is located in an upland area in the west-central section of NAVSURFWARCENDIV adjacent to its western boundary. According to topographic contours reported on a plan sheet (PWO Drawing No. 5316), the maximum elevation at the Sanitary Landfill is 716.3 feet MSL. Elevations for future construction proposed on the same plan sheet specify a maximum finished grade elevation of 722 feet MSL. The Sanitary Landfill is characterized by relatively gentle topographic relief with existing elevations ranging from approximately 702 to 716 feet MSL.

#### 4.4.2.5 Physiography and Hydrology

Surface runoff at the Sanitary Landfill is almost exclusively to the west, southwest, and to a lesser extent the northwest. Surface runoff from the Sanitary Landfill is diverted to intermittent drainageways in these directions. A manmade surface water impoundment is located approximately 600 feet southwest of the Sanitary Landfill. The area of this impoundment was calculated to be approximately 0.85 acres according to the topographic quadrangle (USGS, 1974).

Surface runoff collected in intermittent drainageways, and flowing out of the surface water impoundment enters Seed Tick Creek 3,000 to 5,000 feet from the landfill boundaries. Seed Tick Creek flows in a south-southeasterly direction exiting the southern boundary of NAVSURFWARCENDIV. Seed Tick Creek eventually merges with Boggs Creek south of NAVSURFWARCENDIV. Boggs Creek continues to flow south to merge with the east fork of the White River.

#### 4.4.2.6 Geology

Soils

Detailed soil mapping (McElrath, 1988) in the vicinity of the Sanitary Landfill indicates the presence of four soil units. These soil units, in descending order of percent coverage, include Hosmer silt loam, Wellston silt loam, Udorthents (silty), and Zanesville silt loam. The active landfill area is mapped as covered by Udorthents.

The Hosmer silt loam in the vicinity of the Sanitary Landfill is described as gently sloping (2 to 6 percent slopes). These soils are commonly found on upland ridgetops and loess-capped lake plains. Bedrock in areas mapped as covered with Hosmer silt loam generally occurs at depths greater than 6.5 feet. USCS classifications for the Hosmer silt loam include silt (ML), clayey silt (CL-ML), and clay (CL).

Hydraulic conductivities reported for the Hosmer silt loam vary with depth due to the presence of a fragipan zone occurring at a depth of 23 to 27 inches. Hydraulic conductivity above the fragipan is described as moderate and ranges from $4.2 \times 10^{-5}$ cm/sec to $1.4 \times 10^{-3}$ cm/sec. Surface runoff is medium. The organic matter content of the upper layer is moderate, ranging from 1 to 3 percent. Soil pH in the Hosmer silt loam commonly ranges from 4.0 to 7.3.

The second most abundant soil in the vicinity of the landfill is the Wellston silt loam. In the vicinity of the landfill, Wellston soil is moderately sloping (6 to 12 percent) and is commonly found along ridgetops and sideslopes along drainageways in upland areas. Wellston soil is generally considered deep, having a thickness of greater than 5 feet. USCS classifications for Wellston soil include silt (ML), clay (CL), clayey silt (CL-ML), sandy clay (SC), and silty sand (SM).

The range of hydraulic conductivity reported for the Wellston soils is $4.2 \times 10^{-4}$ cm/sec to $1.4 \times 10^{-3}$ cm/sec. Due to the slope and hydraulic conductivity, surface runoff is rapid and the soil is considered well drained. The organic matter content in the surface layer of Wellston soil is moderate (1 to 3 percent). Soil pH in the Wellston soil commonly ranges from 4.5 to 6.5 (McElrath, 1988).

Soils mapped as silty Udorthent is found almost exclusively in areas used as landfill. As an Udorthent, this soil type is the result of excavation activities. Excavation activities have produced a moderately to strongly sloping soil surface. The thickness of this soil type and depth to bedrock are variable due to the excavation activities that produced them.

Hydraulic conductivity in Udorthents is considered to be moderate and range from $4.2 \times 10^{-4}$ cm/sec to $1.4 \times 10^{-3}$ cm/sec. Surface runoff is commonly rapid due to slope. A trace to no organic matter is found in the surface layer of Udorthent soils (McElrath, 1988).

The final soil type found in the vicinity of the Sanitary Landfill is the Zanesville silt loam. This soil unit is moderately sloping (6 to 12 percent slopes) and is commonly found on ridgetops and the upper sideslopes within natural drainageways in the uplands. Zanesville silt loam soil is considered to be deep, and bedrock is generally encountered at depths of 6 feet or more. The soil unit can be vertically divided into several zones, due to the presence of a fragipan commonly occurring at an average depth of 23 to 31 inches. USCS classifications for Zanesville silt loam soil include clayey silt (CL-ML), clay (CL), silt (ML), sandy clay (SC), silty sand (SM), and silty gravel (GM).

Hydraulic conductivities within the Zanesville silt loam soil unit vary due to vertical variations in the soil. Hydraulic conductivity above the fragipan is reported as moderate and varies from $4.2 \times 10^{-4}$ cm/sec to $1.4 \times 10^{-3}$ cm/sec. Hydraulic conductivity within the fragipan zone ranges from $4.2 \times 10^{-5}$ cm/sec to $1.4 \times 10^{-4}$ cm/sec. Hydraulic conductivity beneath the fragipan increases slightly, ranging from $1.4 \times 10^{-4}$ cm/sec to $4.2 \times 10^{-4}$ cm/sec. Surface water runoff is reported to be rapid. The organic matter in the surface layer is low ranging from 0.5 to 1.0 percent. Soil pH in the Zanesville silt loam ranges from 4.5 to 5.5.

Bedrock

The bedrock surface beneath the Sanitary Landfill is composed of sandstone, shale, and limestone of the Pennsylvanian Age Raccoon Group (Department of the Army, 1978). Subsurface exploration at the landfill has included monitoring well installation and auger and split-spoon borings. Landfill area borings indicate approximately 4 to 16 feet of surficial soils comprised of silt, clay and sandy clay, overlying sandstone and shale bedrock with occasional stringers of coal (NEESA, 1983).

#### 4.4.2.7 Hydrogeology

Based on information reported by the Geotechnical Laboratory of the U.S. Army Engineer Waterways Experiment Station (Dunbar, 1984a), groundwater occurs between approximately 4 and 24 feet beneath the Sanitary Landfill at elevations between approximately 674 feet MSL and 707 feet MSL. Historical groundwater levels are presented in the final EMR (Halliburton NUS, 1992).

Groundwater flow within the surficial soils and the shallow bedrock is primarily to the west and southwest. Horizontal hydraulic gradients average approximately 0.020 ft/ft. Vertical hydraulic gradients between nested pairs of monitoring wells around the perimeter of the filled trenches indicate relatively strong downward gradients ranging between approximately 0.320 ft/ft and 0.890 ft/ft.

#### 4.4.2.8 Previous Investigations

A total of 18 groundwater monitoring wells have been installed at the Sanitary Landfill (Dunbar, 1984a). Eleven of the wells intersect the water table at depths generally less than 20 feet, and seven wells are completed within bedrock at depths of more than 40 feet. Well construction reportedly consists of 4-inch diameter PVC with 1- to 2-foot screens (Dunbar, 1984a). Well construction is summarized in the Final EMR (Halliburton NUS, 1992). Quarterly groundwater quality monitoring is performed.

Analytical Data

Some special wastes have been analyzed for hazardous characteristics prior to disposal in the Sanitary Landfill. These wastes are defined under 329 IAC 2-21 and require a state approval prior to disposal. These wastes were previously defined as hazardous under 330 IAC-4. Regulation 330 IAC-4 has since been repealed. Special waste analyses are summarized in the Final EMR (Halliburton NUS, 1992). None of the analyses indicate that the special wastes are RCRA characteristic hazardous wastes as defined under 40 CFR 261.

Surface runoff and stream contamination from the Sanitary Landfill were evaluated as part of a 1979 study (Mason & Hanger, Silas Mason Company (MHSM), 1979). Seven areas were sampled, including the leachate ponds, surface drainageways, and the Navy-owned conservation pond.

The analyses of leachate and surface runoff samples indicated that detected concentrations of lead and cyanide in leachate samples are above MCLs. In addition, detected concentrations of copper, lead, mercury, zinc, and cyanide exceeded available ambient water quality criteria for the protection of aquatic life. MHSM (1979) recommended that the leachate pond overflow be connected to the sanitary sewer and that the entire landfill area be fenced.

Quarterly groundwater quality monitoring is required under the Sanitary Landfill's Operating Permit (IDEM Correspondence to NWSCC, 1988). Analytical results from June 1981 through September 1991 are summarized in the Final EMR (Halliburton NUS, 1992). Monitoring parameters including manganese, sodium, boron, zinc, sulfate, ammonia, arsenic, barium, cadmium, chromium, mercury, selenium, silver, fluorine, and nitrate were monitored in all wells with sufficient water volume during the March 1991 sampling round and in two wells (1A and 7A) during the September 1991 sampling round. March and September 1991 landfill monitoring well analytical results indicate the Secondary Maximum Concentration Level (SMCLs) or MCLs for lead, total dissolved solids, chloride, iron, and pH were exceeded in landfill groundwater samples. However, iron and total dissolved solids SMCLs were also exceeded in upgradient samples, suggesting that there may be a high background level of these analytes.

The March and September 1991 samples were also analyzed for volatile organic compounds. Methylene chloride was the only volatile organic compound detected. It was detected in Wells 203 and 7A during the September sampling event at concentrations of 0.0007 and 0.0019 mg/l respectively. There is no MCL for methylene chloride.

No SMCLs or MCLs exist for total organic carbon, chemical oxygen demand, hardness, or specific conductance. The maximum detected levels for these parameters, however, are at least an order of magnitude greater than the upgradient levels. The monitoring data, therefore, indicate that the landfill may be impacting groundwater quality.

#### 4.4.2.9 Potential Migration Pathways and Impacts

The interrelationships between contaminant sources, pathways, and receptors at the Sanitary Landfill are presented in the Site Conceptual Model (Figure 4-10).

Potential migration pathways at the Sanitary Landfill include subsurface gas, groundwater, surface water, and air. Gases such as methane and volatilized chemicals can migrate vertically or horizontally within the landfill and will either be released to the atmosphere or will build up in the subsurface. The Permit Amendment Application (RQAW, 1987) stated that gas control was to be provided by constructing cells in a manner to allow upward migration of gases to installed gas vents. This report also stated that the initial operation each day was to break a small hole in the previously placed daily cover to allow migration of methane to the atmosphere.

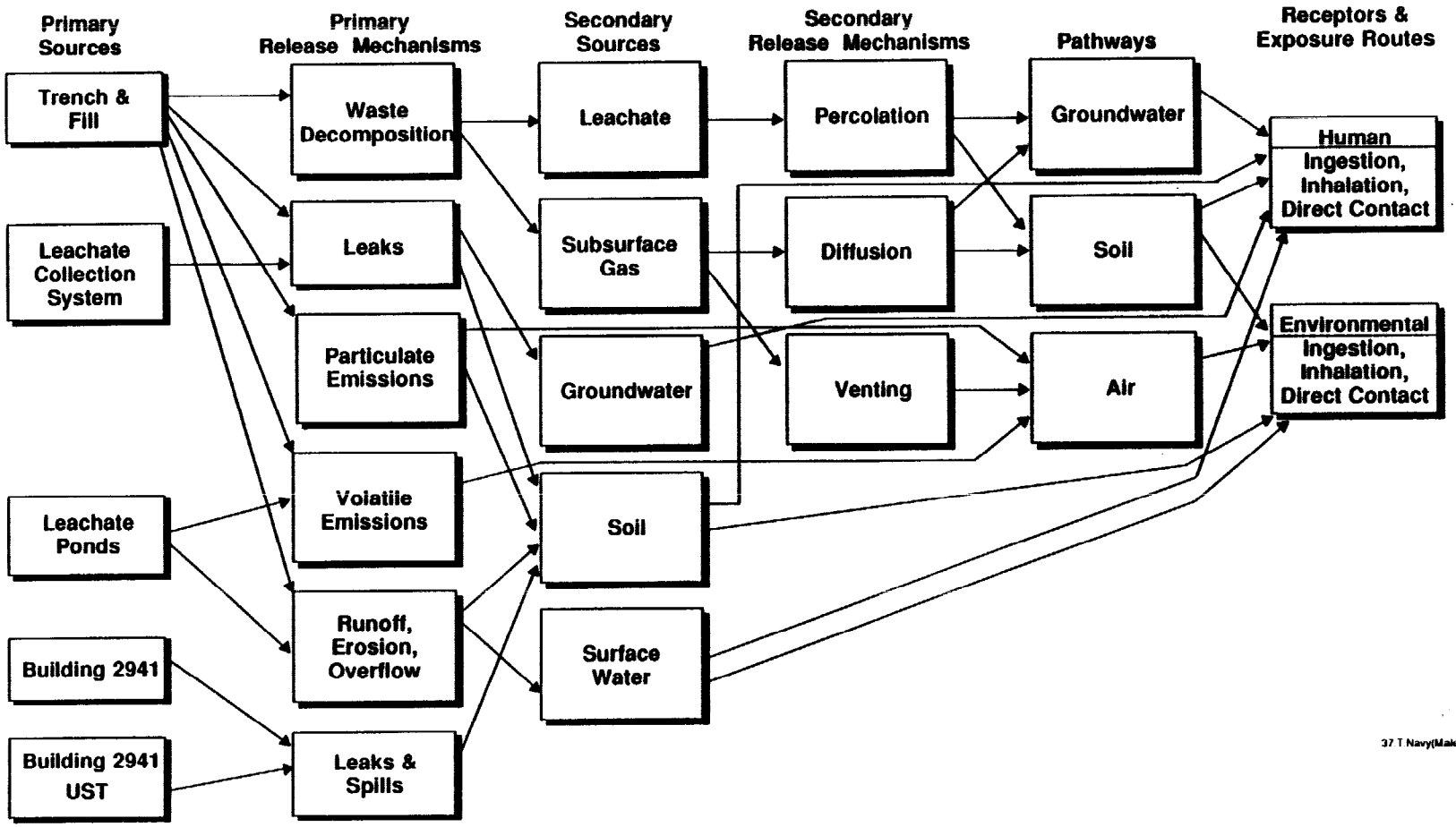
Groundwater provides another potential migration pathway. Water leaching through the landfill will migrate to groundwater if it is not intercepted by the leachate collection system. The collection system was not installed until 1981 (NWSCC, 1992a). Wastes may have been placed directly on fractured bedrock (NEESA, 1983), increasing the potential for materials to enter groundwater. Finally, the Sanitary Landfill has no bottom liner, making it more difficult to collect all the leachate.

Surface water may also act as a migration pathway. Dirt and debris may have been washed away from active cells during rain events. The 1979 study (MHSM, 1979) indicated that during heavy rains, leachate ponds were overflowing in excess of 1 gallon per minute. The proposed upgrade of the leachate ponds (Dames & Moore, 1992) does not exclude consideration of this migration pathway.

Air is a potential migration pathway for gases and particulate matter. Methane vented to the atmosphere is not flared. Particulate matter, especially from past trench and fill operations, may have been dispersed by wind. Dust control measures, such as wetting, were employed to mitigate particulate migration.

**FIGURE 4-10**

**SITE CONCEPTUAL MODEL
SWMU #14/00: SANITARY LANDFILL AND LITHIUM BATTERY
PHASE II RELEASE ASSESSMENT, NAVSURFWARCENDIV
CRANE, INDIANA**

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### 4.4.3 SWMU #16/16, Cast High Explosive Fill/Incinerator Building 146

#### 4.4.3.1 Location and Description

SWMU #16/16 is located in the north central part of NAVSURFWARCENDIV (Figure 4-6). Building 146 is situated along Highway 307 and is also accessed by Railroad 170. Building 146 was an explosive fill and pressure washout facility. Two oil-fed rotary kiln incinerators were also located at Building 146. The site is currently active and is used for renovation/rework and breakdown of munitions. Figure 4-11 shows Building 146 and nearby structures.

Nearby facilities include case filling, case preparation, lunch and locker, and sewage pumping station buildings to the immediate north and fuse and detonator magazines to the south. Magazines and storage buildings are situated to the west of Building 146. Magazines for fuses, detonators, and high explosives lie to the east of this SWMU. Buildings within the immediate vicinity of Building 146 which have housed significant quantities of explosives include Building 145, the case filling plant, and Building 148, the small arms repacking building. Both buildings primarily housed smokeless powder.

Building 146 is located in the NW 1/4 of the NE 1/4, Section 5, Township 5 North, Range 4 West, Martin County, Indiana.

#### 4.4.3.2 Operations

Cast Loading

Building 146 was the site of melt-pouring of TNT, RDX, and HBX explosives into projectiles (cast loading). Between December 1943 and the end of World War II, over 2.5 million 3-inch (40-millimeter) projectiles were loaded in Building 146 (NEESA, 1983).

Demilitarization - Incineration

Beginning in approximately 1967, demilitarization of small-arms ammunition was accomplished in three incinerators located adjacent to Building 146. The incinerators included two rotary kiln incinerators designed as APE 1236s, and a smaller prototype incinerator.

Small-arms ammunition including 20-millimeter, 50-caliber, 30-caliber, shotgun shells, fuses, detonators, boosters, tracers, flare candles, and smoke flares were fed to the incinerators on input conveyor belts and corresponding feed chutes. Upon entering the

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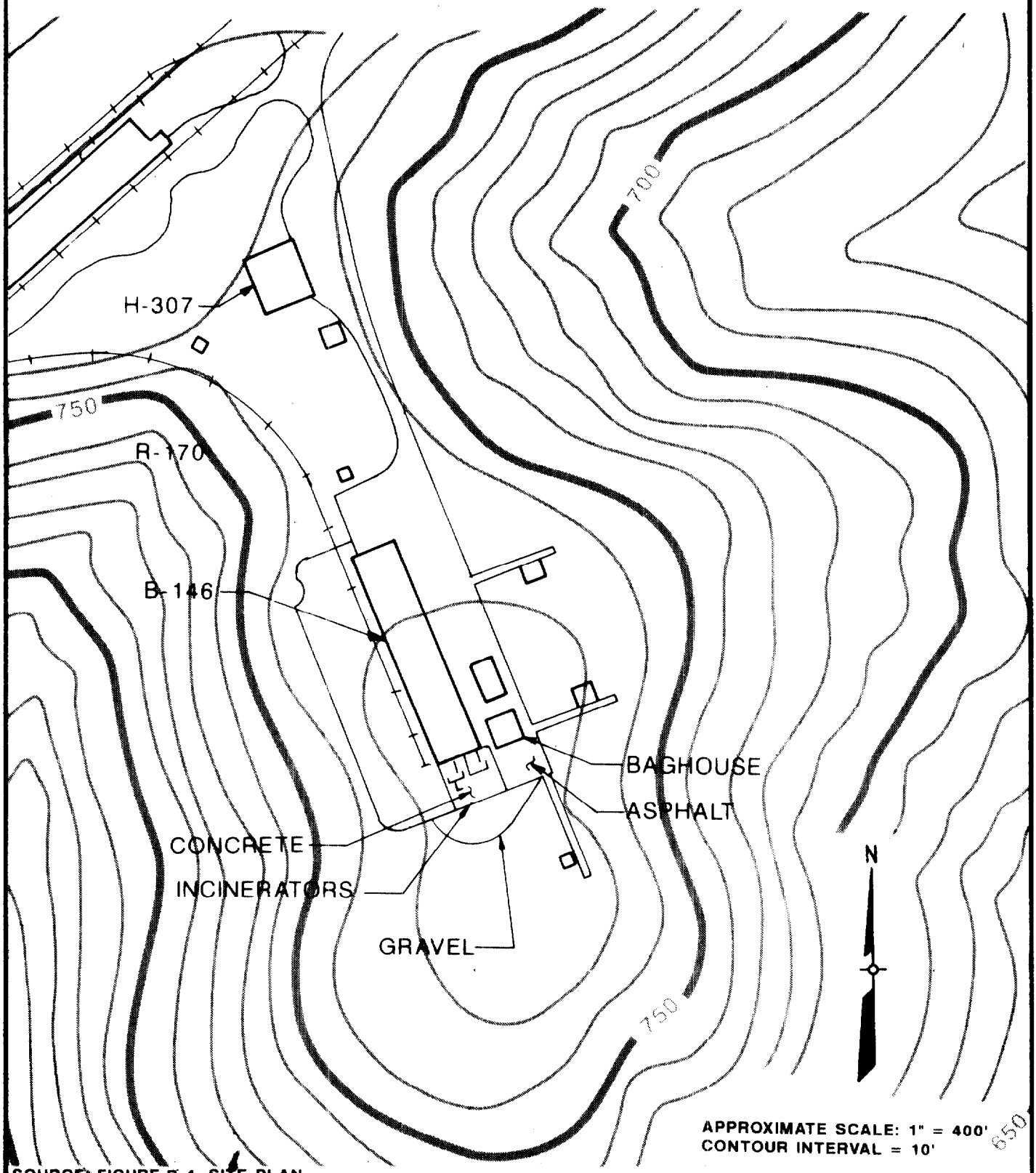



SOURCE: FIGURE B-4, SITE PLAN,
CENTRAL STORAGE FACILITY; INCINERATORS, 1984

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 4-11** 20617

**SWMU #16/16: CAST HIGH EXPLOSIVE FILL / INCINERATOR BLDG. 146**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

L-11079

furnaces, the munitions were propelled through rotary kilns toward fuel-oil burners. As the munitions approached the flame and were heated, they either burned or detonated. Each of the fuel-oil burners was supplied by an aboveground storage tank.

Exhaust gases from the furnace were directed through an air pollution control system consisting of a cyclone and baghouse. The cyclone served as a particulate removal device for the larger particles in the exhaust gases, whereas the baghouse was designed for the removal of smaller particles. In order to remove collected dust and dirt from the bags, a surge of high pressure air was induced to reverse air flow through the bags. The dust then settled into hoppers and was exhausted through motor-driven double discharge gates into collector barrels under the hoppers (RCRA Part B Permit Application, 1984).

Demilitarization - High Pressure Water Washout

High pressure water washout of 5-inch projectiles filled with Composition A was conducted at Building 146. In addition, steamout of army ammunition and rockets containing TNT and Composition B was reportedly conducted between 1954 and 1956 (NEESA, 1983).

The washout demilitarization was accomplished by first drilling out and recovering approximately 5 pounds of powder from each projectile. An additional 3 pounds of powder was then washed out, collected, and disposed of at the burning ground (NEESA, 1983). Prior to 1978, the generated wastewater was discharged to a storm drain with release to a ditch and ultimate transport to Boggs Creek. Subsequent to 1978, wastewater was collected in sumps and transported to the Rockeye area for treatment (A.T. Kearney, Inc., 1987).

#### 4.4.3.3 Waste Description

Wastes historically generated at Building 146 include those resulting from cast high explosive filling, washout demilitarization, and incineration demilitarization. Loading activities produced TNT, RDX, HBX, ammonium picrate residuals, and contaminated wastewater. These were probably originally washed down from within the building into the floor drains, if the drains were in place at that time. The floor drains discharge to settling basins or sumps which subsequently discharge to natural surface drainage. After the Rockeye Treatment Facility was installed, wastewaters generated at Building 146 have been transported to that facility for treatment (Department of the Army, 1978).

Washout activities included demilitarization of 5-inch munitions containing Composition A. Items containing TNT and Composition B were also briefly washed out in Building 146 (Department of the Army, 1979). Until 1975 or 1976, explosive material not reclaimed for resale was washed out directly into a storm drain that discharged into the Boggs Creek Watershed (Department of the Army, 1978). Three to 3-1/2 pounds of unreclaimed material from each 5-inch munition were washed out in this manner (Department of the Army, 1978). No information regarding flow rates generated by the filling or washout activities was obtained. Sediment and surface water data for samples collected near the settling basin areas are presented in Section 4.4.3.8.

No information concerning actual feed items and rates for Building 146 demilitarization was available. Treated wastes consisted primarily of military energetic materials and ordnance that had exceeded the "shelf-life", off-spec versions of these items, or various waste components from the manufacturing processes that could not be recycled or otherwise disposed safely (RCRA Part B Application, 1990). In addition, there are indications that possible incineration of PCB-contaminated fuels or materials has occurred (Memorandum to File, December 1987). These fuel blending procedures were reportedly not intended to incinerate PCBs, but rather to minimize waste oil generation and to supplement fuel requirements (NWSCC, 1992a).

The source emission testing data presented in Section 4.4.3.8 provides further information concerning potential particulate and gaseous releases, particularly those occurring prior to baghouse installation. Initially, incinerator ash was piled near Building 146. Later, ash and residue from burning and baghouse dust was collected in 55-gallon drums and transferred to the Central Storage Facility at NAVSURFWARCENDIV (RCRA Part B Application, 1990). Waste oils were also reportedly run through the Building 146 incinerators (NWSCC, 1991d). This was done to minimize waste oil generation and to supplement fuel requirements (NWSCC, 1992a).

#### 4.4.3.4 Topography

Building 146 occupies an upland area at NAVSURFWARCENDIV. The topography of the upland area is essentially level at an approximate elevation of 763 feet MSL. The relatively level area in the vicinity of Building 146 is in sharp contrast to the steep slopes east, south, and west of the building. Elevation changes on the adjacent slopes average 150 feet vertical difference per 1,000 feet in the horizontal direction. Bottom elevations in the ravines adjacent to the Building 146 area are approximately 595 to 600 feet MSL.

#### 4.4.3.5 Physiography and Hydrology

Surface drainage from the upland area around Building 146 drains to the ravines to the west, south, and east. One drainage ditch near the southwest corner of Building 146 collects drainage from the gravel-covered storage area along the west side of the building. This ditch collects and diverts surface drainage over the western slope.

Surface runoff from the Building 146 area descends the adjacent slopes to enter intermittent drainageways in the bottoms of ravines west and east of Building 146. These intermittent ravine drainageways converge at a point south of Building 146 to form one of the more upstream fingers of Turkey Creek. Turkey Creek flows south-southwest to merge with Boggs Creek. Boggs Creek continues to flow south eventually exiting the southern boundary of NAVSURFWARCENDIV. After exiting NAVSURFWARCENDIV, Boggs Creek continues to flow south and flows into the east fork of the White River.

#### 4.4.3.6 Geology

Soils

Detailed soil mapping near Building 146 by the USDA and SCS (McElrath, 1988) shows the area to be covered by Zanesville-Udorthents complex soils. Zanesville soils are commonly found on ridge tops in upland areas. NAVSURFWARCENDIV udorthents occur in areas which have been affected by earth moving activities. In general, the Zanesville soil and Udorthents are so intricately intermixed that separating them is impractical. The soil near Building 146 is moderately sloping (6 to 12 percent slopes). Soil of the Zanesville-Udorthents complex is characteristically well drained to moderately well drained.

USCS classifications for the upper portions of the Zanesville-Udorthents complex soils are clay (CL), silt (ML), and silty clay (ML-CL). At depth, USCS classifications include clay (CL), sandy clay (SC), silty sand (SM), and silty gravel (GM).

Permeability in the Zanesville-Udorthents complex varies with depth. Zanesville soils exhibit moderate hydraulic conductivity above the fragipan (generally found at a depth of 2.5 to 4.0 feet). Hydraulic conductivities in this zone range from $4.2 \times 10^{-4}$ to $1.4 \times 10^{-3}$ cm/sec. Within the fragipan, hydraulic conductivity is low, reportedly ranging from $4.2 \times 10^{-5}$ to $1.4 \times 10^{-4}$ cm/sec. Below the fragipan, hydraulic conductivity increases to the range found above the fragipan. Hydraulic conductivities in Udorthents are considered moderate and similar to those found above the fragipan in Zanesville soils. Surface runoff is described as medium by the USDA for soils in the Building 146 area. Erosion and runoff are considered significant environmental concerns at Building 146.

Depth to bedrock, in areas covered by Zanesville and Udorthent soils, generally ranges from 48 to greater than 55 inches. Depth to bedrock is often at the lower end of this range when earth moving activities have occurred. Organic matter content in the surface soil layer is low, ranging from 1 to 3 percent in Zanesville soils to absent in Udorthents (McElrath, 1988).

Bedrock

The bedrock surface beneath Building 146 was reported by the Department of the Army (1978) to be composed of sandstone, shale, and limestone of the Pennsylvanian Age Raccoon Group. Borings were reportedly completed by the Army Corps of Engineers in conjunction with monitoring well installation and subsurface investigation. Subsequent investigation of the Building 146 area by the U.S. Army Corps of Engineers (USACE) included borings completed in conjunction with monitoring well installations.

Five borings were completed during the USACE investigation to allow for the installation of groundwater monitoring wells. Three to 6 feet of clayey soil overlies bedrock in these borings. The surficial bedrock was interpreted as the Pennsylvanian Age Raccoon Creek Group. Shale and sandstone of the Raccoon Creek Group are the predominate rock types encountered. Shale thickness varies from 10 to 20 feet, to alternating or interlayered shale and sandstone beds less than 1 inch thick. Sandstone units are reported to be as thick as 10 to 20 feet when not interlayered with shales. Coal seams were encountered during coring at Building 146. Coal seams are reported as discontinuous but thicknesses of up to 4 feet were encountered. Bedrock is exposed on the slopes of adjacent uplands supporting Building 146 and the Demilitarization incinerators (Dunbar, 1984b).

#### 4.4.3.7 Hydrogeology

The general hydrogeologic setting of NAVSURFWARCENDIV was described in Section 2. Information on the hydrogeology of the Building 146 area was obtained from Dunbar (1984b).

Within the five monitoring wells in the vicinity of Building 146, groundwater is reportedly encountered 15 to 38 feet below the ground surface. Groundwater flow beneath the Building 146 incinerators is towards the south.

Groundwater elevation information indicates a horizontal hydraulic gradient of 0.048. Historical water level measurements for the Building 146 wells are presented in the Final EMR (Halliburton NUS, 1992).

Hydraulic conductivity of the clay soil near Building 146 was determined to be $4.25 \times 10^{-6}$ cm/sec through laboratory testing (Dunbar, 1984b). Hydraulic conductivities of bedrock units at Building 146 were not available.

#### 4.4.3.8 Previous Investigations

Analytical data for two demilitarization ash pile samples collected in 1982 show that the ash from the rotary kiln furnaces was a RCRA toxicity characteristic hazardous waste (EIS, Inc., 1982; CWM, 1982).

The Weapons Quality Engineering Center performed source emission testing of the Building 146 rotary furnaces in 1980 and 1981. The purposes of the testing were to determine if emissions would comply with Indiana State emission standards with only treatment by cyclone separation and to determine gaseous emissions from different types of ammunition (Burch and Schwenk, 1982). Particulate and gaseous emission results from the 1980 tests are summarized in the Final EMR (Halliburton NUS, 1992). The emission rates determined from the source emission testing exceeded the allowable rate of emission set forth under Regulation APC-5 of the Air Pollution Control Board of the State of Indiana (Burch and Schwenk, 1981). Opacity testing in 1980 determined that the visible emissions for both the 50 and 30 cal ammunition exceeded standards set forth under Regulation APC-3 (Burch and Schwenk, 1981). These results show that furnace could not comply with Indiana standards without the baghouses on-line.

The gaseous analysis results obtained in 1981 indicated that sulfur dioxide emissions were well below the standard and the study concluded that sulfur dioxide emissions should not present a problem as long as No. 2 fuel oil is used to fire the furnace burners. No nitrogen oxides emission standards from stationary sources were in-place in Indiana during 1980-1981. The 1980 results for 50 cal ammunition were particularly high. The prescribed sample method, however, may not give true indication of actual oxides of nitrogen emission rates (Burch and Schwenk, 1981). In general, the 1981 nitrogen oxides emission rates were significantly lower.

Surface soil/sediment samples have been collected around Building 146 in 1982 and 1985. The 1982 samples exceeded EP toxicity action levels for cadmium and lead. These samples also contained trace levels of explosives and a high oil and grease content. One of the 1985 samples exceeded the EP toxicity action level for lead. None of the 1985 samples contained detectable levels of explosives. The detection levels, however, were relatively high.

Analytical data for sediment samples collected from drainageways during the Water Quality Engineering Special Study (Department of the Army, 1980), revealed high levels of TNT, RDX, and HMX.

Water analytical results for 1972 and 1979 sampling events are summarized in the Final EMR (Halliburton NUS, 1992). The 1979 samples were collected near settling basins or sumps where the Building 146 floor drains discharge (from the same areas that the sediment samples were collected). The 1972 sample contained detectable levels of RDX and HMX.

None of the 1979 samples contained detectable levels of HMX. No measurable concentrations nor related detrimental effects were found in the Building 146 receiving stream, Turkey Creek (Department of the Army, 1980).

Soil samples have been collected from within the Building 146 incinerator bays as part of closure activities (NWSCC Environmental Protection Division Reference File 5090/H3.0). Between October and December 1989, 133 soil samples were collected from 34 locations from depths between 0 and 2 feet below the surface. The samples were analyzed for total metals and PCBs. In March 1990, an additional 16 samples were collected from four locations to represent background conditions. Upon review of the analytical data from the sampling efforts and the sampling data documentation, the IDEM determined that the QA/QC data for the PCB parameters were inadequate (IDEM, 1990). The IDEM directed NAVSURFWARCENDIV to resample at six locations between 0 and 2 feet below the surface. Soil analytical results indicate detectable levels of arsenic, barium, cadmium, chromium, lead, selenium and silver for almost every sample from beneath the incinerator bays and background soil locations. Comparison of analytical results reveals that the concentrations of arsenic, cadmium, chromium, selenium, and silver detected beneath the incinerator bays exceed background conditions. Exceedances involving selenium and silver are considered significant. Comparison of detected concentrations of metal to the ranges commonly found in soil indicate that elevated levels of cadmium and silver are present in soil at Building 146. The PCB analytical data indicates that detectable levels of PCBs were not present at Building 146 sampling locations. No organic compounds were detected in the soil samples.

Four monitoring wells (WES-14-1-83 through WES-14-4-83) were installed near Building 146 in July 1983. During well installation, soil and groundwater samples were collected and analyzed for metals and select organic compounds. An additional well (WES-14-5-83) was installed in September 1983, but was not sampled. Based on average U.S. soil concentrations of metals, the soils around Building 146 appear to contain elevated levels of lead and zinc. Detected concentrations of lead and zinc in samples from wells WES-14-1-83 and WES-14-4-83 were an order of magnitude greater than in samples from wells WES-14-2-83 and WES-14-3-83.

Groundwater samples collected from the wells around Building 146 exceeded drinking water regulations for lead, chromium, nickel, cadmium, mercury, and trichloroethylene. The concentrations of chromium, copper, and trichloroethylene detected in WES-14-3-83 were an order of magnitude greater than detected concentrations in the other three wells. Trichloroethylene, detected in three of the wells, was the only organic compound detected.

#### 4.4.3.9 Potential Contaminant Migration Pathways and Impacts

The interrelationships between contaminant sources, pathways, and receptors at Building 146 are presented in the Site Conceptual Model (Figure 4-12).

Potential migration pathways at Building 146 include air, surface water, and groundwater. Particulate and gaseous emissions were directly released to the atmosphere from the deactivation furnaces prior to baghouse installation and during air pollution control system failure. Also, incinerator ash was previously stored in piles near Building 146. There is no known specific ash pile location (NWSCC, 1992a). Ash was likely dispersed and blown to other portions of NAVSURFWARCENDIV, most notably to the southeast, south, southwest, and west of the incinerator bays. Air should no longer be a migration pathway because the furnaces and ash piles have been removed.

Surface water provides another migration pathway. Historically, contaminated washdown and washout wastewaters have been discharged via floor drains to sumps which empty to the Boggs Creek watershed. Although wastewaters are not currently generated at Building 146, surface water may continue to act as a migration pathway. Contaminants may desorb from sediments, or contaminated sediments may be resuspended and washed from the area.

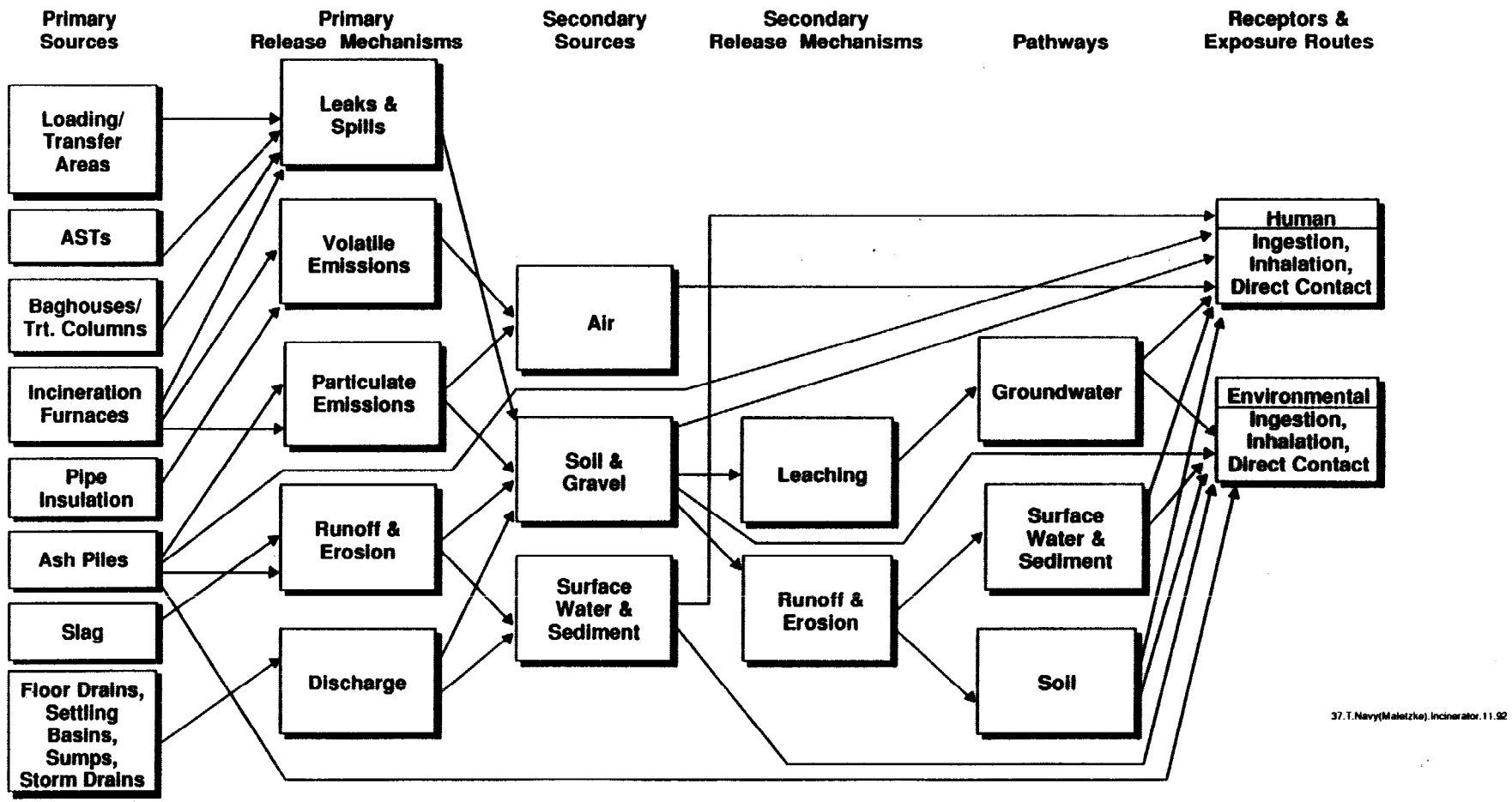
Contaminants sorbed to drainageway sediments or nearby soils could slowly desorb and percolate through the vadose zone to groundwater. Also, precipitation passing through ash piles could mobilize contaminants. Solubilized or suspended contaminants could then either resorb onto underlying soils or migrate to groundwater. Although the ash piles have been removed, contaminants may continue to leach into groundwater from the soils in this area.

The major contaminants resulting from Building 146 loading and washout activities were TNT, RDX, HBX, Composition A, Composition B, and ammonium picrate. HBX is a mixture of RDX, TNT, aluminum, and wax. Composition A contains RDX and beeswax. Composition B is composed of RDX, TNT, and wax. The main compounds of concern in the incinerator ash are the heavy metals lead, barium, cadmium, chromium, and mercury. Potential contamination from PCB oxidation products has also been reported (Memorandum to File, December 1987). Polyaromatic hydrocarbons (PAHs) and

FIGURE 4-12



SITE CONCEPTUAL MODEL
SWMU #16/16: CAST HIGH EXPLOSIVE FILL/INCINERATOR BLDG. 146
PHASE II RELEASE ASSESSMENT, NAVSURFWARCENDIV
CRANE, INDIANA

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undetonated explosives have also been detected in ash from APE-1236 incinerators (Layton et al., 1986). The toxicity and hazards of some of these chemicals are briefly discussed below.

TNT is a dangerous fire risk. TNT is very reactive and will ignite upon contact with strong oxidizers. Contact with ammonia or strong alkalies may increase sensitivity to shock (U.S. Department of Labor, 1978). TNT is toxic by ingestion, inhalation, and skin absorption (Sax and Lewis, 1987). The most notable effects of TNT in humans are aplastic anemia and toxic dermatitis (Burrows et al., 1989).

RDX is toxic by inhalation and skin contact (Sax and Lewis, 1987). Toxic effects by inhalation and ingestion attack the central nervous system and include nausea, irritability, convulsions, unconsciousness, and amnesia (USEPA, 1988a).

Ammonium picrate is a high explosive when dry and is flammable when wet (Sax and Lewis, 1987). At high doses, it causes effects similar to TNT (Burrows et al., 1989).

Aluminum can ignite violently in powder form. Fire powder forms flammable and explosive mixtures in air (Sax and Lewis, 1987). Cadmium is also flammable in powder form. It is toxic by inhalation of dust or fume and is considered a carcinogen. Soluble compounds of cadmium are highly toxic (Sax and Lewis, 1987). Lead is toxic by ingestion or inhalation (Sax and Lewis, 1987). Hexavalent chromium compounds are carcinogenic and corrosive to human tissue (Sax and Lewis, 1987). Mercury is highly toxic by skin absorption and inhalation (Sax and Lewis, 1987).

PCBs are highly toxic and suspected human carcinogens. Some PAH compounds are carcinogenic.

Overall, adsorption to soils will not effectively prevent mobility of secondary explosive compounds through surface soils. Adsorption of TNT onto soils is most closely correlated not with organic content but with extractable iron, cation exchange capacity, and percent clay. Also, adsorption and desorption appear to occur to the same extent, suggesting that continued desorption, and subsequently leaching, may remove TNT from soils unless more strongly adsorbed products are formed (Pennington et al., 1990). The explosive compounds of concern released from Building 146, therefore, will not be immobilized by surface soils. Contaminants in soil will be slowly solubilized by precipitation or surface runoff and will percolate into the groundwater.

In general, two processes can significantly affect the fate and distribution of TNT in the environment, namely microbial transformations and photochemical transformations. Physical transport from aqueous systems is expected to be insignificant because of volatilization and sediment partitioning. There is no evidence for other important

chemical transformation processes, such as hydrolysis or oxidation, under environmental conditions (Burrows et al., 1989). The predominant changes are the reduction of nitro side groups into amino groups and the coupling of rings to produce azoxy compounds (Pennington et al., 1990). The final reduced product is 2,4,6-triaminotoluene. Hydroxylamine intermediates can also couple to form tetranitroazoxytoluenes. The product which predominates depends on the nature of the microbial preparation, microbial species, and conditions under which nitro group reduction takes place.

Photochemical transformation of TNT in environmental waters are more important than microbial transformations because the rates are significantly higher. The photolysis of dilute aqueous solutions gives rise to complex mixtures because primary photoproducts undergo further reaction. The major primary photoproduct is 2,4,6-trinitrobenzaldehyde which is converted to azoxydicarboxylic acid. Smaller amounts of azodicarboxylic acid, decarboxylated azoxy compound, and amide are also formed. Two other photoproducts are 2-amino-4, 6-dinitrobenzoic acid and 4,6-dinitro-1,2-benzisoxazole. The primary transformation products (both biotic and abiotic) of TNT are 4-amino-2,6,-dinitrotoluene (4ADNT) and 2-amino-4,6-dinitrotoluene (2ADNT). These compounds tend to be more persistent in soils, with 4ADNT more resistant than 2ADNT (Pennington, 1990).

Unlike TNT, the ring structure of RDX completely breaks down with anaerobic biodegradation during composting (Doyle, 1986). Aerobic biodegradation of RDX is not known to occur (U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1988). Aerobic biotransformation of RDX in environmental surface water appears to be insignificant and the significance of anaerobes in removing it from soils and standing water zones or bottom sediments is not know (Burrows et al., 1989).

RDX is readily degraded photochemically. Several pathways may be operative. Photolysis in water leads to the formation of nitrate, formaldehyde, and methylene dinitramine. Methylene dinitramine decomposes in water to form formaldehyde and nitrous oxide (Burrows et al., undated). Formaldehyde is biodegradable both aerobically and anaerobically (Howard, 1991). Volatilization, sediment sorption, and hydrolysis are not expected to be significant environmental fate processes (Spanggord et al., 1980).

Specific information concerning the fate and migration of ammonium picrate was not found. Its partition coefficients are similar to TNT. Ammonium picrate, however, is much more soluble than both TNT and RDX. This suggests that it may be more readily transported by groundwater or surface water.

Potential subsurface mobility of the inorganic compounds ranges from low (cadmium, chromium III, lead, mercury) to high (chromium VI). Some inorganic compounds may be present in volatile form which enhances their mobility. Dowdy and Volk (1983) reviewed research data related to metal transport. In soil materials, metals occur on

exchange sites, are incorporated into or on the surface of crystalline or noncrystalline inorganic precipitates, are incorporated into organic compounds, and are present in solution. Movement of metals in natural soils is generally considered minimal because of low solubilities. Metals are often chelated or complexed with organic materials. The chelated compounds may be more soluble than inorganic precipitates. Metal movement will more likely occur for sandy, acid, low organic matter soils which receive high rainfall. Even under these conditions, however, the extent of metal movement will be limited. Most movement will occur through open channels where the soil has little opportunity for metal attenuation. More specific information for some of the metals is presented below. No further migration or dispersal characteristics for aluminum or barium was found.

Cadmium occurs only in divalent form in aqueous solutions (e.g. $Cd^{2+}$, $CdC1^{+}$, $CdSO_4$). Adsorption behavior correlates with CEC of soil and aquifer material. Adsorption/ precipitation increases with increasing pH with most cadmium precipitating at pH>6.

Mercury may occur in more than one oxidation state. It may occur in subsurface in mercuric form ($Hg^{2+}$), mercurous form ($Hg_2$2+), elemental form, and alkylated form (e.g. methyl and ethyl mercury). $Hg_2$2+ and $Hg^{2+}$ are more stable under oxidizing conditions and are strongly adsorbed by soils. Elemental mercury and alkylated forms are more stable under reducing conditions. Conversion to alkylated forms may occur under reducing conditions. Elemental mercury and alkylated-Hg forms are volatile, toxic, and may not be as strongly adsorbed by soils (USEPA, 1990).

Chromium may occur in more than one oxidation state in the subsurface. The trivalent form (Chromium III) is dominant under pH and redox conditions generally present in the subsurface. Chromium III may be converted to the more mobile and toxic hexavalent form (Chromium VI) under oxidizing conditions. Chromium III is readily adsorbed in the subsurface while Chromium VI is not (USEPA, 1990).

Dominant species of lead in aqueous solution are $Pb^{2+}$ under acidic conditions and $Pb^{2+}$-carbonate complexes under alkaline conditions. Adsorption behavior correlates with CEC of soil and aquifer material. Adsorption/precipitation increases with increasing pH with most Pb precipitating at pH>6. Volatile alkylated-Pb compounds may be present or may form under reducing conditions (USEPA, 1990).

PCBs exhibit low potential for subsurface mobility due to relatively low water solubility, low vapor pressure, moderate Henry's Law constants, and high Kow and Koc values. PCBs, which exist as mixtures of isomers, are virtually chemically inert. Most PCBs are virtually insoluble in water and are highly resistant to biodegradation. No information is available on photodecomposition of PCBs. PCBs sorb strongly to soil organic matter and tend to be highly persistent.

PAHs, in general, exhibit low potential subsurface mobility because of low water solubility, low vapor pressure, high Kow and Koc values, and moderate biodegradability. PAHs are also resistant to hydrolysis (Lyman, 1981).

6/RP/78WPD/SECTION.4

# 5.0 SAMPLING AND ANALYSIS PLAN

## 5.1 INTRODUCTION

This plan details the standard procedures to be followed for collecting samples for chemical and physical analyses at three SWMUs within NAVSURFWARCENDIV. The following sections detail the field investigation rationale and approach, as well as media-specific sampling plans including sample locations, equipment requirements, sample collection procedures, decontamination procedures, quality control protocols, and documentation requirements. Media-specific sampling plans integrate SOPs as included in Appendix A.

## 5.2 RFI SAMPLING APPROACH, RATIONALE, AND OBJECTIVES

The EMR completed as part of the Phase I RFI for SWMUs #15/06, #14/00, and #16/16 identified potential releases of hazardous waste or hazardous constituents. Accordingly, Phase II RFI Release Assessments for groundwater, surface water, sediment, and soil were recommended to verify suspected releases. Data presented in the EMR indicate that the primary contaminants associated with the respective SWMUs include pesticides gasoline, waste oil, fuel oil, municipal refuse, special wastes (i.e., asbestos), lithium, heavy metals, explosive residues, contaminated wastewaters, and incinerator ash and residues.

Based upon potential primary contaminant sources and potential contaminant migration pathways and impacts (Section 4.0, Figures 4-8, 4-10, and 4-12) for each SWMU, sampling needs specific to release verification within each SWMU have been identified. Samples to be collected during the Phase II RFI Release Assessment are presented for each SWMU in Tables 5-1 through 5-3. These tables identify, by medium, the numbers and locations of samples to be collected, analytical parameters, and the rationale for sample collection. Sampling locations for each media at the respective SWMUs are depicted on Figures 5-1 through 5-3.

The summary tables demonstrate that the Phase II Release Assessment investigative approach focuses on verification of releases attributable to identified potential primary sources. If the presence of hazardous waste or hazardous constituents is confirmed, further characterization of such releases will be necessary. At that time, Phase III Release Characterizations will be proposed to determine the rate and extent of migration of hazardous waste or constituents and their concentrations in specified media. This phased approach, as defined in the NAVSURFWARCENDIV RCRA Permit, has been

TABLE 5-1

SWMU #15/06 ROADS AND GROUNDS AREA
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Surface Water | Four grab samples to include:<br>1) One from drainageway between Buildings 2801 and 2693.<br>2) One from drainageway south of Building 2801 at its discharge point to the ravine.<br>3) One within drainageway at discharge point south of the washrack. | Specific conductance, pH, temperature | VOCs, SVOCs, metals, $NO_2$+$NO_3$, alkalinity, COD, $SO_4$, TDS, Cl, pesticides | Release verification within areas accepting surface runoff/drainage from the former Asphalt Batch Plant, the washrack, and ravine slope debris. Impact will be based on comparison with the Water Quality Criteria (Section 304A of Clean Water Act). |
| | 4) One within stream bed parallel to Highway 99, south of the Roads and Grounds Area. | | Cyanide | Release verification potentially attributable to plating shop at B-1884 (outside the SWMU). |
| Sediment | Four grab samples coincident with surface water sampling locations. | Visual description | SVOCs, metals, $NO_2$+$NO_3$, PAH, TRPH, pesticides, PCBs | Release verification attributable to spills, leaks, and discharges from primary sources identified above for surface water. Background soil sample will be considered representative of sediment background conditions. |
| Soil | Building 2801 Aboveground Storage Tank: | | | |
| | One surface (0-1") grab sample collected beneath the drain line and valve at the west end of the tank (within the containment wall). | Visual Description | SVOCs, metals, PCB, TRPH, PAH | Release verification coincident with stained soil and observable oil dripping from the valve. |
| | One surface (0-1") grab sample collected within the containment wall, at the east end of the tank. | Visual Description | SVOC, metals, TRPH, PCB, PAH | Release verification for drums stored within the containment wall. |

TABLE 5-1 (Continued)

SWMU #15/06 ROADS AND GROUNDS AREA
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Soil (Continued) | Building 2801 Aboveground Storage Tank (Continued): | | | |
| | One surface (0-1") grab sample collected beneath the gravel outside the containment wall, immediately north of the tank. | Visual description | SVOCs, metals, TRPH, PCB, PAH | Release verification coincident with drum staging outside the containment wall. |
| | Building 2801 Underground Storage Tank (UST): | | | |
| | One subsurface (~10') grab sample for VOCs and maximum of two grub samples for remaining analytes collected from a soil boring completed east of the aboveground tank. | Visual description, Photoioni-zation detector (PID) field screening | VOCs, SVOCs, metals, TRPH, PAH | Release verification targeted at former UST location (undocumented removal) within the containment area north of Building 2801. |
| | Building 2801 UST and Service Pump: | | | |
| | One subsurface (~10') grab sample for VOCs and maximum of two grab samples for remaining analytes collected beneath the gravel parking lot west of Building 2801. | Visual description, PID field screening | VOCs, SVOC, metals, TRPH (gasoline), PAH | Release verification in area of former UST where utility line excavation encountered "heavy petroleum type" materials. |
| | Former Asphalt Batch Plant: | | | |
| | Eighteen surface (1-2") grab samples collected on a grid with approximately 50-foot centers. | Visual description, PID field screening | SVOCs, metals, TRPH, PAH | Release verification within area formerly occupied by the Asphalt Batch Plant (0 to 1-foot discarded, 1 to 2-foot sampling interval retained as representative). |
| | Railroad Embankment: | | | |
| | One surface (0-6") grab sample collected from embankment immediately west of the former Asphalt Batch Plant. | Visual description, PID field screening | SVOCs, metals, TRPH, PAH | Release verification coincident with heavy soil staining on embankment. |

TABLE 5-1 (Continued)

SWMU #15/06 ROADS AND GROUNDS AREA
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Soil (Continued) | Building 2716: | | | |
| | One surface (0-2") grab sample collected adjacent to concrete loading ramp at the south end of the building. | Visual Description | Pesticides, SVOCs, metals | Release verification associated with ureabor (granular herbicide) storage. |
| | Washrack: | | | |
| | One surface (0-1") grab sample collected beneath the gravel in the center of the washrack area. | Visual Description | Pesticides, metals, SVOCs | Release verification for washout operations east of Building 2716. |
| | Buildings 2717 and 2718: | | | |
| | One surface (0-2") grab sample from the northeast corner of each building. | Visual Description | SVOCs, metals, TRPH, PAH | Release verification associated with aboveground fuel storage tanks. |
| | Ravine South of Buildings 2717 and 2718: | | | |
| | One surface (0-1") grab sample from debris-littered slope. | Visual Description | SVOCs, metals, pesticides, TRPH, PAH | Release verification attributable to indiscriminate dumping. |
| | Maximum of three grab samples representative of drum contents (soil directly adjacent to disintegrating drums). | Visual Description | SVOCs, metals, pesticides, TRPH, PAH | Waste characterization and release verification. |
| | Background: | | | |
| | One background soil sample representative of the 0 to 2-foot interval, collected north of the Roads and Grounds Area. | Visual Description | SVOCs, metals, pesticides, TRPH, PAH, PCBs. | Required as representative of background conditions. |
| Groundwater (if encountered) | Two groundwater samples from within shallow borings completed in conjunction with subsurface soil sampling at the Building 2801 UST and Service Pump (east and west of Building 2801. | pH, specific conductance, temperature | VOCs, metals, TRPH, TDS, Cl $SO_4$, COD, TOC, $NO_2$+$NO_3$, alkalinity, Cl, SVOCs | Release verification of potential UST contaminant percolation to groundwater. Impact will be based on comparison to Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs). |

TABLE 5-2

SWMU #14/00 SANITARY LANDFILL AND LITHIUM BATTERY
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Soil | One surface (0-6") grab sample within drainageway west-northwest of the northwest leachate pond. | Visual Description | Metals, SVOCs | Release verification within area accepting surface drainage from the northwest portion of the landfill, including overflow from the northwest leachate pond. |
| | One surface grab sample within drainageway southwest of the southern leachate pond. | Visual Description | Metals, SVOCs | Release verification within area accepting surface drainage from the southern portion of the landfill, including overflow from the southern leachate pond. |
| | One surface grab sample collected adjacent to transformer storage area west of Building 2941. | Visual Description | PCB, metals, SVOCs | Release verification targeted at area accepting surface runoff/drainage from transformer storage area. |
| | Lithium Battery Disposal Area: | | | |
| | Four subsurface (~5') grab samples collected from soil borings completed at the perimeter of the lithium battery disposal area. | Visual Description | Lithium, metals, SVOCs | Release verification for subsurface soils within the estimated vertical limits of lithium battery disposal/burial. |
| | Background: | | | |
| | One background surface soil sample collected east of H-161. | Visual Description | Metals, SVOCs, Lithium, PCBs | Required as representative of background conditions. Will be considered representative of subsurface soils also. |
| Surface Water | Three grab samples to include:<br>1) One from the northwest leachate pond.<br>2) One from the southern leachate pond.<br>3) One from the Navy-owned conservation pond. | pH, specific conductance, temperature | Metals, COD, TDS, $SO_4$, Cl, alkalinity, $NO_2$+$NO_3$, VOCs, SVOCs | Leachate characterization within leachate ponds and release verification for Navy-owned conservation pond (receives drainage from southern portion of the landfill). Impact will be based on comparison with Water Quality Criteria (Section 304A of Clean Water Act). |

TABLE 5-2 (Continued)

SWMU #14/00 SANITARY LANDFILL AND LITHIUM BATTERY
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Sediment | Three grab samples coincident with surface water sampling locations. | Visual Description | SVOCs, metals, VOCs | Release verification for discharges from the leachate ponds. Background soil sample will be considered representative of sediment background conditions. |
| Groundwater | 18 existing groundwater monitoring wells located around the perimeter of the limits of disposal cells. | pH, specific conductance, temperature | Metals, $SO_4$, VOCs, TDS, $NO_2$+$NO_3$, alkalinity, SVOCs, Cl, barium, TOC, COD | Release verification for waste decomposition and leachate percolation to groundwater. |
| | Four groundwater samples from within shallow borings completed in conjunction with subsurface soil sampling at the perimeter of the lithium battery disposal area. | pH, specific conductance, temperature | Metals, lithium, VOCs, TDS, $NO_2$+$NO_3$, alkalinity, SVOCs, Cl, $SO_4$, COD, TOC | Release verification for lithium battery disposal/burial within anticipated shallow water table area. |
| | Background: | | | |
| | Collect samples from existing monitoring wells 1A and 1B. | pH, specific conductance, temperature | Metals, $SO_4$ VOCs, TDS, $NO_2$+$NO_3$, alkalinity, SVOCs, Cl, barium, TOC, COD, lithium | Required as representative background based on anticipated upgradient location. |
| Subsurface Gas | Barhole probing at 25 locations around the perimeter of the waste disposal cells. | Oxygen, combustible gas (methane) | VOCs, hydrocarbons, methane, $H_2S$, $CO_2$ (see Table 5-6) | Release verification of subsurface gas and lateral gas migration through soil. |

TABLE 5-3

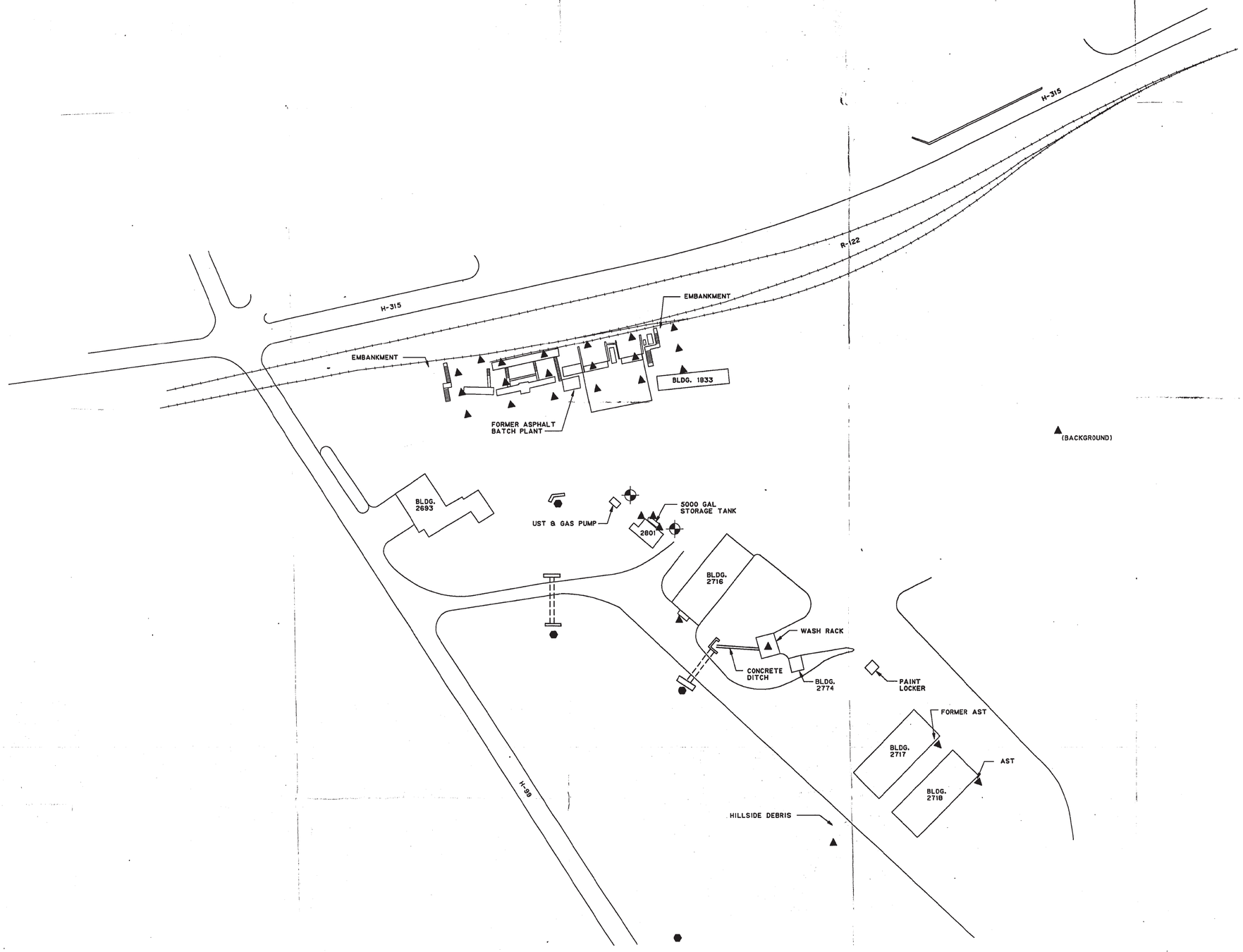
SWMU #16/16 CAST HIGH EXPLOSIVE
FILL/INCINERATOR BUILDING 146
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Soil | Two surface (0-6") grab samples within the northwest-southeast trending drainageway east of Building 146. | Visual description | SVOCs, metals, $NO_2$+$NO_3$, explosives, PCBs | Release verification targeted at area accepting runoff/drainage from the eastern portion of the SWMU (Baghouses, Treatment columns, etc.). |
| | Two surface (0-6") grab samples within the east-west trending drainageway southwest of Building 146. | Visual description | SVOCs, metals, $NO_2$+$NO_3$, explosives, PCBs | Release verification targeted at area accepting runoff/drainage from southern portion of the SWMU (Incinerator Bays, former ash pile, etc.). |
| | One surface grab sample collected beneath stained gravel adjacent to, or beneath, each of three aboveground fuel oil storage tanks (total of 3 samples). | Visual description | SVOCs, metals, $NO_2$+$NO_3$, explosives, TRPH, PAH, PCBs | Release verification attributable to leaks and spills associated with the aboveground storage tanks. |
| | A maximum of 6 surface grab samples within the limits of the former incinerator ash pile (south of Building 146). | Visual description | SVOCs, metals, $NO_2$+$NO_3$, explosives | Release verification attributable to runoff, erosion, and infiltration associated with the former incinerator ash pile. |
| | Background: | | | |
| | One surface background sample collected northwest of Building 146 in the vicinity of existing monitoring well WES-14-2-83. | Visual Description | SVOCs, metals, $NO_2$+$NO_3$, explosives, TRPH, PAH, PCBs | Required as representative of background conditions. |
| Surface Water | Two grab samples to include one sample from each of two settling basins (northeast and northwest of Building 146). | pH, specific conductance, temperature | Explosives, VOCs, SVOCs, metals, $SO_4$, Cl, alkalinity COD, TDS, $NO_3$+$NO_2$ | Release verification associated with discharge from floor drains inside Building 146. Impact will be based on comparison with Water Quality Criteria (Section 304A of Clean Water Act). |

TABLE 5-3 (Continued)

SWMU #16/16 CAST HIGH EXPLOSIVE
FILL/INCINERATOR BUILDING 146
SAMPLING AND ANALYSIS PLAN

| Media | Primary Source/Number/Location | Parameters: Field | Parameters: Analytical | Rationale |
|---|---|---|---|---|
| Sediment | Two grab samples coincident with surface water sampling locations. | Visual description | Explosives, VOCs, SVOCs, metals | Release verification associated with discharge from floor drains inside Building 146. Background soil sample will be considered representative of sediment background conditions. |
| Groundwater | Sample 5 existing groundwater monitoring wells. | pH, specific conductance, temperature | Explosives, VOCs, SVOCs, metals, TDS, $SO_4$, Cl, $NO_2$+$NO_3$, alkalinity, COD | Release verification from Building 146 operations and from infiltration associated with the former incinerator ash pile. |
| | Background: | | | |
| | Sample existing monitoring well WES-14-2-83. | pH, specific conductance, temperature | Explosives, VOCs, SVOCs, metals, TDS, $SO_4$, Cl, $NO_2$+$NO_3$, alkalinity, COD | Required as representative background based on anticipated upgradient location. |




LEGEND

- ▲ SURFACE SOIL GRAB SAMPLE (SEE TABLE 5-1)
- ⬢ SURFACE WATER AND SEDIMENT GRAB SAMPLE
- ⊕ SUBSURFACE SOIL SAMPLE(BORING) AND GROUNDWATER SAMPLE

NOTE:
BACKGROUND SOIL SAMPLING LOCATION IS APPROXIMATE. LOCATION WILL BE DETERMINED IN THE FIELD WITH INPUT FROM NAVSURFWARCENDIV.

N

APPROXIMATE SCALE 0' 25' 50' 100'

SOURCE: PWO DRAWING NO. 1028, PLOT PLAN FOR ROADS AND GROUND AREA

CLEAN CTO #0078
DRAFT

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA WP
MAY 1993

| REV | DATE | DESCRIPTION | DR BY | APP BY |
|---|---|---|---|---|
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| DES BY | JDM | PROJECT NO. 20617 | DATE MAY 1993 |
| DRN BY | | PROJECT RFI PHASE II RELEASE ASSESSMENT NAVSURFWARCENDIV CRANE, INDIANA | |
| CHK BY | LSR | DRAWING TITLE FIGURE 5-1 SWMU #15/16 ROADS AND GROUNDS AREA SAMPLE LOCATIONS | |
| ERV BY | | | |
| GRV BY | | | |
| APP BY | JDM | | |

RUST ENVIRONMENT & INFRASTRUCTURE

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DRAWING NO.

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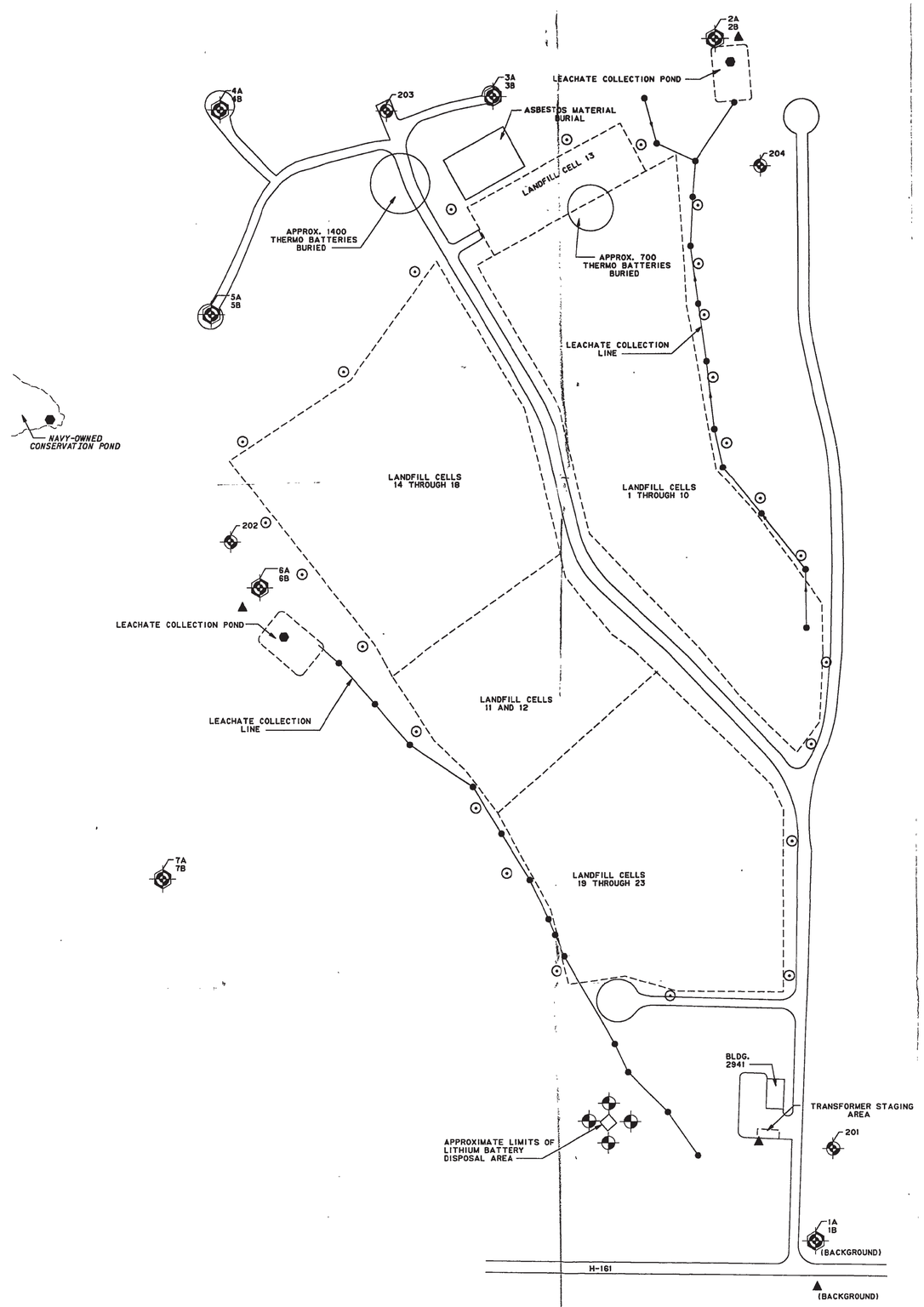


LEGEND

- MANHOLE
- SURFACE (0-6") SOIL GRAB SAMPLE
- SURFACE WATER AND SEDIMENT GRAB SAMPLE
- SUBSURFACE SOIL SAMPLE(BORING) AND GROUNDWATER SAMPLE
- 204 — EXISTING MONITORING WELL (GROUNDWATER SAMPLE)
- 2A 2B — EXISTING MONITORING WELL NEST (GROUNDWATER SAMPLE)
- BARHOLE PROBE (LANDFILL GAS SAMPLE)

N

APPROXIMATE SCALE 0' 50' 100' 200'

SOURCE: PWO DRAWING NO. 4638, CRANE SANITARY LANDFILL, 1985.

CLEAN CTO *0078
DRAFT

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA WP
MAY 1993

| REV | DATE | DESCRIPTION | DR BY | APP BY |
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| DES BY | JDM | |
| DRN BY | | |
| CHK BY | LSR | |
| ERV BY | | |
| GRV BY | | |
| APP BY | JDM | |

PROJECT NO. 206167 | DATE MAY 1993

PROJECT

DRAWING TITLE FIGURE 5-2
SWMU *14/00 LANDFILL AND
LITHIUM BATTERY SAMPLE LOCATIONS
RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

FILE NO. G-71392

DRAWING NO.

RUST ENVIRONMENT & INFRASTRUCTURE

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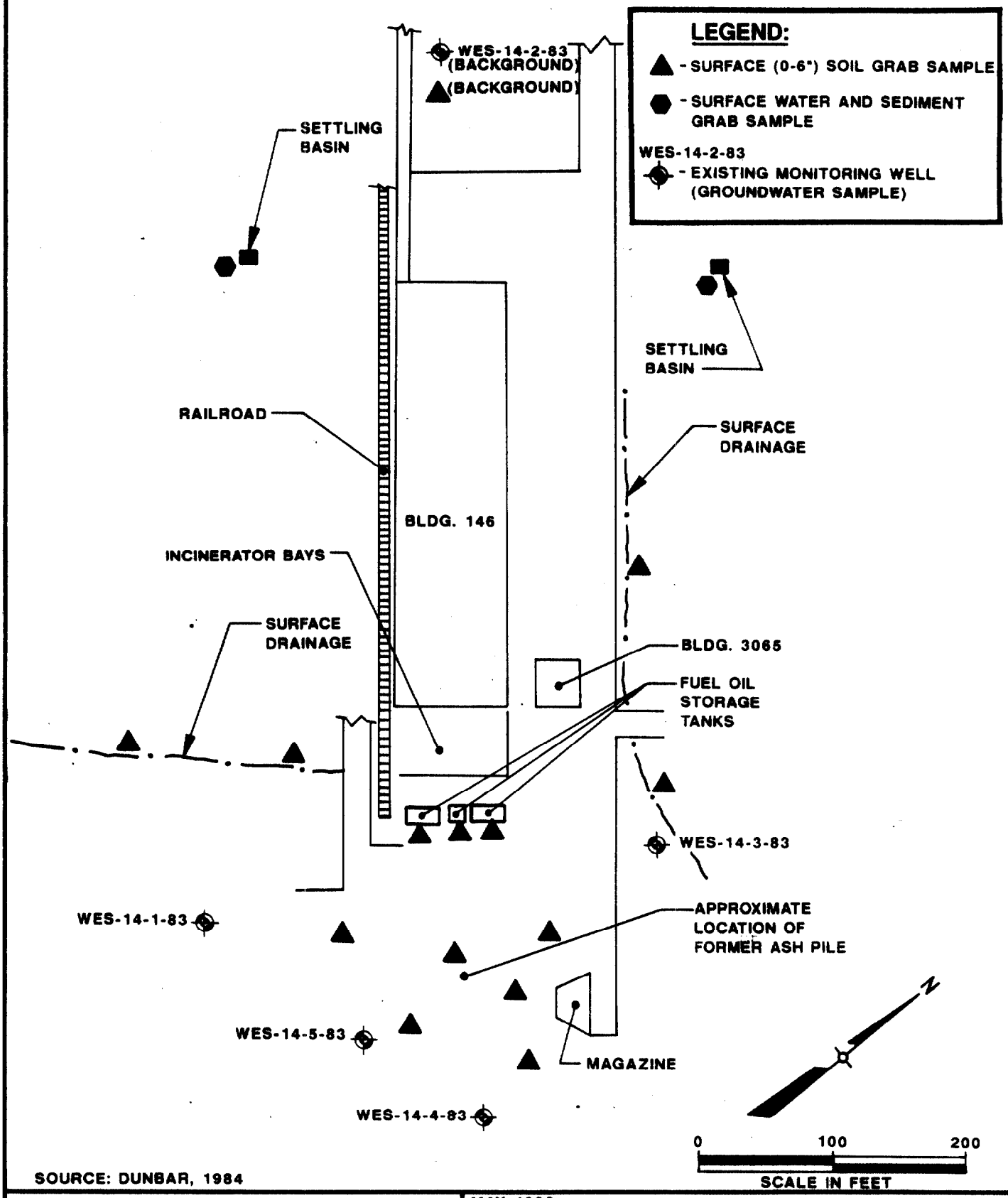
CLEAN CTO #0078
DRAFT

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA WP
MAY 1993




SOURCE: DUNBAR, 1984

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

**FIGURE 5-3**

20617

**SWMU #16/16: CAST HIGH EXPLOSIVE FILL / INCINERATOR BLDG. 146 SAMPLE LOCATIONS**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

L-11078

designed with reference to RCRA Facility Investigation Guidance, Volumes I-IV (USEPA, 1989).

The summary tables (Tables 5-1 through 5-3) also reflect a judgmental sampling approach involving selection of sample locations based on visual evidence, operational characteristics, SWMU characteristics, and waste characteristics. Grab samples will be collected for most media. Grab samples are targeted at potential contaminant hot spots, coincident with areas displaying observable impacts (i.e., soil staining) or within those areas considered most likely impacted based on past or present operations (i.e., sumps). Limited grid sampling will be conducted for less well defined potentially impacted areas (i.e., lithium battery disposal area, former asphalt batch plant).

Media-specific samples will be collected as representative of SWMU-specific background conditions. Background surface soil samples will be collected at locations chosen within each SWMU at upslope and anticipated upgradient locations away from potential primary contaminant sources. In the absence of unimpacted or definable background surface water sample locations, surface water samples will be evaluated with respect to Water Quality Criteria (Section 304A of the Clean Water Act). SWMU-specific background groundwater conditions will be established within existing upgradient monitoring wells defined on the basis of water level measurements and proximity to potential primary contaminant sources. Background samples for respective media will be collected first in the sampling sequence for each SWMU.

Sampling procedures, equipment, decontamination, and documentation will be consistent for each of the three SWMUs. Media-specific procedures are presented in the following sections for Surface Soil Sampling, Surface Water and Sediment Sampling, Groundwater Sampling, Groundwater Hydraulic Characterization, Subsurface Gas Sampling, and Well Inventory.

## 5.3 SURFACE SOIL SAMPLING

The purpose of this section is to identify the equipment and appropriate methods necessary to obtain surface soil samples at each SWMU. As indicated in Tables 5-1 through 5-3, surface soil sampling may include representative portions of soil within the 0 to 2-foot interval. Samples targeted at observable impacts (i.e., soil staining) or at areas likely impacted by recognizable surface operations (i.e., drum staging areas, drainageways, ash stockpiles, etc.) will be restricted to the 0 to 6-inch interval. In areas such as the Roads and Grounds Area, where surface soils have been sufficiently disturbed since contamination may have taken place, surface grab samples may extend to 2 feet below the surface. At the Former Asphalt Batch Plant (within the Roads and Grounds Area), surface soil disturbance likely requires that the 0 to 1-foot interval not

be regarded as representative. Accordingly, samples may be collected from the 1 to 2-foot interval. Surface soil samples will be collected to verify potential releases to soil from primary sources.

### 5.3.1 Sample Locations

The sample locations are described in Tables 5-1 through 5-3, and shown on Figures 5-1 through 5-3. Sample locations will be field-identified with lath or stakes prior to sampling. At the Roads and Grounds Area, a surveyed sampling grid will be established in conjunction with the former Asphalt Batch Plant. Grid sampling will be performed on approximately 40- to 50-foot centers as shown on Figure 5-1. Actual sampling locations will be accurately noted on sample log sheets with reference to survey coordinates.

### 5.3.2 Analytical Parameters

Surface soil samples will be analyzed using approved methods within the holding time parameters dictated by the QAPP (Appendix B). Soil samples will be analyzed for PAH, SVOCs, metals, TRPH, pesticides, PCBs, lithium, and explosives as summarized in Tables 5-1 through 5-3.

### 5.3.3 Equipment

The following equipment and material will be used during surface soil sampling:

1. Stainless steel hand trowels.
2. Stainless steel hand auger with extensions.
3. Water, distilled/deionized.
4. Isopropanol (decon spritz).
5. Five-gallon pail with cover to contain isopropanol rinses.
6. Cleaning brushes.
7. Stainless steel spoons.
8. Stainless steel putty knife.
9. Large stainless steel bowls.
10. Sample containers as indicated in Table 5-4.
11. Sample labels.
12. Lath/wire flags.
13. Marking pens.
14. Shovel.
15. Pick.

## TABLE 5-4

## SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES

| Matrix | Parameter | Container | Preservation | Holding Time |
|---|---|---|---|---|
| Soil/ Sediment | VOC | Two 120-ml VOA glass vial | 4° C | 14 days |
| | SVOC | One 8-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Metals/ Lithium | One 8-oz. wide-mouth glass jar | 4° C | 6 months |
| | PCBs/ Pesticides | One 8-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Explosives | One 4-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | TRPH | One 8-oz. wide-mouth glass jar | 4° C | 28 days |
| | $NO_2+NO_3$ | One 4-oz. wide-mouth glass jar | 4° C | 28 days |
| Groundwater/ Surface Water | VOC | Two 40-ml VOA glass vials | 1:1 HCl, pH <2, 4° C | 14 days |
| | SVOC | Two 1-liter amber glass jars | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Metals/ Lithium | One 1-liter HDPE | 1:1 $HNO_3$, pH <2, 4° C | 6 months |

## TABLE 5-4 (Continued)

## SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES

| Matrix | Parameter | Container | Preservation | Holding Time |
|---|---|---|---|---|
| Groundwater/ Surface Water (Continued) | PCBs/ Pesticides | Two 1-liter amber glass jars | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Explosives | Two 1-liter amber glass jars | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Chloride<br>Sulfate<br>Alkalinity<br>TDS<br>pH | One 1-liter HDPE | 4° C | 28 days<br>28 days<br>14 days<br>7 days<br>Analyze immediately |
| | COD<br>$NO_2+NO_3$ | One 1-liter HDPE | 1:1 $H_2SO_4$, pH <2, 4° C | 28 days |
| | TOC | One 1-liter amber glass jar | 1:1 $H_2SO_4$ pH<2,4° C | 28 days |
| Subsurface Gas | VOCs | SUMMA® Canister | -- | 30 days |
| | Major Compo-nents, and Hydrocarbons | Tedlar Bags | -- | 72 hours |
| | Hydrogen Sulfide | Tedlar Bags | -- | 24 hours |

### 5.3.4 Procedures

Surface soil samples will include grab samples collected in accordance with Halliburton NUS SOP GH-1.3, Section 5.2 (Appendix A). Plant material or gravel will be cleared away with a shovel or pick prior to surface soil sample collection. A decontaminated stainless steel hand trowel or auger will be used to collect soil samples. Each sample will be classified according to the USCS and assigned a color according to a Munsell Soil Color Chart consistent with Halliburton NUS SOP GH-1.5 (Appendix A), and examined for obvious signs of contamination (staining, etc.). Grab samples collected from 0 to 6 inches will be described and placed directly in appropriate sample jars. Samples collected to depths of 1 or 2 feet will be obtained with a hand auger. Auger lifts will be placed in a stainless steel bowl, mixed, and placed in appropriate sample jars. Where the target interval is between 1 and 2 feet, the first foot may be removed with a shovel prior to utilizing the hand auger. The containers and sample volumes required are listed in Table 5-4.

### 5.3.5 Decontamination

Field sampling equipment contacting the soil sample will be decontaminated prior to use and between sample locations to avoid cross-contamination. The decontamination method is as follows:

1. Liquinox wash.
2. Distilled water rinse.
3. Isopropanol rinse.
4. Distilled water rinse.

Decontamination will include disposal of the samplers' gloves and other personal protective equipment which becomes grossly contaminated during sampling events. Decontamination practices, methods, and follow-up are addressed in Halliburton NUS SOP HS-02 (Appendix A).

### 5.3.6 Quality Control

Table 5-5 lists the samples needed for field quality control as detailed in the QAPP (Appendix B). Field duplicates will be collected at the same time and in the same manner as original samples.

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC Officer for completeness and accuracy.

# TABLE 5-5

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #15/06 - ROADS AND GROUNDS AREA | | | | | | | | | | | | |
| Surface Soils | | SVOC | C | 34 | 4 | 1 | -- | 3 | 42 | -- | 2 | 2 |
| | | Metals | C | 34 | 4 | 1 | -- | 3 | 42 | 2 | 2 | -- |
| | | PCBs | C | 4 | 1 | 1 | -- | 1 | 7 | -- | 1 | 1 |
| | | TRPH | C | 32 | 4 | 1 | -- | 3 | 40 | 2 | -- | -- |
| | | VOC | C | 3 | 1 | 1 | 1 | 1 | 7 | -- | 1 | 1 |
| | | Pesticides | C | 7 | 1 | 1 | -- | 1 | 10 | -- | 1 | 1 |
| Surface Water | Temp., pH, Specific Conductance | | EPA 1 | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | Metals | C | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | COD | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | TDS | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | $SO_4$ | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | Alkalinity | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | VOC | C | 4 | -- | -- | 1 | -- | 5 | -- | -- | -- |
| | | SVOC | C | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | $NO_2+NO_3$ | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | Cl | E | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | Pesticides | C | 4 | 1 | -- | -- | 1 | 6 | -- | 1 | 1 |
| | | Cyanide | C | 1 | -- | -- | -- | -- | 1 | -- | -- | -- |
| Sediment | | SVOC | C | 4 | 1 | -- | -- | 1 | 8 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | 1 | 8 | 1 | 1 | -- |
| | | $NO_2+NO_3$ | E | 4 | -- | -- | -- | 1 | 7 | 1 | -- | -- |
| | | TRPH | C | 4 | 1 | 2 | -- | 1 | 8 | 1 | -- | -- |
| | | Pesticides | C | 4 | 1 | -- | -- | 1 | 8 | -- | 1 | 1 |
| | | PCBs | C | 4 | 1 | 2 | -- | 1 | 8 | -- | 1 | 1 |

## TABLE 5-5 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SWMU #15/06 - ROADS AND GROUNDS AREA (Continued)** | | | | | | | | | | | | |
| Groundwater from boreholes (if encountered) | Temp., pH, Specific Conductance | | EPA 1 | 2 | | | | | | | | |
| | | VOC | C | 2 | 1 | 2 | 1 | 1 | 7 | -- | -- | -- |
| | | SVOC | C | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | Metals | C | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TRPH | C | 2 | 1 | 2 | -- | 1 | 6 | -- | 1 | 1 |
| | | Cl | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | $SO_4$ | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | Alkalinity | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | COD | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TDS | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | $NO_2$ + $NO_3$ | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TOC | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| **SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY** | | | | | | | | | | | | |
| Surface Water | Temp., pH, Specific Conductance | | EPA 1 | 3 | -- | -- | -- | -- | 3 | -- | -- | -- |
| | | VOC | C | 3 | 1 | -- | 1 | -- | 5 | -- | 1 | 1 |
| | | SVOC | C | 3 | 1 | -- | -- | -- | 4 | -- | 1 | 1 |
| | | Metals | C | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | Cl | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | $SO_4$ | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | Alkalinity | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | COD | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | TDS | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | $NO_2$+$NO_3$ | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| Sediment | | VOC | C | 3 | 1 | -- | 1 | -- | 5 | -- | -- | -- |
| | | SVOC | C | 3 | 1 | -- | -- | -- | 4 | -- | -- | -- |
| | | Metals | C | 3 | 1 | -- | -- | -- | 4 | -- | -- | -- |
| Surface Soils | | SVOC | C | 4 | 1 | -- | -- | 1 | 6 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | 1 | 6 | 1 | 1 | -- |
| | | Lithium | C | 1 | 1 | 2 | -- | 1 | 5 | 1 | 1 | -- |
| | | PCBs | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |

## TABLE 5-5 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY (Continued) | | | | | | | | | | | | |
| Subsurface Soils | | SVOC | C | 4 | 1 | -- | -- | -- | 5 | -- | -- | -- |
| | | Metals | C | 4 | 1 | -- | -- | -- | 5 | -- | -- | -- |
| | | Lithium | C | 4 | 1 | | -- | 1 | 6 | 1 | 1 | -- |
| Groundwater from existing wells | Temp., pH, Specific Conductance | | EPA 1 | 20 | -- | -- | -- | -- | 20 | -- | -- | -- |
| | | VOC | C | 20 | 6 | 2 | 6 | 2 | 36 | -- | 2 | 2 |
| | | SVOC | C | 20 | 6 | 2 | -- | 2 | 30 | -- | 2 | 2 |
| | | Metals | C | 20 | 6 | 2 | -- | 2 | 30 | 2 | 2 | -- |
| | | Lithium | C | 2 | 1 | 2 | -- | 1 | 6 | 1 | 1 | -- |
| | | Cl | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | $SO_4$ | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | Alkalinity | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | COD | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | TDS | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | $NO_2+NO_3$ | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | TOC | E | 20 | 6 | 2 | -- | 2 | 30 | 2 | -- | -- |
| Groundwater from boreholes | Temp., pH Specific Conductance | | EPA 1 | 4 | | | | | | | | |
| | | VOC | C | 4 | 1 | -- | 1 | -- | 6 | -- | 1 | 1 |
| | | SVOC | C | 4 | 1 | -- | -- | -- | 5 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | -- | 5 | 1 | 1 | -- |
| | | Lithium | C | 4 | 1 | 2 | -- | 1 | 8 | 1 | 1 | -- |
| | | Cl | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | $SO_4$ | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | Alkalinity | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | COD | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | TDS | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | $NO_2+NO_3$ | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | TOC | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |

## TABLE 5-5 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY (Continued)** | | | | | | | | | | | | |
| Subsurface Gas | Oxygen, Methane | | | | | | | | | | | |
| | | VOC | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | Methane | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $O_2$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $H_2S$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $N_2$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | Hydrocarbons | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| **SWMU #16/16 - CAST HIGH EXPLOSIVES FILL/INCINERATOR BUILDING 146** | | | | | | | | | | | | |
| Surface Water | | VOC | C | 2 | 1 | -- | 1 | -- | 4 | -- | -- | -- |
| | | SVOC | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | Explosives | E | 2 | 1 | 2 | -- | -- | 5 | -- | 1 | 1 |
| | | Metals | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | COD | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | Alkalinity | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | TDS | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | $NO_2+NO_3$ | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| Sediment | | VOC | C | 2 | 1 | -- | 1 | 1 | 5 | -- | 1 | 1 |
| | | SVOC | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | Explosives | E | 2 | 1 | -- | -- | 1 | 4 | -- | 1 | 1 |
| | | Metals | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| Surface Soils | | Explosives | E | 14 | 2 | -- | -- | 1 | 17 | -- | 1 | 1 |
| | | Metals | C | 14 | 2 | -- | -- | 2 | 18 | 1 | 1 | -- |
| | | TRPH | C | 4 | 2 | -- | -- | 1 | 7 | -- | -- | -- |
| | | SVOC | C | 14 | 2 | -- | -- | 2 | 18 | -- | 1 | 1 |
| | | $NO_2+NO_3$ | E | 14 | 2 | -- | -- | 2 | 18 | 1 | -- | -- |
| | | PCBs | C | 8 | 2 | -- | -- | 1 | 11 | -- | -- | -- |

## TABLE 5-5 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #16/16 - CAST HIGH EXPLOSIVES FILL/INCINERATOR BUILDING 146 (Continued) | | | | | | | | | | | | |
| Groundwater from existing wells | Temp., pH, Specific Conductance | | EPA 1 | 5 | -- | -- | -- | -- | 5 | -- | -- | -- |
| | | SVOC | C | 6 | 2 | -- | -- | 1 | 9 | -- | 1 | 1 |
| | | Metals | C | 6 | 2 | -- | -- | 1 | 9 | -- | 1 | 1 |
| | | Explosives | E | 6 | 2 | 2 | -- | 1 | 11 | -- | 1 | 1 |
| | | VOC | C | 6 | 2 | -- | 2 | 1 | 11 | -- | 1 | 1 |
| | | TDS | E | 6 | 2 | -- | -- | 1 | 9 | 1 | -- | -- |
| | | $NO_3+NO_2$ | E | 6 | 2 | -- | -- | 1 | 9 | 1 | 1 | -- |
| | | $SO_4$ | E | 6 | 2 | -- | -- | 1 | 9 | 1 | 1 | -- |
| | | Alkalinity | E | 6 | 2 | -- | -- | 1 | 9 | 1 | -- | -- |

(1) Trip blanks will be provided at a frequency of one per cooler containing VOCs samples (soil and water). The number of field blanks are based on two water sources for three events. Rinsate blanks samples will be collected at a frequency of one per day per sampling train. Field duplicates will be collected at a frequency of 1 per 10 samples collected except for explosives and water quality analytes which will be collected at a frequency of 1 per 20 samples collected.

FB - Field Blank
RB - Rinsate Blank
FD - Field Duplicate
LD - Laboratory Duplicate
MS - Matrix Spike
MSD - Matrix Spike Duplicate
TB - Trip Blank

### 5.3.7 Documentation

Soil sampling information and other observations made by the sampler during daily activities will be recorded on the appropriate field forms as included in Halliburton NUS SOPs SA-6.4 and SA-6.5. This will include:

1. Daily Activities Reports
2. Sample Log Sheets
3. Sample Labels
4. Chain of Custody Records
5. Photographs of Sampling Locations

## 5.4 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected to verify releases to surface water bodies and drainageways adjacent to, and within, the SWMUs. Current conditions as well as potential releases to surface water will be verified.

### 5.4.1 Sample Locations

The sample locations are described in Tables 5-1 through 5-3 and shown on Figures 5-1 through 5-3. Sample locations will be field identified prior to sampling. Actual sampling locations will be noted on sample log sheets with reference to permanent structures or other physical features.

### 5.4.2 Analytical Parameters

Surface water and sediment will be analyzed using Navy approved methods and within holding time parameters dictated by the QAPP (Appendix B). Surface water samples will be analyzed in the field for specific conductance, pH, and temperature. Laboratory analysis will include VOCs, SVOCs, metals, explosives, $NO_2$+$NO_3$, alkalinity, COD, $SO_4$, TDS, Cl, and pesticides as summarized in Tables 5-1 through 5-3.

Sediment samples will be visually described and laboratory analysis will include SVOCs, metals, explosives, PAH, TRPH, PCBs, and pesticides as summarized in Tables 5-1 through 5-3.

### 5.4.3 Equipment

The following equipment and materials will be used during surface water and sediment sampling:

1. Sample containers as indicated in Table 5-4.
2. Sampling tube/split-spoon/mud auger.
3. Isopropanol.
4. Five-gallon pail with cover (to contain isopropanol or soap wash water).
5. Alconox or liquinox soap.
6. Cleaning brushes.
7. Stainless steel bowls and spoons.
8. Chest waders.
9. pH meter.
10. Thermometer.
11. Indelible marking pens.
12. Paper towels.
13. Sample labels.
14. Sample log sheets.

### 5.4.4 Procedures

Surface water samples for this investigation consist of grab samples. Samples will be collected bankside where possible or by wading into shallow water where practical. Surface water samples will be collected by immersing the sample container in the body of water consistent with Halliburton NUS SOP SA-1.2, Section 5.3.5 (Appendix A). After sample collection, field measurements of specific conductance, pH, and temperature will be made and recorded on the surface water sample log sheet.

Sediment samples for this investigation include grab samples. Sediment samples coincide to stream banks and stream beds as well as drainageways, leachate pond beds, and settling basins as specified in Tables 5-1 through 5-3. A stainless steel sampling tube will be pushed or driven below the creek or pond bottom. In the case of the settling basins at Building 146, a long-handled scoop will be used to retrieve accumulated sediment from the bottom of the basin. Surface water samples will be collected prior to sediment samples at each location. After the sediment sample is collected it will be visually described with the appropriate data recorded on the sample log sheet, chain of custody record, and the sample labels.

### 5.4.5 Decontamination

Field sampling equipment contacting the surface water or sediment sample will be decontaminated prior to use and between sample locations to avoid cross-contamination. The decontamination method is as follows:

1. Liquinox wash.
2. Distilled water rinse.
3. Isopropanol rinse.
4. Distilled water rinse.

Decontamination will include disposal of the samplers' gloves and other personal protective equipment which become grossly contaminated during sampling events. Decontamination practices, methods, and follow-up are addressed in Halliburton NUS SOP HS-02 (Appendix A).

### 5.4.6 Quality Control

Table 5-5 lists the samples needed for field quality control as detailed in the QAPP (Appendix B). Field duplicates will be collected at the same time and in the same manner as original samples.

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC officer for completeness and accuracy.

### 5.4.7 Documentation

Surface water and sediment sampling information and other observations made by the samplers during daily activities will be recorded on the appropriate field forms as included in Halliburton NUS SOPs SA-6.4 and SA-6.5. This will include:

1. Sample Log Sheets (Surface Water and Sediment)
2. Daily Activities Reports
3. Sample Labels
4. Chain of Custody Records

## 5.5 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling will be conducted to assess potential contaminant releases associated with underground storage tanks at the Roads and Grounds Area and with Lithium Battery disposal/burial at the Sanitary Landfill. Soil borings will be completed to

depths coincident with the water table, or to anticipated vertical positions of underground storage tank bottoms. If a shallow water table is encountered, groundwater will be sampled from within the borehole as described in Section 5.5.3.2. Pending verification of significant releases to subsurface soil or groundwater, additional subsurface soil and groundwater sampling (including monitoring well installation) may be warranted.

### 5.5.1 Soil Boring Locations

Soil borings will be completed at the Roads and Grounds Area and the Sanitary Landfill as shown on Figures 5-1 and 5-2. The sample locations will be field identified prior to mobilization to the respective SWMUs. Field conditions may necessitate relocation of an identified boring location. Soil boring locations at the Lithium Battery disposal area, at the Sanitary Landfill, will be established based upon a surface geophysical survey (see Section 5.9).

### 5.5.2 Equipment

Equipment and materials used during soil boring and well installation activities will include:

1. A fully-equipped drill rig capable of:

    a. Accomplishing soil boring to an approximate 15-foot depth using standard 4 1/4-inch hollow stem auger drilling techniques.
    b. Performing 2-inch and 3-inch (O.D.) continuous stainless steel and standard split-spoon sampling.
    c. Providing standard penetration test information for soils.
    d. Obtaining groundwater samples through screened augers.

2. Fiberglass tape of adequate length to measure depth of boring.
3. Electric water level indicator.
4. Tap water.
5. Munsell Soil Color Chart.
6. Boring logs.
7. Indelible marking pen and black ink pen.
8. Sample labels.
9. Photoionization detector.
10. Oxygen, LEL detector.
11. Hard hat, safety glasses, and steel-toed boots.

### 5.5.3 Procedures

#### 5.5.3.1 Drilling and Soil Sampling Procedures

Borings will be advanced through unconsolidated soils using hollow stem auger techniques as specified in Halliburton NUS SOP GH-1.4 (Appendix A). If soil borings cannot be continued using augers due to encountering bedrock, drilling and sampling will be terminated at depths coincident with bedrock. Subsurface soil will be collected utilizing split-spoon samplers. In unconsolidated soils split-spoon samplers will be advanced ahead of the augers with an ATV or truck mounted drilling rig. The geologist will classify and log subsurface soils using USCS and a Munsell Soil Color Chart and maintain a complete soil boring log for each borehole as detailed in Halliburton NUS SOP GH-1.5 (Appendix A). Soil samples will be collected continuously from each borehole. Upon opening each split-spoon, soil from each depth interval will be placed in appropriate jars for possible use as a VOC sample. These jars will be filled so that no headspace remains. Additional soil from the same interval will be placed in a contaminant-free jar for field headspace analysis. The jar will be sealed with aluminum foil, agitated at least 15 seconds, and allowed a minimum of 5 minutes for any VOCs in the sample to volatize. Just prior to measuring a reading, the jar will be reshaken, and the probe of a photoionization detector (PID) then pierced through the aluminum foil. The maximum meter response within the first 2 to 5 seconds after piercing the foil will be recorded. The split-spoon interval exhibiting the highest PID reading will be submitted to the laboratory for VOC analysis. Jarred soil samples not submitted to the laboratory for VOC analysis will be emptied and spread thinly on the ground surface around the soil boring from which they originated. In the event that none of the split-spoon intervals display PID readings above background, the interval directly above the water table or the interval coincident with termination of the borehole will be submitted to the laboratory for VOC analysis.

Soil samples for analytes other than VOCs (SVOCs, metals, TRPH, and PAH) will be collected from intervals indicative of possible contamination (based on odor, PID reading, color, etc.). Only one such interval per boring will be chosen for laboratory submittal to verify a possible contaminant release. In addition to this sample, or in the absence of any indication of contamination, the interval directly above the water table or the interval coincident with the termination of the borehole will be submitted to the laboratory for SVOC, metal, TRPH, and PAH analysis. This will result in collection and laboratory submittal of at least one sample per borehole and a maximum of two samples per borehole for these analytes.

Atmospheric monitoring for volatile organics will be performed in the breathing zone with a PID and explosive gas indicator in accordance with the site-specific HASP (Appendix C). Instruments will be calibrated in accordance with manufacturers

specifications. Monitoring equipment directives are included in Halliburton NUS SOP ME-01 (Appendix A), which addresses HNU PI-101 organic vapor meters and Halliburton NUS SOP ME-02 (Appendix A), which addresses OVA 128 organic vapor analyzers.

#### 5.5.3.2 Borehole Groundwater Sampling

It is anticipated that shallow (<conjunction with soil borings completed at the Roads and Grounds Area. If encountered, groundwater will be sampled within hollow stem augers or open boreholes. Groundwater sample acquisition will be consistent with procedures outlined for monitoring wells in Section 5.6.3 in accordance with Halliburton NUS SOP SA-1.1 (Appendix A). Prior to sample collection, the water level, the initial pH, conductivity, and dissolved oxygen will be measured. Groundwater samples will be collected using a stainless steel bailer. Sample containers and preservatives to be used are listed in Table 5-4.

### 5.5.4 Decontamination

To ensure that analytical results reflect actual field conditions and concentrations, equipment will be properly decontaminated. Upon arriving at the site and prior to initiation of the drilling program, drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined location at each SWMU. The drill rig and boring equipment will be steam-cleaned prior to set-up at a location, between each borehole, and before leaving the SWMU. The use of various decontamination areas is critical because of the large size of the investigation area. Decontamination water (not containing soap or isopropanol) from the cleaning of drilling and sampling equipment will be discharged to the ground surface near the respective sampling locations. Decontamination of drill rigs and sampling equipment is addressed in Halliburton NUS SOP GH-1.6 (Appendix A).

### 5.5.5 Quality Control

Table 5-5 lists the samples needed for field quality control as detailed in the QAPP (Appendix B). Field duplicates will be collected at the same time and in the same manner as original samples.

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC Officer for completeness and accuracy.

### 5.5.6 Documentation

Subsurface sampling information and other observations made by the sampler during daily activities will be recorded on the appropriate field forms as included in Halliburton NUS SOPs SA-6.4 and SA-6.5. This will include:

1. Daily Activities Reports
2. Boring Logs
3. Sample Labels
4. Chain of Custody Records
5. Groundwater Sample Log Sheets

## 5.6 GROUNDWATER SAMPLING

### 5.6.1 Sampling Locations

One round of groundwater sampling will be conducted from existing monitoring wells at the Sanitary Landfill and at Building 146. The 23 monitoring wells to be sampled are shown on Figures 5-2 and 5-3. Groundwater sampling will be completed subsequent to completion of the well inventory described in Section 5.7.1.

### 5.6.2 Equipment

The following equipment will be used for groundwater sampling:

1. Keck pump.
2. Electric water level indicator or water level popper.
3. Field notebook.
4. Yellow Springs dissolved oxygen meter/temperature meter, manual, spare membranes, and electrode solution.
5. Conductivity meter - Yellow Springs or equivalent.
6. pH meter and calibration buffer solutions - Orion or equivalent.
7. Tap water, distilled water, and isopropanol.
8. Five-gallon pail with cover for collecting and storing isopropanol rinses.
9. Liquinox detergent.
10. Plastic sheeting.
11. Sample bottles and preservatives as listed in Table 5-4.
12. Sample labels.
13. Groundwater sample log sheets.

### 5.6.3 Procedures

Chemical sampling equipment will be transported into the field in clean plastic containers. Equipment removed from the containers will be placed upon clean plastic sheets in order to minimize contamination from ground surface. New sheeting will be used for each sampling location.

Groundwater sample acquisition will be in accordance with Halliburton NUS SOP SA-1.1 (Appendix A). Prior to sample collection, the water level, the initial pH, conductivity, and dissolved oxygen level in the well will be measured. Monitoring wells will then be purged in order to collect samples representative of geochemical conditions. Prior to conducting purging procedures, static water levels in the wells will be measured and recorded. A minimum of five well volumes will then be removed from the monitoring wells through the use of a submersible pump. If well recharge rates are insufficient to conduct continuous pumping, the wells will be pumped dry, and a sample will be obtained soon after recharge.

Pumps used in the purging process will be fitted with a backflow check valve to prevent purge water from flowing back into the well. During the purging process, selected chemical and physical characteristics of the purge water will be monitored. These characteristics include turbidity, conductivity, pH, and temperature. Field meters will be calibrated according to the procedures in the manufacturer's operation manuals. Results of calibration will be recorded on Equipment Calibration Logs as included in Halliburton NUS SOP SA-6.4 (Appendix A). Required purge volumes will be calculated as detailed in Halliburton NUS SOP SA-1.1, Section 5.3 (Appendix A).

Groundwater samples will be collected from the monitoring wells following the purging process. Samples will be collected within 24 hours of well purging, with the exception of those wells where recovery from the purging process exceeds 24 hours. Groundwater samples will be collected using a Keck pump. Sample containers and preservatives to be used are listed in Table 5-4.

### 5.6.4 Decontamination

Decontamination procedures are detailed in Halliburton NUS SOP SF-2.3 (Appendix A). The Keck pump will be cleaned between each use by: 1) a soap and water wash, 2) a tap water rinse, 3) an isopropanol rinse, and 4) two distilled water rinses. One gallon of distilled water will then be pumped through the Keck pump before the next sample is collected. The soap and isopropanol rinses will be retained in separate closed containers for discharge to the base wastewater treatment system.

### 5.6.5 Quality Control

In order to verify the quality of the sampling process, sample blanks and duplicates will be collected as listed in Table 5-5 and detailed in the QAPP (Appendix B).

Field duplicates will be taken as the second sample collected consecutively from one well using the decontaminated Keck pump.

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC Officer for completeness and accuracy.

### 5.6.6 Documentation

Data collected and observations made during groundwater sampling will be recorded on the appropriate field forms as included in Halliburton NUS SOPs SA-6.4 and SA-6.5. This will include:

1. Daily Activities Reports
2. Groundwater Sample Log Sheet
3. Equipment Calibration Logs
4. Sample Labels
5. Chain of Custody Records

## 5.7 GROUNDWATER HYDRAULIC CHARACTERIZATION

### 5.7.1 Monitoring Well Inventory

Prior to groundwater sampling, an inventory of the existing monitoring wells in these SWMUs will be completed to help ensure that required data are available to permit evaluation of the utility of existing monitoring wells for collecting additional samples. The well inventory will include assessment of the structural integrity of the wells, as well as assurance that specific monitoring well samples are representative of water quality conditions in the monitored interval.

#### 5.7.1.1 Monitoring Well Locations

A total of 23 existing monitoring wells at the Sanitary Landfill and at Building 146 will be inventoried. The wells to be inventoried are shown on Figures 5-2 and 5-3.

#### 5.7.1.2 Equipment

The following equipment will be used to complete the well inventory:

1. Electric water level indicator or water level popper
2. Field notebook
3. Distilled water
4. Tools to remove well caps
5. Keys to locked protective covers

#### 5.7.1.3 Monitoring Well Inventory Procedures

The inventory of existing monitoring wells will be completed in accordance with Halliburton NUS SOP GH-1.2 (Appendix A). As part of the well inventory procedures, available borehole drilling and well construction information for the 23 wells will be reviewed. Additionally, the original purpose of each monitoring well will be reviewed to help determine if the well installation meets the current DQOs. Well inventory data will include determination of static water levels, total well depths, well obstruction, and well integrity as detailed in Halliburton NUS SOP GH-1.2 (Appendix A).

#### 5.7.1.4 Decontamination

Water level measuring devices will be rinsed with distilled water prior to use and between well locations.

#### 5.7.1.5 Quality Control

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC Officer for completeness and accuracy.

#### 5.7.1.6 Documentation

Data collected and observations made during the well inventory will be recorded in a field notebook and on appropriate field forms included in Halliburton NUS SOP SA-6.4 and SA-6.5 (Appendix A). This will include:

1. Daily Activities Reports
2. Groundwater Level Measurement Sheets

### 5.7.2 In-Situ Hydraulic Conductivity Testing

In conjunction with the inventory of the existing monitoring wells, in-situ hydraulic conductivity tests (slug tests) will be conducted and water level measurements will be taken to determine the physical characteristics of hydraulic conductivity and horizontal gradients at the water table. The procedures to be followed during groundwater hydraulic characterization are presented in this section.

#### 5.7.2.1 Locations

In-situ hydraulic conductivity tests will be conducted within each of the 23 existing monitoring wells located on Figures 5-2 and 5-3.

#### 5.7.2.2 Equipment

Equipment to be used for in-situ hydraulic conductivity testing includes the following:

1. Stainless steel slug.
2. Rope or cord.
3. Watch with a second hand.
4. Electric water level indicator, water level popper, or teflon-coated woven tape.
5. Water level data logger with pressure transducer.
6. Liquinox.
7. Distilled water.
8. Isopropanol (ACS).
9. Five-gallon pail with cover for collecting and storing isopropanol rinses.
10. Tap water.

#### 5.7.2.3 Testing Procedures

Slug tests will be conducted as detailed in Halliburton NUS SOP GH-2.4 (Appendix A) to estimate the hydraulic conductivity of the subsurface material. The slug tests will consist of falling and rising head tests.

Before starting tests, the equipment will be decontaminated and the static water level and well depth will be measured. A pressure transducer will be inserted into the well below the static water level and sufficiently lowered to avoid contact with the slug. The slug will be inserted into the well below the static water level (falling head test) and the slug will be removed from the well (rising head test). Recording of the water level fluctuations during the slug test will be conducted using either a data logger or hand

measurement with a watch. Readings will be taken until the water level has either recovered to approximately 90 percent of the static water level or stabilized.

#### 5.7.2.4 Decontamination

Slugs or bailers and water level measurement equipment will be decontaminated prior to use, and at each well location to avoid cross contamination. Decontamination procedures will be consistent with Halliburton NUS SOP SF-2.3 (Appendix A) as follows.

1. Wash with soap and water solution.
2. Rinse with tap water.
3. Rinse with isopropanol.
4. Rinse twice with distilled water.

#### 5.7.2.5 Quality Control

Field documentation will undergo a daily internal QC review. Original field forms will be reviewed by the Site QC Officer for completeness and accuracy.

#### 5.7.2.6 Documentation

Data collected and observations made during in-situ hydraulic conductivity tests will be recorded on the appropriate field forms as included in Halliburton NUS SOP SA-6.4 and SA-6.5 (Appendix A). This will include:

1. Daily Activities Report
2. Hydraulic Conductivity Testing Data Sheets

### 5.7.3 Water Level Measurements

Water level measurement (Halliburton NUS SOP GH-2.5 (Appendix A)) will be taken during the well inventory and during in-situ hydraulic conductivity testing. All water level measurements for a SWMU will be collected within a 24-hour period. Weather conditions at the time of measurement and well integrity will also be noted. Static water levels and well depths will be measured and recorded for the purpose of determining the groundwater flow directions and horizontal hydraulic gradients at the site. The water level surface will be measured using a popper or electric water level indicator. Each well will have a reference point (notch in the top of the protective outer casing) from which water level measurements will be taken. Measurements will be noted to the nearest 0.01-foot. A reference point elevation on the well will be established by survey with respect to the National Geodetic Vertical Datum (NGVD), with an accuracy of 0.01-foot.

Water level measurements will be recorded on Groundwater Level Measurement Sheets as included in Halliburton NUS SOP SA-6.4 (Appendix A).

## 5.8 LANDFILL GAS SAMPLING

Landfill gas sampling will be conducted to evaluate lateral gas migration within the landfill and to evaluate the potential for constituents in the landfill gas to dissolve in the groundwater and to produce hazardous air emissions.

### 5.8.1 Sample Locations

Landfill gas sampling will be accomplished through the advancement of up to 25 borehole probes at locations depicted in Figure 5-2. Samples will be collected at the perimeter of the waste.

### 5.8.2 Analytical Parameters

Landfill gas samples will be analyzed in the field for methane and oxygen. Samples which require laboratory analysis will be analyzed for the parameters summarized in Table 5-6.

### 5.8.3 Equipment

The following equipment will be required:

1. Combustible Gas Meter
2. Oxygen Meter
3. Field Notebook and Field Documentation Forms
4. Camera and Film
5. Steel Plunger Bars
6. Small Sledge Hammer
7. SUMMA, Canisters

### 5.8.4 Procedures

A plunger bar approximately 0.5 inches in diameter will be used to make a hole to a depth of approximately 3 feet below the ground surface. Upon removal of the plunger bar, the sampling probe will be immediately inserted into the hole and sealed to minimize air infiltration into the barhole. A combustible gas meter that measures concentration as percent by volume methane equivalents will be used. Methane concentration data will be recorded when a stable value is obtained.

**TABLE 5-6**

**SANITARY LANDFILL GAS ANALYTES**
**GC/MS GAS ANALYSIS**

Volatile Compounds

Benzene
Bromodichloromethane
Carbon Tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethylvinyl Ether
Chloroform
Chloromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
Ethyl Benzene
Methylene Chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
Vinyl Chloride
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene

Major Components

Methane
Carbon Dioxide
Nitrogen
Oxygen
Hydrogen Sulfide

Hydrocarbons

Methane
Ethane
Propane
Butane
Pentane
Hexane
Total Non-Methane Hydrocarbons

Two ranges of detection will be available: 0 to 5 percent, and 0 to 100 percent methane by volume. The combustible gas indicator will also be equipped with a flexible extension hose and rigid metal or fiberglass 30-inch long probe. An oxygen meter will also be used to measure concentrations as percent by volume. The combustible gas meter and oxygen meter will be connected in parallel or used separately.

The oxygen and combustible gas meter will be calibrated at the start and end of each monitoring day. The manufacturer's recommended calibration procedures will be followed to obtain accurate measurements. Two standards will be used to calibrate the meters. A low concentration standard: methane (2.5 percent), oxygen (17 percent), and nitrogen (80.5 percent); and a high concentration standard: methane (50 percent), carbon dioxide (40 percent), and nitrogen (10 percent).

The combustible gas instrument will not to be used at locations where compounds such as tetraethyl lead or hydraulic fluids or lubricants, which contain salines, silicates, or silicones may be present in the atmosphere. These chemicals deaden the sensor and thus reduce measurement accuracy. If it is suspected that such compounds may be present in the test area, the calibration of the instrument will be checked after making a maximum of five measurements.

Combustible gas monitoring will be done initially in the high range. If the reading is less than 5 percent, the procedure will be repeated at the low range.

In the event that measurable concentrations of methane are detected, samples will be extracted from the barhole for laboratory analysis. Samples which require laboratory analysis will be collected in evacuated SUMMA, canisters and will be analyzed for the compounds identified in Table 5-6. SUMMA, canisters will arrive at the site with chain of custody papers and will have been decontaminated and evacuated by the contract laboratory. The monitoring technician will complete the chain of custody document and extract the sample employing the following procedures.

The canister, which is evacuated, will be connected to the probe via stainless steel tubing outfitted with compression fittings to ensure an airtight connection to the canister and the quick connect sampling port on the probe.

A valve on the canister will be opened slowly (one-fourth turn at a time) to allow the sample to enter the canister. Once the canister is filled, the valve will be closed and the sample will be forwarded to the contract laboratory for analysis. The chain of custody form will accompany the canister at all times. The canister will be considered full when the vacuum hissing sound has stopped or when 60 seconds has elapsed, whichever is less. Care will be exercised when utilizing evacuated canisters. All fittings must [be airtight otherwise dilution might occur.

### 5.8.5 Decontamination

No decontamination of barhole probes is necessary.

### 5.8.6 Quality Control

Meters will be calibrated before and after the start and completion of each day of monitoring. The calibration gas will be a certified standard. Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Site Quality Control Officer who will review the field forms for completeness, accuracy, and compliance with the Work Plan.

The laboratory performing the gas analyses will have a QA/QC program in place and will ensure all QA/QC procedures are followed for the analysis of organic compounds. Canisters will be decontaminated by the contract laboratory and evacuated to a known vacuum prior to shipment to the site for sampling. Trip blanks or duplicates will not be required, however the contract laboratory must have a program in place to conduct periodic testing of decontaminated canisters to ensure quality control and the integrity of the sample canisters.

### 5.8.7 Documentation

A complete log of daily monitoring activities will be maintained including atmospheric conditions and gas quality.

A log of calibrations will be maintained and a copy of the standard gas concentration certificate shall be incorporated into the records of the monitoring operations.

## 5.9 ELECTROMAGNETIC SURVEY

An electromagnetic surface geophysical survey will be conducted to identify the limits of lithium battery disposal prior to drilling soil borings at the Sanitary Landfill. The approximate limits of the lithium battery disposal area are shown on Figure 5-2. Based upon determination of the limits of lithium battery disposal, four soil borings (Section 5.5) will be located at the perimeter of this disposal area so as not to drill through any batteries.

### 5.9.1 Equipment

Equipment required for the geophysical survey will consist of:

- Geonics electromagnetic terrain conductivity meter (EM-31) with digital recorder.
- Portable computer, interface cable, and download software.
- Data reduction software.
- Computer contouring software.
- Site base map and aerial photographs.
- Field notebook.
- Brunton compass.
- Steel-toed shoes.
- Roll-a-wheel.
- Spray paint and flagging tape.

### 5.9.2 Procedures

At the Lithium battery disposal area, the electromagnetic geophysical survey will be performed on a pre-surveyed grid which will be staked on 50-foot centers using wooden lath. Each lath will be marked with the east and north grid coordinates based on the Indiana State Coordinate System. The geophysical survey will be conducted along traverse lines spaced 25 feet apart with readings every 25 feet along each traverse line. During the geophysical survey, the crew will position itself using the wooden laths.

The electromagnetic terrain conductivity survey data will be collected using a Geonics EM-31 Terrain Conductivity Meter in accordance with Halliburton NUS SOP GH-3.1 (Appendix A). A two-person crew will collect the data. An instrument operator will record field observations and survey traverse information and an assistant will maintain the traverse orientation. The data will be digitally recorded in a data logger and input into a computer for contouring. A base station will be established for functional checks and to monitor instrument performance during the survey.

In the field, digital data acquired during the gridded geophysical surveys will be computer contoured to confirm that reliable data have been collected and to verify that adequate survey area coverage has been attained to delineate the configuration of electromagnetic anomalies indicative of buried materials.

### 5.9.3 Decontamination

No equipment decontamination is required.

### 5.9.4 Quality Control

Field documentation will undergo a daily internal QC review. Original field documentation, computer disks, and data plots will be stored in a secure area until completion of the field program. Field documentation will be reviewed by the Site QC Officer for completeness and accuracy.

### 5.9.5 Documentation

Data collected during the geophysical surveys will be digitally recorded and stored on diskette. Field observations, computer contour plots of field data, field notes, and equipment calibration checks will be recorded in a bound field notebook. A Daily Activities Report will also be completed.

## 5.10 FIELD SCHEDULE

The proposed field schedule is shown in Table 5-7. This schedule has been developed to accomplish the proposed field investigation using an efficient and cost-effective strategy. Mobilization, sampling sequences, and field team responsibilities have been planned to maximize efficiency of personnel use, pre-mobilization arrangements, and field data prerequisites. The actual scheduling of field work and work plan implementation is contingent on Navy and EPA approval of the work plan documents.

Sampling sequences will be focused to include all surface soil, and surface water and sediment sampling at all three SWMUs during one 10-day period; and subsurface soil sampling and methane gas sampling at the Roads and Grounds Area and Sanitary Landfill during a second 10-day period. Well Inventory, groundwater sampling, well development, water level measurement, surveying, and slug testing will be completed during a third 10-day period. After evaluation of results from the field tasks, a detailed schedule will be prepared for the remaining RA tasks (data validation, data evaluation, report preparation, etc.).

The project schedule is based on the following assumptions:

- Approval of the final Work Plan by the Navy and USEPA and authorization to proceed is obtained by June 1993.
- Access to SWMUs will be provided by the Navy prior to the start of schedule field work for a specific medium.
- A 6-week turnaround time for laboratory analyses is secured.

**TABLE 5-7**

**PROJECT SCHEDULE**

| Activity | Start Date | Completion Date |
|---|---|---|
| Submit Final Work Plan | 05/03/93 | 05/03/93 |
| USEPA/Navy Work Plan Approval and Notice to Proceed | 05/04/93 | 06/04/93 |
| Prefield Preparation | 06/04/93 | 06/25/93 |
| Mobilization | 06/28/93 | 06/28/93 |
| Surface Soil, Surface Water, and Sediment Sampling at all SWMUs | 06/29/93 | 07/07/93 |
| Subsurface Soil and Methane Gas Sampling at Roads and Grounds Area and Sanitary Landfill | 07/12/93 | 07/21/93 |
| Well Inventory Groundwater Sampling, Well Development, Water Level Measurement, Surveying, and Slug Testing | 07/26/93 | 08/04/93 |
| Sample Analyses | 06/29/93 | 09/06/93 |

- The health and safety personal protective requirements are level D with upgrade to Level C.

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## 6.0 SAMPLE IDENTIFICATION NUMBERS

Each sample will be identified using the system described below. These numbers will be used to complete required sample documentation including sample labels, sample tags, and Chain of Custody Records. Documentation will be completed following guidelines provided in Halliburton NUS SOP SA-6.1 (Appendix A). Each field sample identification number will consist of a project identifier, a sample matrix, the year, location number, and collection depth as follows:

CR93-AABB-CC-DD

Where: CR = Project identifier for Naval Surface Warfare Center, Crane Division
93 = 1993 field investigation

AA = SWMU:

- 15 = SWMU #15/06, Roads and Grounds Area
- 14 = SWMU #14/00, Sanitary Landfill and Lithium Battery
- 16 = SWMU #16/16, Cast High Explosive Fill/Incinerator Building 146

BB = Sample Matrix:

- GW = Groundwater
- SD = Sediment
- SS = Soil Sample
- SW = Surface Water Sample
- GS = Gas Sample

CC = Sample location number (numbered sequentially within each SWMU) In the case of existing monitoring wells, existing well numbers/ nomenclature will be used.

DD = Sample depth in feet:

- 01 = Less than 2 feet below surface
- 02 = 2 to 4 feet
- 03 = 4 to 6 feet
- 04 = 6 to 8 feet
- etc.

# 7.0 SAMPLE CUSTODY

The USEPA chain of custody protocols, as described in National Enforcement Investigations Center (NEIC) Policies and Procedures," EPA-330/9-78-001-R, revised June 1985, will be followed. Custody is in three parts: sample collection, laboratory analysis, and final evidence files. Field evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. Custody procedures are outlined in Halliburton NUS SOP SA-6.1 (Appendix A).

6/RP/78WPD/SECTION.7

# 8.0 SAMPLE HANDLING, PACKAGING, AND SHIPMENT

## 8.1 PACKAGING AND SHIPPING

For the purposes of shipping, samples are classified as low, medium, or high level. Each level requires specific packaging, labelling, and shipping as determined by the U.S. Department of Transportation (DOT), the International Air Transport Association (IATA), and each commercial carrier. Requirements listed in this section were obtained from Federal Express and the IATA Dangerous Goods Regulations, effective January 1, 1992.

Soil will be classified as low level if field screening or results of previous laboratory analyses do not exceed 10 ppm. Samples will be prepared consistent with Halliburton NUS SOP SA-6.2 (Appendix A), as detailed in Section 5.0 of the QAPP (Appendix B).

## 8.2 SHIPMENT COORDINATION

The shipping containers will not be sealed until the courier has actually inspected the inside packaging and agreed to the labelling used and the weight/volume.

The FDC will notify the laboratories of all sample shipments on the day of shipment. At that time the following information will be provided:

- FDC name and site office telephone number.
- Site name.
- Exact number(s), matrix(ces), and level(s) of samples.
- Carrier name and airbill number(s) for the shipment.
- Method of shipment (i.e., overnight, 2-day).
- Date of shipment.
- Suspected hazards associated with the samples or site.
- Any irregularities or anticipated problems with the samples, including special handling instruction or deviations from established sampling procedures or numbers of samples.

- Status of the sampling project (i.e., final shipment, update of future shipping schedule).

Sample shipments made after 5:00 p.m. EST will be called in at the start of business the next day (8:00 a.m. EST). Laboratories will be notified by 3:00 p.m. EST Friday concerning information about sample shipments being sent Friday intended for Saturday delivery/pickup.

6/RP/78WPD/SECTION.8

# 9.0 INVESTIGATION-DERIVED WASTE DISPOSAL

## 9.1 INTRODUCTION

Standard wastes generated during sampling activities include: drill cuttings, purge waters, decontamination fluids, personal protective equipment (PPE), disposable sampling equipment, and plastic sheeting. Waste disposal procedures described below will be followed by on-site personnel.

## 9.2 WASTES FOR WASTEWATER TREATMENT PLANT

Equipment decontamination fluids containing isopropanol or soap detergents will be collected in covered 5-gallon pails and discharged to the base wastewater treatment plant upon approval.

## 9.3 WASTES FOR REFUSE HAULER

Wastes such as wastepaper and shipping boxes generated on-site from office-related activities will be staged for disposal by the base refuse hauler.

## 9.4 DISPOSABLE PERSONAL PROTECTIVE EQUIPMENT

Disposable PPE, disposable sampling equipment, and plastic sheeting will be collected in appropriately labeled plastic bags and placed in a designated NAVSURFWARCENDIV dumpster for Navy disposal. Labeling and disposal will be in accordance with appropriate RCRA regulations (USEPA, 1988b).

## 9.5 DRILL CUTTINGS

Drill cuttings will be spread thinly on the ground surface around the soil borings and groundwater monitoring wells from which they originated.

## 9.6 PURGE WATER AND DECONTAMINATION WATER

Purge water derived from the development and sampling of groundwater monitoring wells will be discharged to the ground surface at the well location but at least 10 feet from the

well so as not to directly recharge the well. Decontamination water from the steam cleaning of drilling and sampling equipment not containing soap or isopropanol will be discharged to the ground surface adjacent to the sampling location. Steam cleaning will take place at least 25 feet away from sampling locations.

6/RP/78WPD/SECTION.9

# 10.0 FIELD MEASUREMENTS/SCREENING

## 10.1 FIELD MEASUREMENTS

Field measurements and screening data obtained during sample collection activities will be recorded as specified within Section 5.0.

## 10.2 CALIBRATION OF FIELD EQUIPMENT

Equipment to be used during the field sampling will be examined to determine that it is in an operable condition and will be calibrated at the beginning and end of each day. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance and operating requirements are being observed.

## 10.3 PREVENTIVE MAINTENANCE PROCEDURES/SCHEDULE

Field equipment will be maintained and calibrated according to manufacturer's specifications. Maintenance and calibration will be documented on Equipment Calibration Logs as specified in Halliburton NUS SOP SA-6.4 (Appendix A).

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# 11.0 DATA MANAGEMENT PLAN

## 11.1 FIELD MEASUREMENTS

Data from field measurements and sample collection activities will be appropriately recorded on field documentation forms as detailed in Section 5.0. If the data are to be used on the project reports, they will be reduced or summarized and presented in the RA report.

## 11.2 LABORATORY SERVICES

Data reduction will be performed by the laboratory in accordance with the requirements of the laboratory-specific SOPs. Subsequent to receipt of data from the laboratory, data validation will be performed by the Halliburton NUS Team according to the Halliburton NUS/NEESA Data Validation Template/Reference Book. Data evaluation of validated analytical data may include data reduction and tabulation of statistical analysis, environmental fate and transport modeling, and mapping. The results will be incorporated into the RA report.

Diskette deliverables received from the laboratory will be utilized for Navy Level C reporting. The diskettes will be uploaded to Oracle relational database software. Oracle may be used to provide statistical analysis of the data and for generation of report tables. Report tables generated from Oracle are backchecked against hardcopy reports received from the laboratory to verify correctness of uploaded data. Results for the TCLP metals analyses will be reported for both the measured analyte value corrected for analytical bias (using matrix spike recovery) and the uncorrected value. Organic analytical results will be reported using Contract Laboratory Program (CLP) Statement of Work (SOW) format and forms.

6/RP/78WPD/SECTION.11

## 12.0 REFERENCES

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## APPENDIX A

## HNUS SOPs

| | |
|---|---|
| GH-1.2 | Evaluation of Existing Monitoring Wells |
| GH-1.3 | Soil and Rock Sampling |
| GH-1.4 | Soil and Rock Drilling Methods |
| GH-1.5 | Borehole and Sample Logging |
| GH-1.6 | Decontamination of Drilling Rigs and Monitoring Well Materials |
| GH-2.4 | In-Situ Hydraulic Conductivity Testing |
| GH-3.1 | Resistivity and Electromagnetic Induction |
| HS-02 | Decontamination |
| ME-01 | HNU PI-101 Organic Vapor Meter |
| ME-02 | OVA 128 Organic Vapor Analyzer |
| SA-1.1 | Groundwater Sample Acquisition |
| SA-1.2 | Surface Water and Sediment Sampling |
| SA-6.1 | Sample Identification and Chain of Custody |
| SA-6.2 | Sample Packaging and Shipping |
| SA-6.4 | Remedial Investigation Forms |
| SA-6.5 | Field Reports |

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| | | Effective Date 05/04/90 | Revision 1 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject EVALUATION OF EXISTING MONITORING WELLS | | Approved D. Senovich | |

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## 1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the proper methods for evaluating existing monitoring wells, and to insure that the validity of data to be collected from these wells is usable during site investigations.

## 2.0 SCOPE

This procedure is applicable during stages of a site investigation. The procedures are applicable to all existing monitoring wells and, for the most part, are independent of construction materials and methods.

The program represents a comprehensive approach to evaluating existing monitoring wells. Because of its comprehensiveness, completion of the program as specified will result in some duplication of effort. The actual level of evaluation program will depend on the data that are available (or which can be made available), the use to which that data will be put (i.e., the data quality objectives), and the effect that data will have on the time, budget and data quality for the overall program.

## 3.0 GLOSSARY

Data Quality Objectives (DQO) - qualitative and quantitative statements specifying data quality (i.e. measurement of uncertainty) required to support the objectives of the groundwater monitoring program.

## 4.0 RESPONSIBILITIES

Site Geologist - responsible for overseeing field inspections and for assessing the structural integrity of the wells and related field conditions. The geologist will carry out well evaluation procedures and assess the physical condition of the wells. These results and conclusions concerning the conditions of existing monitoring wells should be discussed with the Site Manager and Field Operation Leader, who together, will then determine which of the existing monitoring wells can be utilized.

## 5.0 PROCEDURES

Accurate, valid and useful groundwater monitoring requires that four important conditions be met:

- Proper characterization of site hydrogeology;
- Proper design of the groundwater monitoring program, including adequate numbers of wells installed at appropriate locations and depths;
- Satisfactory methods of groundwater sampling and analysis to meet the data quality objectives (DQOs);
- The assurance that specific monitoring well samples are representative of water quality conditions in the monitored interval.

To insure that these conditions are met, adequate descriptions of subsurface geology, well construction methods and well testing results must be available. The following steps will help to insure that the required data are available to permit an evaluation of the utility of existing monitoring wells for collecting additional samples.

## 5.1 PRELIMINARY EVALUATION

A necessary first step in evaluating existing monitoring well data will be the study and review of the original work plan for monitoring well installation (if available). This will help to familiarize the geologist with specific site conditions requiring analysis, will promote an understanding of the original purpose of the monitoring wells and will help to determine if the well installation can meet the current DQOs. For example, existing wells may be sufficient for RCRA compliance but not for contaminant plume identification. Of particular interest during this phase of the project will be the rationale for the horizontal location of the wells and the vertical position and length of the monitored interval.

The next step of the evaluation should involve a review of all available information concerning borehole drilling and well construction. This will allow interpretation of groundwater flow conditions and area geology and will help to establish consistency between hydraulic properties of the well to physical features of the well or formation. The physical features which should be identified and detailed, if available, include:

- The well identification number, permit number and location by referenced coordinates the distance from prominent site features, or the location of the well on a map;
- The installation dates, drilling methods, well development methods, and contractors;
- The depth to bedrock -- where rock cores were not taken, auger refusal, drive casing refusal or penetration test results (blow counts for split-spoon sampling) may be used to estimate bedrock interface;
- The soil profile and stratigraphy;
- The borehole depth and diameter;
- The elevation of the top of the protective casing, the top of the well riser, and the ground surface;
- The total depth of the well;
- The type of well materials, screen type, slot size, and length, and the elevation/depths of the screen, interval, and/or monitored interval;
- The elevation/depths of the tops and bottom of the filter pack and well seals and the type and size;

## 5.2 FIELD INSPECTION

During the onsite inspection of existing monitoring wells, features to be noted include:

- The condition of the protective casing, cap and lock;
- The condition of the cement seal surrounding the protective casing;
- The presence of depressions or standing water around the casing;
- The presence of any electrical cable and its connections.

If the protective casing, cap and lock have been damaged or the cement collar appears deteriorated, or if there are any depressions around the well casing capable of holding water, surface water may have infiltrated into the well. This may invalidate previous sampling results since the time when leakage started is unknown.

The routine physical inspection must be followed by a more detailed investigation to identify other potential routes of contamination or sampling equipment malfunction. Any of these may invalidate previously-collected water quality data. If the monitoring well is to be used in the future, the steps described above should be taken to rehabilitate the well. After disconnecting any wires, cables or electrical sources, remove the lock and open the cap. Check for the presence of organic vapors with a PID or FID meter and combustible gas meter to determine the appropriate worker safety level. The following information should be noted:

- Cap function;
- Physical characteristics and composition of the inner casing or riser, including inner diameter and annular space;
- Presence of grout between the riser and outer protective casing and the existence of drain holes in the protective casing;
- Presence of a riser cap, method of attachment to casing, and venting of the riser;
- Presence of dedicated sampling equipment; if possible, remove such equipment and inspect size, materials of construction and condition.
- The final step of the field inspection is to confirm previous hydraulic or physical property data and to obtain data not previously available. Specific field investigative activities which should be carried out include:
- This includes the determination of static water levels, total well depth and well obstruction. This may be accomplished using a weighted tape measure which can also be used to check for sediment (the weight will advance slowly if sediment is present, and the presence of sediment on the weight upon removal should be noted). If sediment is present, the well be should be redeveloped before sampling.
- As a final step, the location, condition and expected water quality of the wells should be reviewed in light of their usefulness for the intended purpose of the investigation.

## 6.0 RECORDS

A record of all field procedures, tests and observations should be recorded in a field log book. Entries in the log book should include the individuals participating in the field effort, and the date and time. The use of annotated sketches may help to supplement the evaluation.

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| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject SOIL AND ROCK SAMPLING | | Approved D. Senovich | |

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6.0 REFERENCES

7.0 RECORDS

## 1.0 PURPOSE

The purpose of this procedure is to identify the equipment, sequence of events, and appropriate methods necessary to obtain soil, both surface and subsurface, and rock samples during field sampling activities.

## 2.0 SCOPE

The methods described within this procedure are applicable while collecting surface and subsurface soil samples; obtaining rock core samples for lithologic and hydrogeologic evaluation; excavation/foundation design and related civil engineering purposes.

## 3.0 GLOSSARY

Hand Auger- A sampling device used to extract soil from the ground in a relatively undisturbed form.

Thin-Walled Tube Sampler - A thin-walled metal tube (also called Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches O.D. and 18 to 54 inches long. A stationary piston device may be included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant materials using a drive weight mounted in the drilling string. A standard split spoon sampler (used for performing Standard Penetration Tests) is 2 inches outside diameter (OD) and 1-3/8 inches inside diameter (ID). This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. These split-spoon samplers range in size from 2-inch O.D. to 3-1/2-inch O.D., depending upon manufacturer. The larger sizes are commonly used when a larger volume of material is required.

Rock Coring - A method in which a continuous solid cylindrical sample of rock or compact rock-like soil is obtained by the use of a double tube core barrel that is equipped with an appropriate diamond-studded drill bit which is advanced with a hydraulic rotary drilling machine.

Wire-Line Coring - As an alternate for conventional coring, this is valuable in deep hole drilling, since this method eliminates trips in and out of the hole with the coring equipment. With this technique the core barrel becomes an integral part of the drill rod string. The drill rod serves as both a coring device and casing.

## 4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for overall management of field activities and ensuring that the appropriate sampling procedures are being implemented.

Site Geologist - The site geologist directly oversees the sampling procedures, classifies soil and rock samples, and directs the packaging and shipping of soil samples. Such duties may also be performed by geotechnical engineers, field technicians, or other qualified field personnel.

## 5.0 PROCEDURES

### 5.1 SUBSURFACE SOIL SAMPLES

Subsurface soil samples are used to characterize subsurface stratigraphy. This characterization can indicate the potential for migration of chemical contaminants in the subsurface. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Where the remedial activities may include in-situ treatment or the excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Engineering and physical properties of soil may also be of interest should site construction activities be planned. Soil types, grain size distribution, shear strength, compressibility, permeability, plasticity, unit weight, and moisture content are some of the physical characteristics that may be determined for soil samples.

Penetration tests are also described in this procedure. The tests can be used to estimate various physical and engineering parameters such as relative density, unconfined compressive strength, and consolidation characteristics of soils.

The procedures described here are representative of a larger number of possible drilling and sampling techniques. The choice of techniques is based on a large number of variables such as cost, DQOs, local geology, etc. The final choice of methods must be made with the assistance of drilling subcontractors familiar with the local geologic conditions. Alternative techniques must be based upon the underlying principles of quality assurance implicit in the following procedures.

#### 5.1.1 Equipment

The following equipment is used for subsurface soil sampling and test boring:

- Drilling equipment, provided by subcontractor.
- Split barrel (split spoon) samplers, OD 2 inches, ID 1-3/8 inches, either 20-inch or 26 inches long. Larger O.D. samplers are available if a larger volume of sample is needed. A common size is 3-inch O.D. (2-1/2-inch I.D.).
- Thin walled tubes (Shelby), O.D. 2 to 5 inches, 18 to 54 inches long.
- Drive weight assembly, 140-lb. ( ± 2 lb.) weight, driving head and guide permitting free fall of 30 inches ( ± 1 inch).
- Drive weight assembly, 300-lb. ( ± 2 lb.) weight, driving head and guide permitting free fall of 18 inches ( ± 1 inch).
- Accessory equipment, including labels, logbook, paraffin, and sample jars.

### 5.1.2 Split Barrel (Split Spoon) Sampling (ASTM D1586-84)

The following method will be used for split barrel sampling:

- Clean out the borehole to the desired sampling depth using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts, withdraw the drill bit slowly to prevent loosening of the soil around the hole and maintain the water level in the hole at or above groundwater level.

- Side-discharge bits are permissible. A bottom-discharge bit shall not be used. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below the sampling elevation.

- Install the split barrel sampler and sampling rods into the boring to the desired sampling depth. After seating the sampler by means of a single hammer blow, three 6-inch increments shall be marked on the sampling rod so that the progress of the sampler can be monitored.

- The 2-inch OD split barrel sampler shall be driven with blows from a 140-lb. (± 2 lb.) hammer falling 30 inches (± 1 inch) until either a total of 50 blows have been applied during any one of the three 6-inch increments, a total of 100 blows have been applied, there is no observed advance of the sampler for 10 successive hammer blows, or until the sampler has advanced 18 inches without reaching any of the blow count limitation constraints described herein. This process is referred to as the Standard Penetration Test.

- A 300-lb. weight falling 18 inches is sometimes used to drive a 2-1/2-inch or 3-inch O.D. spoon sampler. This procedure is used where dense materials are enountered or when a large volume of sample is required. However, this method does not conform the ASTM specifications.

- Repeat this operation at intervals not greater than 5 feet in homogeneous strata, or as specified in the sampling plan.

- Record the number of blows required to effect each 6 inches of penetration or fraction thereof. The first 6 inches is considered to be seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last 1 foot penetrated.

- Bring the sampler to the surface and remove both ends and one half of the split barrel so that the soil recovered rests in the remaining half of the barrel. Describe carefully the sample interval, recovery (length), composition, structure, consistency, color, condition, etc., of the recovered soil then put a representative portion of each sample into a jar, without ramming. Jars with samples not taken for chemical analysis shall be sealed with wax, or hermetically sealed (using a teflon cap liner) to prevent evaporation of the soil moisture, if the sample is to be later evaluated for moisture content. Affix labels to the jar and complete Chain-of-Custody and other required sample data forms. Protect samples against extreme temperature changes and breakage by placing them in appropriate cartons stored in a protected area. Pertinent data which shall be noted on the label or written on the jar lid for each sample includes the project number, boring number, sample number, depth interval, blow counts, and date of sampling.

- An addition to the sampler mentioned above is an internal liner, which is split longitudinally and has a thin-wall brass, steel, or paper liner inserted inside, which will preserve the sample. However, since the development of the thin-walled samplers (mentioned below) the split barrel sampler with liner has declined in use.

### 5.1.3 Thin Walled Tube (Shelby Tube) Sampling (ASTM D1587-83)

When it is desired to take undisturbed samples of soil, thin-walled seamless tube samplers (Shelby tubes) will be used. The following method will be used:

- Clean out the borehole to the sampling depth, being careful to minimize the chance for disturbance of the material to be sampled. In saturated materials, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and maintain the water level in the hole at or above groundwater level.

- The use of bottom discharge bits or jetting through an open-tube sampler to clean out the hole shall not be allowed. Any side discharge bits are permitted.

- A stationary piston-type sampler may be required to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used. Prior to inserting the tube sampler in the hole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the sampling rods from pushing the sample out of the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.

- To minimize chemical reaction between the sample and the sampling tube, brass tubes may be required, especially if the tube is stored for an extended time prior to testing. While steel tubes coated with shellac are less expensive than brass, they are more reactive, and shall only be used when the sample will be tested within a few days after sampling or if chemical reaction is not anticipated. With the sampling tube resting on the bottom of the hole and the water level in the boring at the groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed farther than the length provided for the soil sample. Allow about 3 inches in the tube for cuttings and sludge.

- Upon removal of the sampler tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube and measure the length of sample again. After removing at least an inch of soil from the lower end and after inserting an impervious disk, seal both ends of the tube with at least a 1/2-inch thickness of wax applied in a way that will prevent the wax from entering the sample. Newspaper or other types of filler must be placed in voids at either end of the sampler prior to sealing with wax. Place plastic caps on the ends of the sampler, tape in the caps place, and dip the ends in wax.

- Affix labels to the tubes as required and record sample number, depth, penetration, and recovery length on the label. Mark the same information and "up" direction on the tube with indelible ink, and mark the end of the sample. Complete Chain-of-Custody and other required forms. Do not allow tubes to freeze and store the samples vertically (with the same orientation they had in the ground, i.e., top of sample is up) in a cool place out of the

sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

Thin-walled undisturbed tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often, very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Denison or Pitcher core samplers can be used to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs and therefore their use shall be weighed against the increased cost and the need for an undisturbed sample. In any case, if a sample cannot be obtained with a tube sampler, an attempt shall be made with a split barrel sampler at the same depth so that at least a sample can be obtained for classification purposes.

### 5.1.4 Continuous Core Soil Samples

The CME continuous sample tube system provides a method of sampling soil continuously during hollow stem augering. The 5-foot sample barrel fits within the lead auger of a hollow auger column. The sampling system can be used with a wide range of I.D. hollow stem augers (from 3-1/4-inch to 8-1/4-inch I.D.). This method has been used to sample many different materials such as glacial drift, hard clays and shales, mine tailigs, etc. This method is particularly used when SPT samples are not required and a large volume of material is needed. Also, this method is useful when a visual description of the subsurface lithology is required.

## 5.2 SURFACE SOIL SAMPLES

For loosely packed earth or waste pile samples, stainless steel scoops or trowels can be used to collect representative samples. For densely packed soils or deeper soil samples, a hand or power soil auger may be used.

The following methods are to be used:

- Use a soil auger for deep samples (6 to 24 inches) or a scoop or trowel for surface samples. Remove debris, rocks, twigs, and vegetation before collection of soil. Mark the location with a numbered stake if possible and locate sample points on a sketch of the site.

- Use a new or freshly-decontaminated sampler for each sample taken. Attach a label and identification tag. Record all required information in the field logbook and on the sample log sheet, Chain-of-Custody record, and other required forms.

- Pack and ship accordingly.

- When a representative composited sample is to be prepared (e.g., samples taken from a gridded area or from several different depths), it is best to composite individual samples in the laboratory where they can be more precisely composited on a weight or volume basis. If this is not possible, the individual samples (all of equal volume, i.e., the sample bottles shall be full) shall be placed in a decontaminated stainless steel bucket, mixed thoroughly using a stainless steel spatula or trowel, and a composite sample collected.

## 5.3 WASTE PILE SAMPLES

The use of stainless steel scoops or trowels to obtain small discrete samples of homogeneous waste piles is usually sufficient for most conditions. Layered (nonhomogeneous) piles require the use of tube samplers to obtain cross-sectional samples.

- Collect small, equal portions of the waste from several points around the pile, penetrating it as far as practical. Use numbered stakes, if possible, to mark the sampling locations and locate sampling points on the site sketch.

- Place the waste sample in a glass container. Attach a label and identification tag. Record all the required information in the field logbook and on the sample log sheet and other required forms.

For layered, nonhomogeneous piles, grain samplers, sampling triers, or waste pile samplers must be used at several representative locations to acquire a cross-section of the pile. The basic steps to obtain each sample are

- Insert a sampler into the pile at a 0- to 45-degree angle from the horizontal to minimize spillage.

- Rotate the sampler once or twice to cut a core of waste material. Rotate the grain sampler inner tube to the open position and then shake the sampler a few times to allow the material to enter the open slits. Move the sampler into position with slots upward (grain sampler closed) and slowly withdraw from the pile.

## 5.4 ROCK SAMPLING (CORING) (ASTM D2113-83)

Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less, or for specific intervals in the drill hole that require detailed logging and/or analyzing. It can, however, proceed for thousands of feet continuously, depending on the size of the drill rig. It yields better quality data than air rotary drilling, although at a substantially reduced drilling rate. Rate of drilling varies widely, depending on the characteristics of lithologies encountered, drilling methods, depth of drilling, and condition of drilling equipment. Average output in a 10-hour day ranges from 40 to over 200 feet. Downhole geophysical logging or television camera monitoring is sometimes used to complement the data generated by coring.

Borehole diameter can be drilled to various sizes, depending on the information needed. Standard sizes of core barrels (showing core diameter) and casing are shown in Attachment No. 1.

Core drilling is used when formations are too hard to be sampled by soil sampling methods and a continuous solid sample is desired. Usually, soil samples are used for overburden, and coring begins in sound bedrock. Casing is set into bedrock before coring begins to prevent loose material from entering the borehole, to prevent loss of drilling fluid, and to prevent cross contamination of aquifers.

## ATTACHMENT 1

## STANDARD SIZES OF CORE BARRELS AND CASING

| Coring bit size | Nominal * | | Set size * | |
|---|---|---|---|---|
| | O.D. | I.D. | O.D. | I.D. |
| RWT | $1\frac{5}{32}$ | $\frac{3}{4}$ | 1.160 | .735 |
| EWT | $1\frac{1}{2}$ | $\frac{29}{32}$ | 1.470 | 905 |
| EX, EXL, EWG, EWM | $1\frac{1}{2}$ | $\frac{13}{16}$ | 1.470 | 845 |
| AWT | $1\frac{7}{8}$ | $1\frac{9}{32}$ | 1.875 | 1.281 |
| AX, AXL, AWG, AWM | $1\frac{7}{8}$ | $1\frac{3}{16}$ | 1.875 | 1.185 |
| BWT | $2\frac{3}{8}$ | $1\frac{3}{4}$ | 2.345 | 1.750 |
| BX, BXL, BWG, BWM | $2\frac{3}{8}$ | $1\frac{5}{8}$ | 2.345 | 1.655 |
| NWT | 3 | $2\frac{5}{16}$ | 2.965 | 2.313 |
| NX, NXL, NWG, NWM | 3 | $2\frac{1}{8}$ | 2.965 | 2.155 |
| HWT | $3\frac{29}{32}$ | $3\frac{3}{16}$ | 3.889 | 3.187 |
| HWG | $3\frac{29}{32}$ | 3 | 3.889 | 3.000 |
| $2\frac{3}{4} \times 3\frac{7}{8}$ | $3\frac{7}{8}$ | $2\frac{3}{4}$ | 3.840 | 2.690 |
| $4 \times 5\frac{1}{2}$ | $5\frac{1}{2}$ | 4 | 5.435 | 3.970 |
| $6 \times 7\frac{3}{4}$ | $7\frac{3}{4}$ | 6 | 7.655 | 5.970 |
| AX Wire line 1/ | $1\frac{7}{8}$ | 1 | 1.875 | 1.000 |
| BX Wire line 1/ | $2\frac{3}{8}$ | $1\frac{7}{16}$ | 2.345 | 1.437 |
| NX Wire line 1/ | 3 | $1\frac{15}{16}$ | 2.965 | 1.937 |

* All dimensions are in inches; to convert to millimeters, multiply by 254.
1/ Wire line dimensions and designations may vary according to manufacturer

ATTACHMENT 1
PAGE TWO

| Size Designations | | | Casing coupling | | | | | Approximate core diameter | |
|---|---|---|---|---|---|---|---|---|---|
| Casing; Casing coupling; Casing bits; Core barrel bits | Rod; Rod couplings | Casing O.D., inches | O.D., inches | I.D., inches | Casing bit, O.D., inches | Core barrel bit O.D., inches* | Drill rod O.D., inches | Normal, inches | Thinwall, inches |
| RX | RW | 1.437 | 1.437 | 1.188 | 1.485 | 1.160 | 1.094 | — | .735 |
| EX | E | 1.812 | 1.812 | 1.500 | 1.875 | 1.470 | 1.313 | .845 | .905 |
| AX | A | 2.250 | 2.250 | 1.906 | 2.345 | 1.875 | 1.625 | 1.185 | 1.281 |
| BX | B | 2.875 | 2.875 | 2.375 | 2.965 | 2.345 | 1.906 | 1.655 | 1.750 |
| NX | N | 3.500 | 3.500 | 3.000 | 3.615 | 2.965 | 2.375 | 2.155 | 2.313 |
| HX | HW | 4.500 | 4.500 | 3.938 | 4.625 | 3.890 | 3.500 | 3.000 | 3.187 |
| RW | RW | 1.437 | Flush joint | No coupling | 1.485 | 1.160 | 1.094 | — | .735 |
| EW | EW | 1.812 | | | 1.875 | 1.470 | 1.375 | .845 | .905 |
| AW | AW | 2.250 | | | 2.345 | 1.875 | 1.750 | 1.185 | 1.281 |
| BW | BW | 2.875 | | | 2.965 | 2.345 | 2.125 | 1.655 | 1.750 |
| NW | NW | 3.500 | | | 3.615 | 2.965 | 2.625 | 2.155 | 2.313 |
| HW | HW | 4.500 | | | 4.625 | 3.890 | 3.500 | 3.000 | 3.187 |
| PW | — | 5.500 | | | 5.650 | — | — | — | — |
| SW | — | 6.625 | | | 6.790 | — | — | — | — |
| UW | — | 7.625 | | | 7.800 | — | — | — | — |
| ZW | — | 8.625 | | | 8.810 | — | — | — | — |
| — | AX 1/ | — | — | — | — | 1.875 | 1.750 | 1.000 | — |
| — | BX 1/ | — | — | — | — | 2.345 | 2.250 | 1.437 | — |
| — | NX 1/ | — | — | — | — | 2.965 | 2.813 | 1.937 | — |

* For hole diameter approximation, assume $\frac{1}{32}$ inch larger than core barrel bit.

1/ Wire line size designation, drill rod only, serves as both casing and drill rod. Wire line core bit, and core diameters vary slightly according to manufacturer.

NOMINAL DIMENSIONS FOR DRILL CASINGS AND ACCESSORIES. (DIAMOND CORE DRILL MANUFACTURERS ASSOCIATION). 288-D-2889.

Drilling through bedrock is initiated by using a diamond-tipped core bit threaded to a drill rod (outer core barrel) with a rate of drilling determined by the downward pressure, rotation speed of drill rods, drilling fluid pressure in the borehole, and the characteristics of the rock (mineralogy, cementation, weathering).

### 5.4.1 Diamond Core Drilling

A penetration of typically less than 6 inches per 50 blows using a 140-lb. hammer dropping 30 inches with a 2-inch split spoon sampler shall be considered an indication that soil sampling methods may not be applicable and that coring may be necessary to obtain samples.

When formations are encountered that are too hard to be sampled by soil sampling methods, the following diamond core drilling procedure may be used.

- Firmly seat a casing into the bedrock or the hard material to prevent loose materials from entering the hole and to prevent the loss of drilling fluid return. Level the surface of the rock or hard material when necessary by the use of a fishtail or other bits. If the drill hole can be retained open without the casing and if cross contamination of aquifers in the unconsolidated materials is unlikely, it may be omitted.

- Begin the core drilling using a double-tube swivel-core barrel of the desired size. After drilling no more than 10 feet (3 m), remove the core barrel from the hole, and take out the core. If the core blocks the flow of the drilling fluid during drilling, remove the core barrel immediately. In soft materials, a large starting size may be specified for the coring tools; where local experience indicates satisfactory core recovery or where hard, sound materials are anticipated, a smaller size or the single-tube type may be specified and longer runs may be drilled. NX/NW size coring equpment is the most commonly used size.

- When soft materials are encountered that produce less than 50 percent recovery, stop the core drilling. If soil samples are desired, secure such samples in accordance with the procedures described in ASTM Method D 1586 (Split Barrel Sampling) or in Method D 1587 (Thin-Walled Tube Sampling) for Sampling of Soils (see Section 5.1.1 and 5.1.2). Resume diamond core drilling when refusal materials are again encountered.

- Since rock structures and the occurrence of seams, fissures, cavities, and broken areas are among the most important items to be detected and described, take special care to obtain and record these features. If such broken zones or cavities prevent further advance of the boring, one of the following three steps shall be taken: (1) cement the hole; (2) ream and case; or (3) case and advance with the next smaller size core barrel, as the conditions warrant.

- In soft, seamy, or otherwise unsound rock, where core recovery may be difficult, M-design core barrels may be used. In hard, sound rock where a high percentage of core recovery is anticipated, the single-tube core barrel may be employed.

### 5.4.2 Rock Sample Preparation and Documentation

Once the rock coring has been completed and the core recovered, the rock core shall be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core shall be described, classified, and logged using a uniform system as presented in Procedure GH-1.5. If moisture content will be determined or if it is desirable to prevent drying (e.g.,

to prevent shrinkage of clay formations) or oxidation of the core, the core shall be wrapped in plastic sleeves immediately after logging. Each plastic sleeve shall be labeled with indelible ink. The boring number, run number, and the footage represented in each sleeve shall be included, as well as the top and bottom of the core run.

After sampling, rock cores shall be placed in the sequence of recovery in well-constructed wooden boxes provided by the drilling contractor. Rock cores from two different borings shall not be placed in the same core box unless accepted by the Site Geologist. The core boxes shall be constructed to accommodate at least 20 linear feet of core in rows of approximately 5 feet each and shall be constructed with hinged tops secured with screws, and a latch (usually a hook and eye) to keep the top securely fastened down. Wood partitions shall be placed at the end of each core run and between rows. The depth from the surface of the boring to the top and bottom of the drill run and run number shall be marked on the wooden partitions with indelible ink. A wooden partition (wooden block) shall be placed at the end of each run with the depth of the bottom of the run written on the block. These blocks will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores shall be the same in all core boxes. Rock core shall be placed in the box so that, when the box is open, with the inside of the lid facing the observer,the top of the cored interval contained within the box is in the upper left corner of the box,and the bottom of the cored interval is in the lower right corner of the box (see Attachment 2). The top and bottom of each core obtained and its true depth shall be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row shall be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

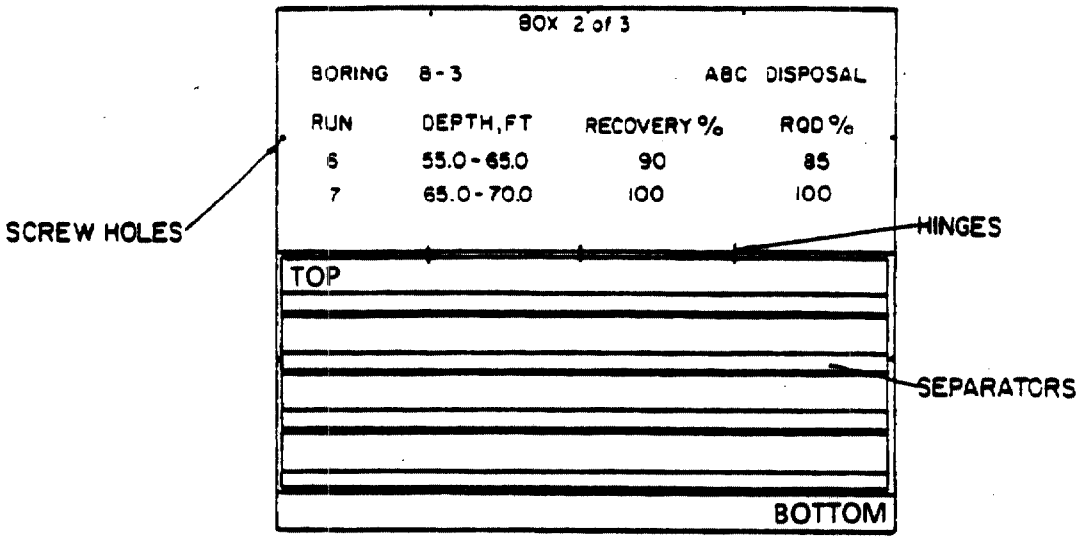
The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data on the box's contents. At a minimum, the following information shall be included:

- Project name
- Project number
- Boring number
- Run numbers
- Footage (depths)
- Recovery
- RQD (%)
- Box number and total number of boxes for that boring (Example: Box 5 of 7).

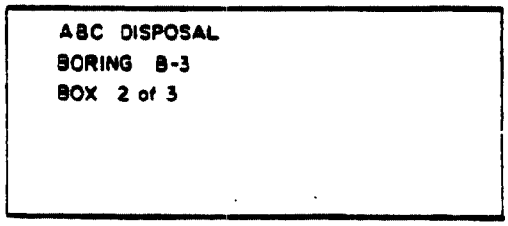
For easy retrieval when core boxes are stacked, the sides and ends of the box shall also be labeled and include project number, boring number, top and bottom depths of core and box number. Attachment No. 2 illustrates a typical rock core box.

Prior to final closing of the core box, a photograph of the recovered core and the labeling on the inside cover shall be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores).

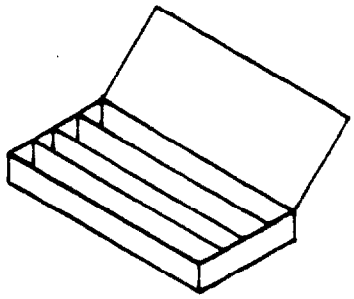
## ATTACHMENT 2

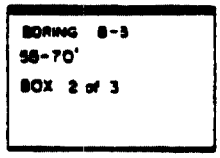



CORE BOX (OBLIQUE VIEW)




CORE BOX (TOP VIEW)






CORE BOX (END VIEW)

**TYPICAL ROCK CORE BOX**

NOT TO SCALE

NUS CORPORATION
A Halliburton Company

## 6.0 REFERENCES

American Society for Testing and Materials, 1985. Method for Penetration Test and Split Barrel Sampling of Soils. ASTM Method D 1586-84, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

American Society for Testing and Materials, 1985. Thin-Walled Tube Sampling of Soils. Method D-1587-83, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

Acker Drill Co., 1958. Basic Procedures of Soil Sampling. Acker Drill Co., Scranton, Pennsylvania.

American Society for Testing and Materials, 1989. Standrd Practice for Diamond Core Drilling for Site Investigation. ASTM Method D2113-83 (reapproved 1987), Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

U.S. Department of the Interior, 1974, Earth Manual, A Water Resources Technical Publication, 810 pages.

Central Mine Equipment Company, Drilling Equipment, St. Louis, Missouri.

## 7.0 RECORDS

None.

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number GH-1.4 | Page 1 of 20 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 1 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject SOIL AND ROCK DRILLING METHODS | | Approved D. Senovich | |

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## 1.0 PURPOSE

The purpose of this procedure is to describe the methods, the sequence of operations and the equipment necessary to perform soil and rock borings.

## 2.0 SCOPE

This guideline addresses most of the accepted and standard drilling techniques, their benefits and drawbacks. It should be used generally to determine what type of drilling techniques would be most successful depending on site-specific geologic conditions and the type of sampling required.

## 3.0 GLOSSARY

Boulders - Rounded, semi-rounded or naturally angular particles of rock larger than 12 inches in diameter.

Clay - Fine grained soil or portions of soil having certain physical properties, composition and texture. Clay exhibits plastic properties within a range of water contents and exhibits considerable strength when air dried. Clay consists usually of fragments of hydrous aluminum or magnesium silicate minerals, and it consists predominantly of grains with diameters of less than 0.005 mm.

Cobbles - Rounded, semi-rounded or naturally angular particles of rock between 3 inches and 12 inches in diameter.

Gravel - Rounded or semirounded particles of rock that will pass a 3 inch sieve (7.62 cm) and be retained on a No. 4 U.S. standard sieve (4.76 mm). Coarse gravel is larger than 3/4-inches, while fine gravel is finer than 3/4-inches.

Stone - Crushed or naturally angular particles of rock that will pass a 3 inch sieve (7.62 cm) and be retained on a No. 4 U.S. standard sieve (4.76 mm).

Rock - Any consolidated or coherent and relatively hard, naturally formed mass of mineral matter.

Sand - Particles of rock that will pass a No. 4 U.S. standard sieve (4.76 mm) and be retained on a No. 200 U.S. standard sieve (0.074 mm). Coarse sand is larger than a No. 10 sieve, and fine sand is finer than a No. 40 sieve (0.42 mm).

Silt - Material passing the No. 200 U.S. standard sieve (0.074 mm) that is nonplastic or very slightly plastic and that exhibits little or no strength when air dried.

Soil - Sediments or other unconsolidated accumulations of solid particles that are produced by the physical and chemical disintegration of rock and that may contain organic matter.

Undisturbed Sample - A soil sample that has been obtained by methods in which every precaution has been taken to minimize disturbance to the sample.

Water Table - A surface in an aquifer where groundwater pressure is equal to atmospheric pressure.

## 4.0 RESPONSIBILITIES

Site Manager - In consultation with the project geologist, responsible for evaluating the drilling requirements for the site and specifying drilling techniques that will be successful given the study objectives and geologic conditions at the site. He should also determine the disposal methods for products generated by drilling, such as drill cuttings and well development water, as well as any specialized supplies or logistical support required for the drilling operations.

Site Geologist/Rig Geologist - Responsible for insuring that standard and approved drilling procedures are followed. The geologist will generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, and other pertinent drilling and testing information that may be obtained during drilling (see Attachment A of Procedure GH-1.7). Often this position for inspecting the drilling operations may be filled by other geotechnical personnel, such as soils and foundation engineers, civil engineers, etc.

Determination of the exact location for borings is the responsibility of the site geologist. The final location for drilling must be properly documented on the boring log. The general area in which the borings are to be located will be shown on a site map included in the Work Plan.

Field Operations Leader - Responsible for overall supervision and scheduling of drilling activities.

Drilling Subcontractor - Responsible for obtaining all drilling permits and clearances, and supplying all services (including labor), equipment and material required to perform the drilling, testing, and well installation program, as well as maintenance and quality control of such required equipment except as stated in signed and approved subcontracts.

The driller must report any major technical or analytical problems encountered in the field to the Field Operations Leader within 24 hours, and must provide advance written notification for any changes in field procedures describing and justifying such changes. No such changes shall be made unless requested and authorized in writing by the Field Operations Leader.

The drilling subcontractor will be responsible for following decontamination procedures specified in the Work Plan. Upon completion of the work, the Drilling Subcontractor will be responsible for demobilizing all equipment, cleaning up any materials deposited on site during drilling operations, and properly backfilling any open borings.

## 5.0 PROCEDURES

### 5.1 GENERAL

The purpose of drilling boreholes is:

- To determine the type, thickness, and certain physical and chemical properties of the soil, water and rock strata which underlie the site, and
- To install monitoring wells or piezometers.

All drilling and sampling equipment will be cleaned using appropriate decontamination procedures (see Procedure GH-1.6 and SF-2.3) between samples and borings. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first, and at the most contaminated locations last, to reduce the risk of spreading contamination between locations. All borings must be logged by the rig geologist as they proceed (see Procedure GH-1.5) unless the FSAP specifically states that

logging is not required. Situations where logging would not be required would include installation of multiple well points within a small area, or a "second attempt" boring adjacent to a boring that could not be continued through resistant material. In the latter case, the boring log can be resumed 5 feet above the depth at which the initial boring was abandoned, although the rig geologist should still confirm that the stratigraphy at the redrilled location conforms essentially with that encountered at the original location. If significant differences are seen, each hole should be logged separately.

## 5.2 DRILLING METHODS

The selected drilling methods described below apply to drilling in subsurface materials, including, but not limited to, sand, gravel, clay, silt, cobbles, boulders, rock and man-made fill. Drilling methods should be selected after studying the site geology and terrain, purpose of drilling, waste conditions at the site, and the overall subsurface investigation program proposed for the site. The full range of different drilling methods applicable to the proposed program should be identified with final selection based on relative cost, availability, time constraints, and how well each method meets the sampling and testing requirements of the individual drilling program.

### 5.2.1 Continuous-Flight Hollow-Stem Auger Drilling

This method of drilling consists of screwing augers with a hollow stem into the ground. Cuttings are brought to the surface by the rotating action of the auger. This method is relatively quick and inexpensive. Advantages of this type of drilling include:

- Samples can be obtained without pulling the augers out of the hole. However, this is a poor method for obtaining grab samples from thin, discrete formations because of mixing of soils which occurs as the material is brought to the surface. Sampling of such formations will require the use of split-barrel or thin-wall tube samplers advanced through the hollow core of the auger.

- No drilling fluids are required.

- A well can be installed inside the auger stem and backfilled as the augers are withdrawn.

Disadvantages and limitations of this method of drilling include:

- Augering can only be done in unconsolidated materials.

- The inside diameter of hollow stem augers used for well installation should be at least four inches greater than the well casing. Use of such large diameter hollow stem augers is more expensive than the use of small diameter augers in boreholes not used for well installation. Furthermore, the density of unconsolidated materials and depths become more of a limiting factor. More friction is produced with the larger diameter auger and subsequently greater torque is needed to advance the boring.

- The maximum effective depth for drilling is 150 feet or less, depending on site conditions and the size of augers used.

- In augering through clean sand formations below the water table, the sand will tend to flow into the hollow stem when the plug is removed for soil sampling or well installation. If the condition of "running" or "flowing" sands is persistent at a site, an alternative method of drilling is recommended, in particular for wells or boreholes deeper than 25 feet. Hollow stem auger drilling is the preferred method of drilling. Most alternative

methods require the introduction of water or mud downhole (air rotary is the exception) to maintain the open borehole. With these other methods great care must be taken to ensure that the method does not interfere with the collection of a representative sample which is the object of the construction. With this in mind, the preferred order of choice of drilling method after hollow stem augering (HSA) is:

- Cable tool
- Casing drive (air)
- Air rotary
- Mud rotary
- Drive and wash
- Jetting

However, the use of any method will also depend on efficiency and cost-effectiveness. In many cases, mud rotary is the only feasible alternative to hollow stem augering. Thus, mud rotary drilling is generally acceptable as a first substitute for HSA.

The procedures for sampling soils through holes drilled by hollow-stem auger shall conform with the applicable ASTM Standards: D1587-83 and D1586-84. The hollow stem auger may be advanced by any power-operated drilling machine having sufficient torque and ram range to rotate and force the auger to the desired depth. The machine must, however, be equipped with the accessory equipment needed to perform required sampling, or rock coring.

When taking soil samples for chemical analysis, the hollow-stem auger shall be plugged until the desired sampling depth is reached. Samples can be taken using split-spoon or thin wall tube samplers driven into the formation in advance of the auger (see Procedure GH-1.3). If the sample is to be taken at a relatively deep point, the auger may be advanced without a plug to within five feet of the sample depth. Then clean out the auger stem, insert a plug and continue to the sampling depth. The plug is then removed and samples taken as specified by the rig geologist. Samples should be taken according to the specifications of the sampling plan. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. The sequence shall be repeated for each sample desired.

The hollow-stem auger may be used without the plug when boring for geotechnical examination or for well installation.

When drilling below the water table, specially-designed plugs which allow passage of formation water but not solid material shall be used (see Reference 1 of this guideline). This method also prevents blow back and plugging of the auger when the plug is removed for sampling.

Alternately, it may be necessary to keep the hollow stem full of water, at least to the level of the water table, to prevent blowback and plugging of the auger. If water is added to the hole, it must be sampled and analyzed to determine if it is free from contaminants prior to use. In addition, the amount of water introduced, the amount recovered upon attainment of depth, and the amount of water extracted during well development must be carefully logged in order to ensure that a representative sample of the formation water can be obtained. Well development should occur as soon after well completion as practicable (see GH-1.7 for Well Development Procedures). If gravelly or hard material is encountered which prevents advancing the auger to the desired depth, augering should be halted and either driven casing or hydraulic rotary methods should be attempted. If the depth to the bedrock/soil interface and bedrock lithology must be determined, then a 5-foot confirmatory core run should be conducted (see Section 5.2.9).

At the option of the Field Operations Leader, when resistant materials prevent the advancement of the auger, a new boring can be attempted. The original boring must be properly backfilled and the new boring started a short distance away at a location determined by the site geologist. If multiple water bearing strata were encountered, the original boring must be grouted. In some formations it may be prudent to also grout borings which only penetrate the water table aquifer, since loose soil backfill in the boring would still provide a preferred pathway for surface liquids to reach the water table.

### 5.2.2 Continuous-Flight Solid-Stem Auger Drilling

This method is similar to hollow-stem augering. Practical application of this method is severely restricted as compared with hollow stem augers. Split barrel (split-spoon) sampling cannot be done without pulling the augers which may allow the hole to collapse. The method is therefore very time consuming and is not cost effective. Also, augers would have to be withdrawn before installing a monitoring well, which again, may allow the hole to collapse. Furthermore, geologic logging by examining the soils brought to the surface is unreliable as in the case of the hollow stem auger, and depth to water may be difficult to determine while drilling.

There would be very few situations where use of a solid stem auger would be preferable to other drilling methods. The only practical applications of this method would be to drill boreholes for well installation where no lithologic information is desired and the soils are such that the borehole can be expected to remain open after the augers are withdrawn. Alternatively, the technique can be used to find depth to bedrock in an area when no other information is required from drilling.

### 5.2.3 Rotary Drilling

Direct rotary drilling includes air-rotary and fluid-rotary drilling. Air-rotary drilling is a method of drilling where the drill rig simultaneously turns and exerts a downward pressure on the drilling rods and bit while circulating compressed air down the inside of the drill rods, around the bit, and out the annulus of the borehole. Air circulation serves to both cool the bit and remove the cuttings from the borehole. Advantages of this method include:

- The drilling rate is high (even in rock).
- The cost per foot of drilling is relatively low.
- Air rotary rigs are common in most areas.
- No drilling fluid is required (except when water is injec d to keep down dust).
- The borehole diameter is large, to allow room for prop well installation procedures.

Disadvantages to using this method include:

- Formations must be logged from the cuttings that are blown to the surface and thus the depths of materials logged are approximate.
- Air blown into the formation during drilling may "bind" the formation and impede well development and natural groundwater flow.
- In-situ samples cannot be taken, unless the hole is cased.
- Casing must generally be used in unconsolidated materials.
- Air rotary drill rigs are large and heavy.

A variation of the typical air-rotary drill bit is a down hole hammer which hammers the drill bit down as it drills. This makes drilling in hard rock faster. Air-rotary drills can also be adapted to use for rock coring although they are generally slower than other types of core drills. A major application of the air-rotary drilling method would be to drill holes in rock for well installation.

Fluid-Rotary drilling operates in a similar manner to air rotary drilling except that a drilling fluid ("mud") or clean water is used in place of air to cool the drill bit and remove cuttings. There are a variety of fluids that can be used with this drilling method, including bentonite slurry and synthetic slurries. If a drilling fluid other than water/cuttings is used, it must be a natural clay (i.e., bentonite) and a "background" sample of the fluid should be taken for analysis of possible organic or inorganic contaminants.

Advantages to the fluid-rotary drilling method include:

- The ability to drill in many types of formations.
- Relatively quick and inexpensive.
- Split barrel (split-spoon) or thin-wall tube samples can be obtained without removing drill rods if the appropriate size drill rods and bits (i.e., fish-tail or drag bit) are used.
- In some borings temporary casing may not be needed as the drilling fluids may keep the borehole open.
- Drill rigs are readily available in most areas.

Disadvantages to this method include:

- Formation logging is not as accurate as with hollow stem auger method if split barrel (split-spoon) samples are not taken (i.e., the depths of materials logged from cuttings delivered to the surface are approximate).
- Drilling fluids reduce permeability of the formation adjacent to the boring to some degree, and require more extensive well development than "dry" techniques (augering, air-rotary).
- No information on depth to water is obtainable while drilling.
- Fluids are needed for drilling, and there is some question about the effects of the drilling fluids on water samples obtained. For this reason as well, extensive well development may be required.
- In very porous materials (i.e., rubble fill, boulders, coarse gravel) drilling fluids may be continuously lost into the formation. This will require either constant replenishment of the drilling fluid, or the use of casing through this formation.
- Drill rigs are large and heavy, and must be supported with supplied water.
- Ground water samples can be potentially diluted with drilling fluid.

The procedures for performing direct rotary soil investigations and sampling shall conform with the applicable ASTM standards: D2113-83, D1587-83, and D1586-84.

For air or fluid-rotary drilling, the rotary drill may be advanced to the desired depth by any power-operated drilling machine having sufficient torque and ram range to rotate and force the bit to the desired depth. The drilling machine must, however, be equipped with any accessory equipment needed to perform required sampling, or coring. Prior to sampling, any settled drill cuttings in the borehole must be removed.

Soil samples shall be taken as specified by the Work Plan or more frequently if requested by the field geologist. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool.

When field conditions prevent the advancement of the hole to the desired depth, a new boring may be drilled at the request of the Field Operations Leader. The original boring shall be backfilled using methods and materials appropriate for the given site and a new boring started a short distance away at a location determined by the site geologist.

### 5.2.4 Reverse Circulation Rotary Drilling

The common reverse-circulation rig is a water or mud rotary rig with a large diameter drill pipe which circulates the drilling water down the annulus and up the inside of the drill pipe (reverse flow direction from direct mud rotary). This type of rig is used for the construction of large-capacity production water wells and is not suited for small, water-quality sampling wells because of the use of drilling muds and the large diameter hole which is created. A few special reverse-circulation rotary rigs are made with double-wall drill pipe. The drilling water or air is circulated down the annulus between the drill pipes and up inside the inner pipe.

Advantages of the latter method include:

- The formation water is not contaminated by the drilling water.
- Formation samples can be obtained, from known depths.
- When drilling with air, immediate information is available regarding the water-bearing properties of formations penetrated.
- Collapsing of the hole in unconsolidated formations is not as great a problem as when drilling with the normal air rotary rig.

Disadvantages include:

- Double-wall, reverse-circulation drill rigs are very rare and expensive to operate.
- Placing cement grout around the outside of the well casing above a well screen often is difficult, especially when the screen and casing are placed down through the inner drill pipe before the drill pipe is pulled out.

### 5.2.5 Drill-through Casing Driver

The driven-casing method consists of alternately driving casing (fitted with a sharp, hardened casing shoe) into the ground using a hammer lifted and dropped by the drill rig or an air hammer and cleaning out the casing using a rotary chopping bit and air or water to flush out the materials. The casing is driven down in stages (usually 5 feet per stage). A continuous record is kept of the blows per foot in driving the casing (see Procedure GH-1.5). The casing is normally advanced by a 300-pound

hammer falling freely through a height of 30-inches. Simultaneous washing and driving of the casing is not recommended. If this procedure is used, the elevations between which water is used in driving the casing should be recorded.

The driven casing method is used in unconsolidated formations only. When the boring is to be used for later well installation, the driven casing used should be at least four inches larger in diameter than the well casing to be installed. Advantages to this method of drilling include:

- Split barrel (split-spoon) sampling can be conducted while drilling.
- Well installation is easily accomplished.
- Drill rigs used are relatively small and mobile.
- The use of casing minimizes flow into the hole from upper water-bearing layers; therefore multiple aquifers can be penetrated and sampled for rough field determinations of some water quality parameters.

Some of the disadvantages include:

- This method can only be used in unconsolidated formations.
- The method is slower than other methods (average drilling progress is 30 to 50 feet per day).
- Maximum depth of the borehole varies with the size of the drill rig and casing diameter used, and the nature of the formations drilled.
- The cost per hour or per foot of drilling may be substantially higher than other drilling methods.
- It is difficult and time consuming to pull back the casing if it has been driven very deep (deeper than 50 feet in many formations).

### 5.2.6 Cable Tool Drilling

A cable tool rig uses a heavy, solid-steel, chisel-type drill bit ("tool") suspended on a steel cable, which when raised and dropped chisels or pounds a hole through the soils and rock. Drilling progress may be expedited by the use of "slip-jars" which serve as a cable-activated down hole percussion device to hammer the bit ahead.

When drilling through the unsaturated zone, some water must be added to the hole. The cuttings are suspended in the water and then bailed out periodically. Below the water table, after sufficient ground water enters the borehole to replace the water removed by bailing, no further water need be added.

When soft caving formations are encountered, it is usually necessary to drive casing as the hole is advanced to prevent collapse of the hole. Often the drilling can be only a few feet below the bottom of the casing. Because the drill bit is lowered through the casing, the hole created by the bit is smaller than the casing. Therefore, the casing (with a sharp, hardened casing shoe on the bottom) must be driven into the hole (see Section 5.2.5 of this guideline).

Advantages of the cable-tool method include the following:

- Information regarding water-bearing zones is readily available during the drilling. Even relative permeabilities and rough water quality data from different zones penetrated can be obtained by skille operators.

- The cable-tool rig ca erate satisfactorily in all formations, but is best suited for caving, boulder, c or coa avel type formations (e.g., glacial till) or formations with large cavities abo ne wat le (such as limestones).

- When casing is used, casing seals formation water out of the hole, preventing down-hole contamination and allowing sampling of deeper aquifers for field-measurable water quality parameters.

- Split barrel (split spoon) or thin-wall tube samples can be collected through the casing.

Disadvantages include:

- Drilling is slow compared with rotary rigs.

- The necessity of driving the casing in unconsolidated formations requires that the casing be pulled back if exposure of selected water-bearing zones is desired. This process complicates the well completion process and often increases costs. There is also a chance that the casing may become stuck in the hole.

- The relatively large diameters required (minimum of 4-inch casing) plus the cost of steel casing result in higher costs compared to rotary drilling methods where casing is not required, such as use of a hollow stem auger.

- Cable-tool rigs have largely been replaced by rotary rigs. In some parts of the U.S., availability may be difficult.

### 5.2.7 Jet Drilling (Washing)

Jet drilling, which should be used only for piezometer or vadose zone sampler installation, consists of pumping water or drilling mud down through a small diameter (1/2 to 2-inch) standard pipe (steel or PVC). The pipe may be fitted with a chisel bit or a special jetting screen. Formation materials dislodged by the bit and jetting action of the water are brought to the surface through the annulus around the pipe. As the pipe is jetted deeper, additional lengths of pipe may be added at the surface.

Jet percussion is a variation of the jetting method, in which the casing is driven with a drive weight. Normally, this method is used to place 2-inch diameter casing in shallow, unconsolidated sand formations but has been used to install 3- to 4-inch diameter casings to 200 feet.

Jetting is acceptable in very soft formations, usually for shallow sampling, and when introduction of drilling water to the formation is acceptable. Such conditions would occur during rough stratigraphic investigation or installation of piezometers for water level measurement. Advantages of this method include:

- Jetting is fast and inexpensive.
- Because of the small amount of equipment required, jetting can be accomplished in locations where access by a normal drilling rig would be very difficult. For example, it would be possible to jet down a well point in the center of a lagoon at a fraction of the cost of using a drill rig.
- Jetting numerous well points just into a shallow water table is an inexpensive method for determining the water table contours, hence flow direction.

Disadvantages include the following:

- A large amount of foreign water or drilling mud is introduced above and into the formation to be sampled.
- Jetting is usually done in very soft formations which are subject to caving. Because of this caving, it is often not possible to place a grout seal above the screen to assure that water in the well is only from the screened interval.
- The diameter of the casing is usually limited to 2 inches; therefore, samples must be obtained by methods applicable to small diameter casings.
- Jetting is only possible in very soft formations that do not contain boulders or coarse gravel, and the depth limitation is shallow (about 30 feet without jet percussion equipment).
- Large quantities of water are often needed.

### 5.2.8 Drilling with a Hand Auger

This method is applicable wherever the formation, total depth of sampling, and the site and groundwater conditions are such as to allow hand auger drilling. Hand augering can also be considered at locations where drill rig access is not possible. All hand auger borings will be performed according to ASTM D1452-80.

Samples should be taken continuously unless otherwise specified by the Work Plan. Any required sampling is performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. Typical equipment used for sampling and advancing shallow "hand auger" holes are Iwan samplers (which are rotated) or post hole diggers (which are operated like tongs). This technique is slow but effective where larger pieces of equipment do not have access and where very shallow holes are desired (less than 5 feet). Surficial soils must be composed of relatively soft and non-cemented formations to allow penetration by the auger.

### 5.2.9 Rock Drilling and Coring

When soil borings cannot be continued using augers or rotary methods due to the hardness of the soil or when rock or large boulders are encountered, drilling and sampling can be performed using a diamond bit corer in accordance with ASTM D2113.

Drilling is done by rotating and applying downward pressure to the drill rods and drill bit. The drill bit is a circular, hollow, diamond studded bit attached to the outer core barrel in a double tube core barrel. The use of single tube core barrels is not recommended, as the rotation of the barrel erodes the sample and limits its use for detailed geological evaluation. Water or air is circulated down through the drill rods and annular space between the core barrel tubes to cool the bit and remove the cuttings. The bit cuts a core out of the rock which rises into an inner barrel mounted inside the outer barrel. The inner core barrel and rock core are removed by lowering a wire line with a coupling into the drill rods, latching onto the inner barrel and withdrawing the inner barrel. A less efficient variation to this method utilizes a core barrel that cannot be removed without pulling all of the drill rods. This variation is practical only if less than 50 feet of core is required.

Core borings are made through the casing used for the soil borings. The casing must be driven and sealed into the rock formation to prevent seepage from the overburden into the hole to be cored (see Section 5.3 of this guideline). A double-tube core barrel with a diamond bit and reaming shell or equivalent should be used to recover rock cores of a size specified in the Work Plan. The most common core barrel diameters are listed in Attachment A. Soft or decomposed rock should be sampled with a driven split-barrel whenever possible or cored with a Denison or Pitcher sampler.

When coring rock, including shale and claystone, the speed of the drill and the drilling pressure, amount and pressure of water, and length of run can be varied to give the maximum recovery from the rock being drilled. Should any rock formation be so soft or broken that the pieces continually fall into the hole, causing unsatisfactory coring, the hole should be reamed and a flush joint casing installed to a point below the broken formation. The size of the flush joint casing must permit securing the core size specified. When soft or broken rock is anticipated, the length of core runs should be reduced to less than 5 feet to avoid core loss and minimize core disturbance.

Advantages of core drilling include:

- Undisturbed rock cores can be recovered for examination and/or testing.
- In formations in which the cored hole will remain open without casing, water from the rock fractures may be recovered from the well without the installation of a well screen and gravel pack.
- Formation logging is extremely accurate.
- Drill rigs are relatively small and mobile.

Disadvantages include:

- Water or air is needed for drilling.
- Coring is slower than rotary drilling (and more expensive).

- Depth to water cannot accurately be determined if water is used for drilling.

- The size of the borehole is limited.

This drilling method is useful if accurate determinations of rock lithology are desired or if open wells are to be installed into bedrock. To install larger diameter wells in coreholes, the hole must be reamed out to the proper size after boring, using air or mud rotary drilling methods.

### 5.2.10 Drilling & Support Vehicles.

In addition to the drilling method required to accomplish the objectives of the field program, the type of vehicle carrying the drill rig and/or support equipment, and its suitability for the site terrain, will often be an additional deciding factor in planning the drilling program. The types of vehicles available are extensive, and depend upon the particular drilling subcontractor's fleet. Most large drilling subcontractors will have a wide variety of vehicle and drill types suited for most drilling assignments in their particular region, while smaller drilling subcontractors will usually have a fleet of much more limited diversity. The weight size, and means of locomotion (tires, tracks, etc.) of the drill rig must be selected to be compatible with the site terrain, to assure adequate mobility between borehole locations. Such considerations also apply to necessary support vehicles used to transport water and/or drilling materials to the drill rigs at the borehole locations. When the drill rigs or support vehicles do not have adequate mobility to easily traverse the site, provisions must be made for assisting equipment, such as bulldozers, winches, timber planking, etc., to maintain adequate progress during the drilling program.

Some of the typical vehicles which are usually available for drill rigs and support equipment are:

- Totally portable drilling/sampling equipment, where all necessary components (tripods, samplers, hammers, catheads, etc.) may be hand-carried to the borehole site. Drilling/sampling methods used with such equipment include:

  - Hand augers and lightweight motorized augers
  - Retractable plug samplers-driven by hand (hammer)
  - Motorized cathead - a lightweight aluminum tripod with a small gas-engine cathead mounted on one leg, used to install small diameter cased borings. This rig is sometimes called a "monkey on a stick."

- Skid-mounted drilling equipment containing a rotary drill or engine-driven cathead (to lift hammers and drill string), a pump, and a dismounted tripod. The skid is pushed, dragged, or winched (using the cathead drum) between boring locations.

- Small truck-mounted drilling equipment uses a jeep, stake body or other light truck (4 to 6 wheels), upon which are mounted the drill and/or a cathead, a pump, and a tripod or small drilling derrick. On some rigs the drill and/or a cathead are driven by a power take-off from the truck, instead of by a separate engine.

- Track-mounted drilling equipment is similar to truck-mounted rigs, except that the vehicle used has wide bulldozer tracks for traversing soft ground. Sometimes a continuous-track "all terrain vehicle" is also modified for this purpose. Some types of tracked drill rigs are called "bombardier" or "weasel" rigs.

- Heavy truck-mounted drilling equipment is mounted on tandem or dual tandem trucks to transport the drill, derrick, winches, and pumps or compressors. The drill may be provided

with a separate engine or may use a power take-off from the truck engine. Large augers, hydraulic rotary and reverse circulation rotary drilling equipment are usually mounted on such heavy duty trucks. For soft-ground sites, the drilling equipment is sometimes mounted on and off the road vehicle having low pressure, very wide diameter tires and capable of floating; these vehicles are called "swamp buggy" rigs.

- Marine drilling equipment is mounted on various floating equipment for drilling borings in lakes, estuaries and other bodies of water. The floating equipment varies, and is often manufactured or customized by the drilling subcontractor to suit specific drilling requirements. Typically, the range of flotation vehicles includes:

  - Barrel float rigs - a drill rig mounted on a timber platform buoyed by empty 55-gallo drums or similar flotation units.

  - Barge-mounted drill rigs.

  - Jack-up platforms - drilling equipment mounted on a floating platform having retractable legs to support the unit on the sea or lake bed when the platform is jacked up out of the water.

  - Drill ships - for deep ocean drilling.

In addition to the mobility for the drilling equipment, similar consideration must be given for equipment to support the drilling operations. Such vehicles or floating equipment are needed to transport drill water, drilling supplies and equipment, samples, drilling personnel, etc. to and/or from various boring locations.

### 5.2.11 Equipment Sizes

In planning subsurface exploration programs, care must be taken in specifying the various drilling components, so that they will fit properly in the boring or well.

For drilling open boreholes using rotary drilling equipment, tri-cone drill bits are employed with air, water or drilling mud to remove cuttings and cool the bit. Tri-cone bits are slightly smaller than the holes they drill (i.e., 5-7/8" or 7-7/8" bits will nominally drill 6" and 8" holes, respectively).

For obtaining split-barrel samples of a formation, samplers are manufactured in sizes ranging from 2-inches to 4-1/2 inches in outside diameter. However, the most commonly used size is the 2-inch O.D., 1-3/8-inch I.D. split-barrel sampler. When this sampler is used, and driven by a 140-pound ( ± 2 pound) hammer dropping 30-inches ( ± 1 inch), the procedure is called a Standard Penetration Test, and the blows per foot required to advance the sampler into the formation can be correlated to the formation's density or strength.

In planning the drilling of boreholes using hollow stem augers or casing, in which thin-wall tube samples or diamond core drilling will be performed, refer to the various sizes and clearances provided in Attachment A of this guideline. Sizes selected must be stated in the Work Plan.

### 5.2.12 Estimated Drilling Progress

To estimate the anticipated rates of drilling progress for a site the following must be considered:

- The speed of the drilling method employed.
- Applicable site conditions (e.g., terrain, mobility between borings, difficult drilling conditions in bouldery soils, rubble fill or broken rock, etc.).
- Project-imposed restrictions (e.g., drilling while wearing personal protective equipment, decontamination of drilling equipment, etc.).

Based on recent experience in drilling average soil conditions (no boulders) and taking samples at 5-foot intervals, for moderate depth (30' to 50') boreholes (not including installation or development of wells), the following daily rates of total drilling progress may be anticipated for the following drilling methods:

| Drilling Method | Average Daily Progress (linear feet) |
|---|---|
| Hollow-stem augers | 75' |
| Solid-stem augers | 50' |
| Mud Rotary Drilling | 100' (cuttings samples) |
| Reverse Circulation Rotary | 100' (cuttings samples) |
| Skid Rig with driven casing | 30' |
| Rotary with driven casing | 50' |
| Cable Tool | 30' |
| Hand Auger | Varies |
| Continuous Rock Coring | 50' |

## 5.3 PREVENTION OF CROSS-CONTAMINATION

A telescoping or multiple casing technique minimizes the potential for the migration of contaminated groundwater to lower strata below a confining layer. The telescoping technique consists of drilling to a confining layer utilizing a spun casing method with a diamond cutting or augering shoe, (a method similar to the rock coring method described in Section 5.2.9, except that larger casing is used) or a driven-casing method (see Section 5.2.5 of this guideline), and installing a specified diameter steel well casing. The operation consists of three separate steps. Initially, a drilling casing usually of 8-inch diameter is installed followed by installation of the well casing (6-inch diameter is common for 2-inch wells). This well casing is driven into the confining layer to insure a tight seal at the bottom of the hole. The well casing is sealed at the bottom with a bentonite-cement slurry. The remaining depth of the boring is drilled utilizing a narrower diameter spun or driven casing technique within the outer well casing. A smaller diameter well casing with an appropriate length of slotted screen on the lower end is installed to the surface.

Clean sand is placed in the annulus around and to a point about 2 feet above the screen prior to withdrawal of the drilling casing. The annular space above the screen and to a point 2 feet above the bottom of the outer well casing is sealed with a tremied cement-bentonite slurry which is pressure-grouted or displacement-grouted into the hole. The remaining casing annulus is backfilled with clean material and grouted at the surface, or it is grouted all the way to the surface.

## 5.4 CLEANOUT OF CASING PRIOR TO SAMPLING

The boring hole must be completely cleaned of disturbed soil, segregated coarse material and clay adhering to the inside walls of the casing. The cleaning must extend to the bottom edge of the casing and, if possible, a short distance further (1 or 2 inches) to bypass disturbed soil resulting from the advancement of the casing. Loss of wash water during cleaning should be recorded.

For disturbed samples both above and below the water table and where introduction of relatively large volumes of wash water is permissible, the cleaning operation is usually performed by washing the material out of the casing with water; however, the cleaning should never be accomplished with a strong, downward directed jet which will disturb the underlying soil. When clean-out has reached the bottom of the casing or slightly below (as specified above), the string of tools should be lifted one foot off the bottom with the water still flowing, until the wash water coming out of the casing is clear of granular soil particles. In formations where the cuttings contain gravel and other larger particles, it is often useful to repeatedly raise and lower the drill rods and wash bit while washing out the hole, to surge these large particles upward out of the hole. As a time saver, the drilling contractor may be permitted to use a split barrel (split-spoon) sampler with the ball check valve removed as the clean out tool, provided the material below the spoon is not disturbed and the shoe of the spoon is not damaged. However, because the ball check valve has been removed, in some formations it may be necessary to install a flap valve or spring sample retainer in the split spoon bit, to prevent the sample from falling out as the sampler is withdrawn from the hole. The use of jet-type chopping bits is discouraged except where large boulders and cobbles or hard-cemented soils are encountered. If water markedly softens the soils above the water table, clean out should be performed dry with an auger.

For undisturbed samples below the water table, or where wash water must be minimized, clean out is usually accomplished with an appropriate diameter clean out auger. This auger has cutting blades at the bottom to carry loose material up into the auger, and up-turned water jets just above the cutting blades to carry the removed soil to the surface. In this manner there is a minimum of disturbance at the top of the material to be sampled. If any gravel material washes down into the casing and cannot be removed by the cleanout auger, a split-barrel sample can be taken to remove it. Bailers and sandpumps should not be used. For undisturbed samples above the groundwater table, all operations must be performed in a dry manner.

If all of the cuttings created by drilling through the overlying formations are not cleaned from the borehole prior to sampling, some of the problems which may be encountered during sampling include:

- When sampling is attempted through the cuttings remaining in the borehole, all or part of the sampler may become filled with the cuttings. This limits the amount of sample from the underlying formation which can enter and be retained in the sampler, and also raises questions on the validity of the sample.

- If the cuttings remaining in the borehole contain coarse gravel and/or other large particles, these may block the bit of the sampler and prevent any materials from the underlying formation from entering the sampler when the sampler is advanced.

- In cased borings, should sampling be attempted through cuttings which remain in the lower portion of the casing, these cuttings could cause the sampler to become bound into the casing, such that it becomes very difficult to either advance or retract the sampler.

- When sampler blow counts are used to estimate the density or strength of the formation being sampled, the presence of cuttings in the borehole will usually give erroneously high sample blow counts.

To confirm that all cuttings have been removed from the borehole prior to attempting sampling, it is important that the rig geologist measure the "stickup" of the drill string. This is accomplished by measuring the assembled length of all drill rods and bits or samplers (the drill string) as they are lowered to the bottom of the hole, below some convenient reference point of the drill string; then to measure the height of this reference point above the ground surface. The difference of these measurements is the depth of the drill string (lower end of the bit or sampler) below the ground surface, which must then be compared with the depth of sampling required (installed depth of casing or depth of borehole drilled). If the length of drill string below grade is more than the drilled or casing depth, the borehole has been cleaned too deeply, and this deeper depth of sampling must be recorded on the log. If the length of drill string below grade is less than the drilled or casing depth, the difference represents the thickness of cuttings which remain in the borehole. In most cases, an inch or two of cuttings may be left in the borehole with little or no problem. However, if more than a few inches for cuttings are encountered, the borehole must be recleaned prior to attempting sampling.

## 5.5 MATERIALS OF CONSTRUCTION

The effects of monitoring well construction materials on specific chemical analytical parameters are described and/or referenced in FT-7.01. However, there are several materials used during drilling, particularly drilling fluids and lubricants, which must be used with care to avoid compromising the representativeness of soil and ground water samples.

The use of synthetic or organic polymer slurries is not permitted at any location where soil samples for chemical analysis are to be collected. These slurry materials could be used for installation of long term monitoring wells, but the early time data in time series collection of ground water data may then be suspect. If synthetic or organic polymer muds are proposed for use at a given site, a complete written justification including methods are procedures for their use must be provided by the site geologist and approved by the site manager. The specific slurry composition and the concentration of selected chemicals for each site must be known.

For many drilling operations, potable water is an adequate lubricant for drill stem and drilling tool connections. However, there are instances, such as drilling in tight clayey formations or in loose gravels, when threaded couplings must be lubricated to avoid binding. In these instances, to be determined in the field at the judgment of the site geologist and noted in the Site Logbook, and only after approval by the site manager, a vegetable oil or silicone based lubricant should be used. Petroleum based greases, etc. will not be permitted. Samples of lubricants used must be provided and analyzed for chemical parameters appropriate to the given site.

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## 7.0 ATTACHMENTS

Attachment A - Drilling Equipment Sizes

## ATTACHMENT A

## DRILLING EQUIPMENT SIZES

| Drilling Component | Designation or Hole Size (in) | O.D. (in) | I.D. (in) | Coupling I.D. (in) |
|---|---|---|---|---|
| Hollow-Stem Augers (Ref 7) | 6 1/4 | 5 | 2 1/4 | |
| | 6 3/4 | 5 3/4 | 2 3/4 | - |
| | 7 1/4 | 6 1/4 | 3 1/4 | - |
| | 13 1/4 | 12 | 6 | - |
| Thin Wall Tube Samplers (Ref 7) | - | 2 | 1 7/8 | - |
| | - | 2 1/2 | 2 3/8 | - |
| | - | 3 | 2 7/8 | - |
| | - | 3 1/2 | 3 3/8 | - |
| | - | 4 1/2 | 4 3/8 | - |
| | - | 5 | 4 3/4 | - |
| Drill Rods (Ref 7) | RW | 1 3/32 | 23/32 | 13/32 |
| | EW | 1 3/8 | 15/16 | 7/16 |
| | AW | 1 3/4 | 1 1/4 | 5/8 |
| | BW | 2 1/8 | 1 3/4 | 3/4 |
| | NW | 2 5/8 | 2 1/4 | 1 3/8 |
| | HW | 3 1/2 | 3 1/16 | 2 3/8 |
| | E | 1 5/16 | 7/8 | 7/16 |
| | A | 1 5/8 | 1 1/8 | 9/16 |
| | B | 1 7/8 | 1 1/4 | 5/8 |
| | N | 2 3/8 | 2 | 1 |
| | | | | Wall Thickness (in) |
| Driven External Coupled Extra Strong Steel* Casing (Ref 8) | 2 1/2 | 2.875 | 2.323 | 0.276 |
| | 3 | 3.5 | 2.9 | 0.300 |
| | 3 1/2 | 4.0 | 3.364 | 0.318 |
| | 4 | 4.5 | 3.826 | 0.337 |
| | 5 | 5.63 | 4.813 | 0.375 |
| | 6 | 6.625 | 5.761 | 0.432 |
| | 8 | 8.625 | 7.625 | 0.500 |
| | 10 | 10.750 | 9.750 | 0.500 |
| | 12 | 12.750 | 11.750 | 0.500 |

* Add twice the casing wall thickness to casing O.D. to obtain the approximate O.D. of the external pipe couplings.

## ATTACHMENT A

## DRILLING EQUIPMENT SIZES

| Drilling Component | Designation or Hole Size (in) | O.D. (in) | I.D (in) | Coupling I.D. (in) |
|---|---|---|---|---|
| Flush Coupled Casing (Ref 7) | RX | 1 7/16 | 1 3/16 | 1 3/16 |
| | EX | 1 13/16 | 1 5/8 | 1 1/2 |
| | AX | 2 1/4 | 2 | 1 29/32 |
| | BX | 2 7/8 | 2 9/16 | 2 3/8 |
| | NX | 3 1/2 | 3 3/16 | 3 |
| | HX | 4 1/2 | 4 1/8 | 3 15/16 |
| Flush Joint Casing (Ref 7) | RW | 1 7/16 | 1 3/16 | |
| | EW | 1 13/16 | 1 1/2 | |
| | AW | 2 1/4 | 1 29/32 | |
| | BW | 2 7/8 | 2 3/8 | |
| | NW | 3 1/2 | 3 | |
| | HW | 4 1/2 | 4 | |
| | PW | 5 1/2 | 5 | |
| | SW | 6 5/8 | 6 | |
| | UW | 7 5/8 | 7 | |
| | ZW | 8 5/8 | 8 | |
| Diamond Core Barrels (Ref 7) | EWM | 1 1/2 | 7/8 ** | |
| | AWM | 1 7/8 | 1 1/8 ** | |
| | BWM | 2 3/8 | 1 5/8 ** | |
| | NWM | 3 | 2 1/8 | |
| | HWG | 3 7/8 | 3 | |
| | 2 3/4 X 3 7/8 | 3 7/8 | 2 11/16 | |
| | 4 X 5 1/2 | 5 1/2 | 3 15/16 | |
| | 6 X 7 3/4 | 7 3/4 | 5 15/16 | |
| | AQ (wireline) | 1 57/64 | 1 1/16 ** | |
| | BQ (wireline) | 2 23/64 | 1 7/16 ** | |
| | NQ (wireline) | 2 63/64 | 1 7/8 | |
| | HQ (wireline) | 3 25/32 | 2 1/2 | |

** Because of the fragile nature of the core and the difficulty to identify rock details, use of small diameter core (1 3/8") is not recommended.

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| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject BOREHOLE AND SAMPLE LOGGING | | Approved D. Senovich | |

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## 1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

## 2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Site Geologist - Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used onsite the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

## 5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

### 5.1 MATERIALS NEEDED

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute HCl
- Ruler (marked in tenths and hundreths of feet)
- Hand Lens

### 5.2 CLASSIFICATION OF SOILS

All data shall be written directly on the boring log (Exhibit 4-1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

### 5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Exhibit 4-2. This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse grained soils shall be divided into rock fragments, sand, or gravel. The terms and sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as (1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

### 5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

### 5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.2. Those designations are:

| Designation | Standard Penetration Resistance (Blows per Foot) |
|---|---|
| Very loose | 0 to 4 |
| Loose | 5 to 10 |
| Medium dense | 11 to 30 |
| Dense | 31 to 50 |
| Very dense | Over 50 |

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140 pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, and SC (see Exhibit 4-2).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Exhibit 4-3. Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Exhibit 4-2).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength) or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are as follows:

| Consistency | Unc. Compressive Str. Tons/Square Foot | Standard Penetration Resistance (Blows per Foot) | Field Identification Methods |
|---|---|---|---|
| Very soft | Less than 0.25 | 0 to 2 | Easily penetrated several inches by fist |
| Soft | 0.25 to 0.50 | 2 to 4 | Easily penetrated several inches by thumb |
| Medium stiff | 0.50 to 1.0 | 4 to 8 | Can be penetrated several inches by thumb |
| Very stiff | 1.0 to 2.0 | 8 to 15 | Readily indented by thumb |
| Hard | 2.0 to 4.0 | 15 to 30 | Readily indented by thumbnail |
| Hard | More than 4.0 | Over 30 | Indented with difficulty by thumbnail |

### 5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

| Terms of Identifying Proportion of the Component | Defining Range of Percentages by Weight |
|---|---|
| trace | 0 - 10 percent |
| some | 11 - 30 percent |
| and or adjective form of the soil type (e.g., "sandy") | 31 - 50 percent |

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

### 5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

### 5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Exhibit 4-4.

### 5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

### 5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

## 5.3 CLASSIFICATION OF ROCKS

Rocks are grouped into three main divisions, including sedimentary, igneous and metamorphic rocks. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. ractures irregularly. Medium thick to thick bedded.

- Claystone - Vary fine grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. These include conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

### 5.3.1 Rock Type

As described above, there are numerous names of sedimentary rocks. In most cases a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Exhibit 4-5 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a handlens, the rock is a siltstone. If the grains are not distinguishable with a handlens, the rock is a claystone.

### 5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock Color Charts shall not be used unless specified by the project manager.

### 5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification will also be used for rock classification.

### 5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

### 5.3.5 Fracturing

The degree of fracturing or brokeness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2 in. spacing between fractures
- Broken (BR.) - 2 in. to 1 ft. spacing between fractures
- Blocky (BL.) - 1 to 3 ft. spacing between fractures
- Massive (M.) - 3 to 10 ft. spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD
(After Deere, 1964)

RQD % = r/l x 100

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

### 5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

### 5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified)
- Description of any filled cavities or vugs.
- Cementation (calcoreous, siliceous, hematitic)

- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

### 5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inch or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite - A fine to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

## 5.4 ABBREVIATIONS

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

| | | |
|---|---|---|
| C - Coarse | Lt - Light | Yl - Yellow |
| Med - Medium | BR - Broken | Or - Orange |
| F - Fine | BL - Blocky | SS - Sandstone |
| V - Very | M - Massive | Sh - Shale |
| Sl - Slight | Br - Brown | LS - Limestone |
| Occ - Occasional | Bl - Black | Fgr - Fine grained |
| Tr - Trace | | |

## 5.5 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceeding sections shall be used to complete the logs. A sample boring log has been provided as Exhibit 4-6. The field geologist/engineer shall use this example as a guide in completing each borings log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided on the back of the boring log, for field use.

### 5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.
- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology a 13.7 feet, shall be lined off at the proportional location between the 13 and 14 foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart of back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace 0 - 10 percent
  - Some 11 - 30 percent
  - And 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the Remarks Column and shall include, but is not limited by the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

  - Angularity - describe angularity of coarse grained particles using Angular, Subangular, Subrounded, Rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.

  - Particle shape - flat, elongated, or flat and elongated.

  - Maximum particle size or dimension.

  - Water level observations.

  - Reaction with HCl - none, weak or strong.

- Additional comments:

  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

  - Indicate odor and HNu or OVA reading if applicable.

  - Indicate any change in lithology by drawing in line through the lithology change column and indicate the depth. This will help later on when cross-sections are constructed.

  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop and any other useful information (i.e., borehole size, casing set, changes in drilling method).

  - Vertical lines shall be drawn (as shown in Exhibit 4.6) in columns 5 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.

  - Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

### 5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent and core recovery under the appropriate columns.

- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.

- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.

- Enter brokeness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:

  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.
  - Indicate calcareous zones, description of any cavities or vugs.
  - Indicate any loss or gain of drill water.
  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:

  - Type and size of core obtained.
  - Depth casing was set.
  - Type of Rig used.

- As a final check the boring log shall include the following:

  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.

  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

### 5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5 foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.

- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.

- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.

- Record this and any other useful information onto the boring log as provided in Exhibit 4-1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split barrel and rock core sampling methods be used at selected boring locations during the field investigation to

provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

## 5.6 REVIEW

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

## 6.0 REFERENCES

Unified Soil Classification System (USCS)

ASTM D2488, 1985

Earth Manual, U.S. Department of the Interior, 1974

## 7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

## EXHIBIT 4-1

**BORING LOG** — **NUS CORPORATION**

PROJECT: ..... BORING NO.: .....
PROJECT NO.: ..... DATE: ..... DRILLER: .....
ELEVATION: ..... FIELD GEOLOGIST: .....
WATER LEVEL DATA : .....
(Date, Time & Conditions) .....

| SAMPLE NO. & TYPE OR RQD | DEPTH (ft.) OR RUN NO. | BLOWS/ 6" OR RQD (%) | SAMPLE RECOVERY /SAMPLE LENGTH | LITHOLOGY CHANGE (Depth, ft.) OR SCREENED INTERVAL | MATERIAL DESCRIPTION | | | BORE LOG REMARKS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | | |
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REMARKS _____

BORING _____

PAGE ____ OF ____

# SOIL TERMS

## UNIFIED SOIL CLASSIFICATION (USCS)

### COARSE GRAINED SOILS
More than half of material is LARGER than No. 200 sieve size

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights) | | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|
| GRAVELS 50%(+)>#4 | CLEAN GRAVELS Low % fines | Wide range in grain size and substantial amounts of all intermediate particle sizes. | GW | Well graded gravels, gravel-sand mixtures, little or no fines |
| | | Predominantly one size or a range of sizes with some intermediate sizes missing. | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines. |
| | GRAVELS w/FINES High % fines | Non plastic fines (for identification procedures see ML) | GM | Silty gravels, poorly graded gravel-sand-silt mixtures. |
| | | Plastic fines (for identification procedures see CL) | GC | Clayey gravels, poorly graded gravel-sand-clay mixtures. |
| SANDS 50%(+)<#4 | CLEAN SANDS Low % fines | Wide range in grain size and substantial amounts of all intermediate particle sizes. | SW | Well graded sand, gravelly sands, little or no fines |
| | | Predominantly one size or a range of sizes with some intermediate sizes missing. | SP | Poorly graded sands, gravelly sands, little or no fines. |
| | SANDS w/FINES High % fines | Non plastic fines (for identification procedures see ML) | SM | Silty sands, poorly graded sand-silt mixtures. |
| | | Plastic fines (for identification procedures see CL) | SC | Clayey sands, poorly graded sand-clay mixtures. |

### FINE GRAINED SOILS
More than half of material is SMALLER than No. 200 sieve size

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights) | | | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|---|
| Identification procedures on fraction smaller than No. 40 sieve size | | | | | |
| SILTS & CLAYS Liquid limit < 50 | DRY STRENGTH (Crushing characteristics) | DILATANCY (Reaction to Shaking) | TOUGHNESS (Consistency Near Plastic Limit) | | |
| | None to slight | Quick to slow | None | ML | Inorganic silts and very fine sands, rock flour silty or clayey fine sands with slight plasticity |
| | Medium to high | None to very slow | Medium | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | Slight to medium | Slow | Slight | OL | Organic silts and organic silt-clays of low plasticity |
| SILTS & CLAYS Liquid limit > 50 | Slight to medium | Slow to none | Slight to medium | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts |
| | High to very high | None | High | CH | Inorganic clays of high plasticity, fat clays |
| | Medium to high | None to very slow | Slight to medium | OH | Organic clays of medium to high plasticity |
| HIGHLY ORGANIC SOILS | Readily identified by color, odor, spongy feel and frequently by fibrous texture. | | | Pt | Peat and other organic soils |

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

### DENSITY OF GRANULAR SOILS

| DESIGNATION | STANDARD PENETRATION RESISTANCE - BLOWS/FOOT |
|---|---|
| Very loose | 0-4 |
| Loose | 5-10 |
| Medium dense | 11-30 |
| Dense | 31-50 |
| Very dense | Over 50 |

### CONSISTENCY OF COHESIVE SOILS

| CONSISTENCY | UNC. COMPRESSIVE STR. TONS/SQ. FT. | STANDARD PENETRATION RESISTANCE - BLOWS/FOOT | FIELD IDENTIFICATION METHODS |
|---|---|---|---|
| Very soft | Less than 0.25 | 0 to 2 | Easily penetrated several inches by fist |
| Soft | 0.25 to 0.50 | 2 to 4 | Easily penetrated several inches by thumb |
| Medium stiff | 0.50 to 1.0 | 4 to 8 | Can be penetrated several inches by thumb |
| Stiff | 1.0 to 2.0 | 8 to 15 | Readily indented by thumb |
| Very stiff | 2.0 to 4.0 | 15 to 30 | Readily indented by thumbnail |
| Hard | More than 4.0 | Over 30 | Indented with difficulty by thumbnail |

# ROCK TERMS

### ROCK HARDNESS (FROM CORE SAMPLES)

| DESCRIPTIVE TERMS | SCREWDRIVER OR KNIFE EFFECTS | HAMMER EFFECTS |
|---|---|---|
| Soft | Easily gouged | Crushes when pressed with hammer |
| Medium soft | Can be gouged | Breaks (one blow) Crumbly edges |
| Medium hard | Can be scratched | Breaks (one blow) Sharp edges |
| Hard | Cannot be scratched | Breaks conchoidally (several blows) Sharp edges |

### ROCK BROKENNESS

| DESCRIPTIVE TERMS | ABBREVIATION | SPACING |
|---|---|---|
| Very broken | (V. Br.) | 0 - 2" |
| Broken | (Br.) | 2" - 1' |
| Blocky | (Bl.) | 1' - 3' |
| Massive | (M.) | 3' - 10' |

**LEGEND**

**SOIL SAMPLES - TYPES**

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

**ROCK SAMPLES - TYPES**

X - NX (Conventional) Core (~2 1/8" O.D.)
Q - NQ (Wireline) Core (~1 7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

**WATER LEVELS**

12/18
▽ 12.5' Initial Level w/Date & Depth

12/18
▽ 10.5' Stabilized Level w/Date & Depth

EXHIBIT 4-2

**EXHIBIT 4-3**

**CONSISTENCY FOR COHESIVE SOILS**

| Consistency | (Blows per Foot) | Unconfined Compressive Strength (tons/square foot by pocket penetration | Field Identification |
| --- | --- | --- | --- |
| Very soft | 0 to 2 | Less than 0.25 | Easily penetrated several inches by fist |
| Soft | 2 to 4 | 0.25 to 0.50 | Easily penetrated several inches by thumb |
| Medium stiff | 4 to 8 | 0.50 to 1.0 | Can be penetrated several inches by thumb with moderate effort |
| Stiff | 8 to 15 | 1.0 to 2.0 | Readily indented by thumb but penetrated only with great effort |
| Very stiff | 15 to 30 | 2.0 to 4.0 | Readily indented by thumbnail |
| Hard | Over 30 | More than 4.0 | Indented by thumbnail |

**EXHIBIT 4-4**

**BEDDING THICKNESS CLASSIFICATION**

| Thickness (Metric) | Thickness (Approximate English Equivalent) | Classification |
| --- | --- | --- |
| > 1.0 meter | > 3.3' | Massive |
| 30 cm - 1 meter | 1.0' - 3.3' | Thick Bedded |
| 10 cm - 30 cm | 4" - 1.0' | Medium Bedded |
| 3 cm - 10 cm | 1" - 4" | Thin Bedded |
| 1 cm - 3 cm | 2/5" - 1" | Very Thin Bedded |
| 3 mm - 1 cm | 1/8" - 2/5" | Laminated |
| 1 mm - 3 mm | 1/32" - 1/8" | Thinly Laminated |
| < 1 mm | < 1/32" | Micro Laminated |

(Weir, 1973 and Ingram, 1954)

**EXHIBIT 4-5**

**GRAIN SIZE CLASSIFICATION FOR ROCKS**

| Particle Name | Grain Size Diameter |
| --- | --- |
| Cobbles | > 64 mm |
| Pebbles | 4-64 mm |
| Granules | 2-4 mm |
| Very Coarse Sand | 1-2 mm |
| Coarse Sand | 0.5-1 mm |
| Medium Sand | 0.25-0.5 mm |
| Fine Sand | 0.125-0.25 mm |
| Very Fine Sand | 0.0625-0.125 mm |
| Silt | 0.0039-0.0625 mm |

After Wentworth, 1922

**BORING LOG** — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO: MW 3A
PROJECT NO.: 619Y — DATE: 9-21-87 — DRILLER: B. GOLLIHUE
ELEVATION: 510.07 — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions): WL 26.35 -TPVC 10-16-87

| SAMPLE NO. & TYPE/ RQD | DEPTH (ft) / RUN NO. | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY / SAMPLE LENGTH | LITHOLOGY CHANGE (Depth ft) OR SCREEN ZONE | MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | USCS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| S-1 | 0.0 | 4/6 | 1.5/1.5 | | STIFF | BRN | CLAYEY SILT - TR SHALE | ML | 0-6" TOPSOIL MOIST 0PPM |
| | 1.5 | 6 | | | | | FRAG - TR ORG. | | RESIDUAL SOIL. |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | 5.0 | | | | | | | | |
| S-2 | 6.0 | 11/100/5.5 | 0.8/1.0 | 5.5 / 6.0 | M. SOFT | GRAY BRN | DEC SHALE AND SILT | VBR | DAMP 0PPM |
| | | | | | TO | | | | REFUSAL @ 6' 5.5 TOP OF DEC ROCK |
| | | | | | M. HARD | | | | |
| | | | | | | | | | AUGERED TO 15' W/SOLID STEM AUG |
| | | | | | | | | | CUTTING MOIST @ ≈8' WATER @ 11'± |
| | | | | | | | | | WL @ 12:10 PM WAS ≈ 9' FROM GS. |
| | | | | | | | | | SET 4" PVC CAS. @ 15.0' |
| | | | | | | | | | |
| 9-21 | 15.0 | | | | | | | | |
| 9-22 | | | | | M. HARD | BRN GRAY | SILTY SHALE - FEW | VBR | SEVERAL 0 PPM |
| | | | | | | | QUARTZ PCS | | Fe STAINED JOINTS ON CORE |
| | | | | | | | | | THRUOUT RUN. |
| | | | | | | | | | JOINTS AND BREAKS |
| | | | | | | | | | ARE HORIZ TO LO &. |
| | | | | | | | | | W/VUGS ON LOWER |
| 0.2/10.0 | ① | 0%/10 | 7.0/10.0 | | | | | | PORTION 23 TO 25 OF CORE |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | 25.0 | | | | | | | | |

REMARKS: ACCESS AD II RIG - SOLID STEM AUGERS USED TO ADVANCE BORING - 140 LB WT & 30" DROP - TO TAKE 2" Φ SP SPOON SAMPLES - SET UP OVER HOLE @ 11:10 AM. WILL SAMPLE THIS HOLE - SET 4" CASING THEN DO SHALLOW WELL. STARTED TO CORE 9-22-87 USING THE WIRE-LINE CORING METHOD.

* See Legend on Back

BORING MW 3A

PAGE 1 OF 3

**BORING LOG** — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO.: MW 3A
PROJECT NO.: 619Y — DATE: 9-22-87 — DRILLER: B. GOULIHUE
ELEVATION: — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

| | SAMPLE NO & TYPE RQD | DEPTH (ft) RUN | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY SAMPLE LENGTH | LITHOLOGY CHANGE (Depth/ft) | MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | USCS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 9-22 | | 25.0 | | | | M.HARD | GRAY | SILTY SHALE | VBR | SHALE IS VBR W/ HORIZ TO LO ∠ JNTS |
| | | | | | | | | (SILTSTONE) | | ≈26 TO 27 2" VERT |
| | | | | | | | | - FEW QUARTZ | | JOINTS. IRON STAINS ON JNTS |
| | | | | | | | | SEAMS | | ROCK BECOMES AND BREAKS MORE LIKE |
| | | | | | | | | | | A SILTSTONE WITH DEPTH. |
| | 0/10.0 | ② | 0.9/0 | 8.7/10.0 | | | | | | |
| | | | | | | | | | BR | ≈32 TO 33 FEW QUARTZ PIECES W/ |
| | | | | | | | | | VBR | VUGS. SL. MICACEOUS |
| | | | | | | | | | | VF QUARTZ GRAINS IN MATRIX - 30X MAG. |
| | | 35.0 | | | | | | | | ≈34 TO 35 - 2 VERT JOINTS |
| | | | | | | M.HARD | GRAY | SILTY SHALE (SILTSTONE) | VBR | 35.0-35.5 QUARTZ PIECES |
| | | | | | | | | - FEW QUARTZ | BR | |
| | | | | | | | | SEAMS | VBR | BECOMES SL. CALCAR. @ 37± THIN CALCITE |
| | | | | | | | | | | LAMINATIONS. WHITE STAINED JNTS |
| | | | | | | | | | BR | THRUOUT RUN MORE SO 35-37± |
| | 1.9/10.0 | ③ | 10.8/0 | 9.3/10.0 | | | | | VBR | 39.5 → 42.0 |
| | | | | | | | | | | 42.7 → 43.0 HI ∠ JNT |
| | | | | | | | | | BR | 42.4 → 42.7 VERT JNT |
| | | | | | | | | | | |
| | | 45.0 | | | | | | | VBR | |
| | | | | | | | | | | 45.3 → 45.5 VERT JNT. & VBR |
| | | | | | | | | | | 47.5 VERT JOINT |
| | | | | | | | | | BR | 48. HI ∠ JOINT |
| | | | | | | | | | | SLIGHTLY CALCAREOUS MORE CALCITE |
| | | | | | | | | | | PRESENT |

REMARKS

BORING MW 3A

PAGE 2 OF 3

* See Legend on Back

**BORING LOG** — NUS CORPORATION

PROJECT: HEBELKA SITE — BORING NO. MW3A
PROJECT NO. 619Y — DATE: 9-22-87 — DRILLER: B. GOLLIHUE
ELEVATION: — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

| SAMPLE NO. & TYPE | DEPTH (ft) | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY SAMPLE LENGTH | LITHOLOGY CHANGE (Depth ft) | MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | USCS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1.9/10.0 | 4 | 19% | 10.0/10.0 | | M.HARD | GRAY | SILTY SHALE (SILTSTONE) | VBR | 50.5 → 51.0 VBR |
| | | | | | | | SL. CALCAREOUS | BR | 51.5 → 54.0 BR w/ SEV LO & JOINTS |
| | 55.0 | | | | | | | | |
| | | | | | | | | VBR | POOR RECOVERY w/ SOFT ZONES. |
| 0/10 | 5 | 0% | 1.8/10.0 | | | | | | |
| | 65.0 | | | | | | | | |
| | | | | 66 | | | | | |
| | | | | | | | | | 68.0 - DRILLER NOTED SOFT AREA - LOSS OF 1/3 OF WATER - CHANGE IN COLOR OF DRILL WATER TO YELLOW BROWN |
| 0/10 | 6 | 0% | 1.3/10.0 | | | | | | |
| | | | | | | | | | POOR RECOVERY |
| | | | | | | | | | FEW CALCAREOUS ZONES. |
| | 75.0 | | | 76 | | | | | |

REMARKS AT 75' @ 1:45 PM - PULLING TOOLS - TO REAM HOLE. AT 1:50 PM CORED HOLE TO 75' REAMED TWICE DUE TO RUNNING SAND (FRACTURE) AT ≈ 68. REAMED 2ND TIME TO 81'. SET WELL 66'-76'.

BORING MW3A

PAGE 3 OF 3

* See Legend on Back

## EXHIBIT 4-6

**BORING LOG** — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO: MW 013
PROJECT NO: 473 Y — DATE: 7-7-87 — DRILLER: B ERICSON
ELEVATION: 1462.37 — FIELD GEOLOGIST: S J CONTI — PENN-DRILL
WATER LEVEL DATA (Date, Time & Conditions): 5.54' @ 8:50 AM 7-23-87 T-PVC — ACKER AD-II

| SAMPLE NO & TYPE OR RQD | DEPTH (ft) OR RUN NO | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY SAMPLE LENGTH | LITHOLOGY CHANGE (Depth ft) OR SCREEN INT | MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | ROCK OR USCS | REMARKS (HNU) (HEAD SP) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | 5 / 3 | 1.4/1.5 | | LOOSE | BLK BRN | CLAYEY SILT AND CINDER | ML | MOIST (0PPM) |
| S-1 | | 2 | | | | | TR-COAL FRAG | | 3/4 Φ FRAG - NEAR OLD |
| | | | | | | | TR-CC FRAG | | R.R. LINE. |
| | | | | | | | (FILL) | | |
| | 5.0 | | | | | RED BRN TO GRAY | | | |
| S-2 | | 1 / 1 | 1.3/1.5 | 6.0 | V. LOOSE | | SANDY SILT-TR FRAG TO | SM | MOIST TO WET (0PPM) |
| | 6.5 | 3 | | | | | SILTY SAND-TR GRAVEL | | GRAY SAND @ 6' ± |
| | | | | | | | | | NUCLEOUS 1.0X4 NATURAL |
| | | | | | | | | | DRILLER NOTE H2O 8-10' |
| | 10.0 | | | | | | | | |
| S-3 | | 11 / 23 | 1.2/1.5 | | DENSE | BRN | SILTY SAND AND S.S. | GM | WET (0PPM) |
| | 11.5 | 27 | | | | | FRAGS. (GRAY) | | 1" Φ SIZE MAX SIZE |
| | | | | | | | | | SUBANGULAR TO SUBROUNDED GRAVEL |
| | 15.0 | | | | | | | | |
| S-4 | | 9 / 47 | 1.0/1.5 | | V. DENSE | BRN | SILTY FINE TO C. SAND | GM | WET (0PPM) |
| | 16.5 | 43 | | | | | AND GRAVEL | | 1" Φ SIZE MAX SIZE |
| | | | | | | | | | SUBANGULAR TO SUBROUNDED GRAVEL |
| | 20.0 | | | | | | | | |
| S-5 | 20.9 | 17 / 50/2" | .6/.9 | | V. DENSE | ORANG BRN | SILTY SAND - SOME | GM | WET (0PPM) |
| | | | | | | | GRAVEL AND | | MOIST |
| | | | | | | | S.S FRAGS | | BECOMES MORE LIKE SANDY SILT AT BOTM OF SAMPLE |

REMARKS: START @ 1:15 PM - 7-7-87 USING 4¼" ID HOLLOW STEMS
S-4 @ 3:30 PM TO ADVANCE THE BORING USING
S-5 @ 4:30 PM ACKER DRILL - MOUNTED ON FORD 8000 TRUCK
SAMPLES TAKEN USING 140 lb WT AND 30 INCH DROP.

BORING MW 013
PAGE 1 OF 4

**BORING LOG** — **NUS CORPORATION**

PROJECT: WESTLINE SITE
PROJECT NO.: 473Y
ELEVATION:
WATER LEVEL DATA
(Date, Time & Conditions)

DATE: 7-7-87
FIELD GEOLOGIST: S. CONTI

BORING NO.: MW013
DRILLER: E. ERICSON

| | SAMPLE NO. & TYPE OR RQD | DEPTH (ft.) OR RUN NO | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY SAMPLE LENGTH | LITHOLOGY CHANGE (Depth ft.) OR SCREEN INT | MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | ROCK OR USCS | REMARKS (HNU) |
|---|---|---|---|---|---|---|---|---|---|---|
| | S-6 | 25.0 | 6 17 | 1.1/1.5 | | DENSE | DUE BLUE | SILTY SAND - SOME | SM | WET 0 PPM |
| | | 26.5 | 30 | | | | GRAY | GRAVEL - TR CLAY | | C.S. IS METABLE FIRST CHANGE IN |
| | | | | | | | | TR. SS. FRAG | | COLOR. NOT ENOUGH CLAY TO BE CONFINING |
| | | | | | | | | | | NOTE: MAY SET ZONE 2 |
| 7/7 | | 30.0 | | | | | MOTTLED | | | CASING @ 28' |
| 7/8 | S-7 | | 17 27 | 1.4/1.5 | | V. DENSE | BRN BLUE GRAY | SILTY SAND - SOME GRAVEL | SM/ | MOIST > WET (0 PPM) |
| | | 31.5 | 36 | | | | | TR. SS. FRAG - | GM | CAUSES SAND IS FINE |
| | | | | | | | | TR CLAY | | GRAY & METABLE. SURROUNDED GRAVEL |
| | | | | | | | | | | NOT TRUE CLAY - BUT MAY BE SEMI-CONFINING. |
| | | 35.0 | | | | | | | | |
| | S-8 | 35.9 | 30 50/4 | 0.7/0.9 | | V. DENSE | BLUE GRAY | SILTY F. TO C. SAND - | SM/ | MOIST → WET (0 PPM) |
| | | | | | | | | SOME GRAVEL | GM | V. SL. TR. CLAY - LESS |
| | | | | | | | | TR. SS. FRAG. | | THAN S-7 |
| | | | | | | | | | | SOME SAND THAN ABOVE. |
| | | 40.0 | | | | | BLUE | | | POSSIBLE 35 TO 45 SCREEN LOC. SQUEEZED |
| | S-9 | | 31 34 | 1.2/1.5 | | V. DENSE | BRN GRAY | SILTY SAND (FINE TO M.) | SM | HOLE TIGHTER WHEN MOIST → WET (0 PPM) |
| | | 41.5 | 24 | | | | | SOME GRAVEL - TR | GM | LITTLE MORE CLAY THAN |
| | | | | | | | | CLAY | | S-8 SUBROUNDED GRAVEL |
| | | | | | | | | | | VERY SLOW DRILLING 40-45 (RIG STALLS) |
| | | 45.0 | | | | | BLUE | | | LESS CLAY LAST 3" OF SAMPLE |
| | S-10 | | 13 34 | 1.2/1.5 | | V. DENSE | BRN GRAY | SILTY SAND (FINE TO M.) | SM/ | MOIST → WET (0 PPM) |
| | | 46.5 | 50 | | | | | SOME GRAVEL - TR | GM | 1" Ø SIZE - HOLDS TOGETHER WHEN SQUEEZ'D |
| | | | | | | | | CLAY | | BUT NOT COHESIVE CLASSIFICATION |
| | | | | | | | | | | CONTINUE DRILLING TO 50' |

REMARKS S-6 @ 4:40 PM
S-8 @ 8:36 AM 7-8-87
S-10 @ 10:40 AM S-11 @

BORING MW013

PAGE 2 OF 4

**BORING LOG** — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW 013
PROJECT NO.: 473Y — DATE: 7-8-87 — DRILLER: B. ERICSON
ELEVATION: — FIELD GEOLOGIST: S. COUTU
WATER LEVEL DATA:
(Date, Time & Conditions)

| SAMPLE NO & TYPE OR RQD | DEPTH (ft.) OR RUN NO. | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY / SAMPLE LENGTH | LITHOLOGY CHANGE (Depth ft.) OR SCREEN INT | MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | USCS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| S-11 | 50.0 | 15 / 41 | 1.0/1.3 | | V. DENSE | MOTTLED BLUE | SILTY SAND - SOME GR. | GM | MOIST - (OPPM) |
| | 51.3 | 50/3 | | | | BRN GRAY | TR CLAY | SM | MOTTLED W/ PCS OF BLACK COAL/LIGNITE. |
| | | | | | | | | | MORE CLAY THAN ABOVE PORTIONS OF SAMPLE - COHESIVE CLASSIF. |
| | 55.0 | | | 55.0 | | | | | |
| S-12 | | 11 / 15 | 1.1/1.5 | | V. STIFF TO STIFF | GRAY ORANG BRN | SANDY CLAY / CLAYEY SAND | SC | MOIST → WET (OPPM) |
| | 56.5 | 26 | | | | | SOME GRAVEL | | NOTE COLOR CHANGE ALSO - MORE CLAY THAN ANY SAMPLE SUB-ROUNDED GRAINS |
| | | | | | | | | | FIRST COHESIVE TYPE CLASSIF. |
| | 60.0 | 40 | | | | | | | |
| S-13 | 60.9 | 50/.4 | 0.7/0.9 | | V. DENSE | ORANG BRN | SANDY CLAY / CLAYEY SAND - SOME | SC | MOIST → WET (OPPM) |
| | | | | | | | GRAVEL | GW | NOT AS MUCH CLAY AS S-12 BUT VERY COMPACT. SUBROUNDED GRAINS |
| | | | | | | | | | SET CAS. @ 60'. |
| | 65.0 | | | | | | | | |
| 7/13 S-14 | 65.8 | 37 / 50/3 | 0.7/0.8 | | V. DENSE | BRN ORANG | SILTY SAND - SOME GR. | SM | MOIST (OPPM) |
| | | | | | | | AND ROCK FRAG - | GW | MORE CLAY TOWARDS TOP OF SAMPLE MAX 3/4" Ø SIZE |
| | | | | 68.0 | | | TR. CLAY | | |
| | | | | | | YELLOW BRN | | | COLOR CHANGE AT ≈ 68' MORE SAND PER DRILLER - BOTTOM OF SEAM CONF LAYER ? |
| | 70.0 | | | | | | | | |
| 7/14 S-15 | | 59 / 39 | 1.0/1.5 | | V. DENSE | YELLOW BRN | CLAYEY SAND (F. TO C.) SOME | SC | MOIST → WET (OPPM) |
| | 71.5 | 41 | | | | | GRAVEL - TR | GC | 1" MAX GRAVEL |
| | | | | | | | ROCK FRAG. | | MORE GRAVEL @ 72' PER DRILLER |

REMARKS: USING HOLLOW STEM TO ADVANCE BORING - WASHING OUT THRU AUGERS, WHEN NEEDED TO DRILL SAMPLE
S-12 @ 1:46 PM
S-13 → 3:32 PM - LOGGED IN BY 3:47 PM
SET 6" Ø STEEL CASING TO 62' - WILL DRILL BELOW CASING AFTER GROUT SETS UP. S-14 @ 3:20 PM 7-13-87
S-15 - 7:57 AM 7-14-87

BORING MW 013
PAGE 3 OF 4

**BORING LOG** — **NUS CORPORATION**

PROJECT: WESTLINE SITE
PROJECT NO.: 437Y
ELEVATION:
WATER LEVEL DATA:
(Date, Time & Conditions)
DATE: 7-13-87 / 7-14-87
FIELD GEOLOGIST: S.J. CONTI
BORING NO: MW013
DRILLER: B. ERICSON

| SAMPLE NO. & TYPE OR RQD | DEPTH (Ft.) OR RUN NO | BLOWS 6" OR RQD (%) | SAMPLE RECOVERY SAMPLE LENGTH | LITHOLOGY CHANGE (Depth (ft.) or Scale) | MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | BRAZNESS OR ROCK TYPE USCS | REMARKS (HNU) |
|---|---|---|---|---|---|---|---|---|---|
| S-16 | 75.0 | 28 50/.5 | 0.9/1.0 | 75 | V. DENSE | GRAY ORANG BRN | FINE TO C. CLAYEY SAND - SOME | SC | WET (OPPM) |
| | 76.0 | | | | | | GRAVEL - TR | | NOT AS MUCH CLAY AS S-15 - BOTM OF |
| | | | | | | | ROCK FRAG (S.S.) | | SAMPLE BECOMES MORE SANDY |
| | | | | | | | | | MAX 1" Ø RC. |
| | 80.0 | | | | | | | | NO SAMPLE @ 80' - |
| | | | | | | | | | DECIDED TO GO TO 85' |
| | 85.0 | 50/.4 | 0.4/0.4 | | V. DENSE | GRAY ORANG BRN | SILTY F. TO C. SAND - SOME | SW | WET (OPPM) |
| S-17 | 85.4 | | | 85 | | | GRAVEL - TR | | SUBROUNDED GRAINS |
| | | | | | | | S.S. FRAG - TR | | V. SL TR CLAY - WILL |
| | | | | | | | CLAY | | SET SCREEN ≈ 75 TO 85' IN THIS |
| | | | | | | | | | BORING. |
| | | | | | | | BOTM OF HOLE @ 85.0' | | |

REMARKS S-17 @ 2:20 PM 7-14-87 - METHOD BEHIND 6" CASING SPUN 4" Ø - 5 7/8" OD CASING TO BOTM. USING WATER AS DRILLING FLUID

BORING MW 013

PAGE 4 OF 4

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number GH-1.6 | Page 1 of 3 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS | | Approved D. Senovich | |

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**SECTION**

1.0 PURPOSE

2.0 SCOPE

3.0 GLOSSARY

4.0 RESPONSIBILITIES

5.0 PROCEDURES

6.0 RECORDS

## 1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the appropriate procedures to be followed when conducting decontamination activities of drilling equipment and monitoring well materials used during field investigations.

## 2.0 SCOPE

This procedure addresses only drilling equipment and monitoring well materials decontamination, and shall not be considered for use with chemical sampling and field analytical equipment decontamination.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for ensuring that project specific plans and the implementation of field investigations are in compliance with these procedures.

## 5.0 PROCEDURES

To insure that analytical chemical results are reflective of the actual concentrations present at sampling locations, various drilling equipment involved in field investigations must be properly decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

Prior to the initiation of a drilling program. all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment which might contact environmental sample. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.) In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens.

The steam cleaning area shall be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases, due to budget constraints, such an elaborate decontamination pad is not possible. In such cases, a plastic lined gravel bed pad with a collection system may serve as an adequate decontamination area. The location of the steam cleaning area shall be on site in order to minimize potential impacts at certain sites.

Guidance to be used when decontaminating equipment shall include:

- As a general rule, any part of the drilling rig which extends over the borehole, shall be steam cleaned.
- All drilling rods, augers, and any other equipment which will be introduced to the hole shall be steam cleaned.
- The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Rinsate samples of well casing and screens may be necessary if specifically required for a given site. If required, at least 1 percent, and no more than 5 percent of steam cleaned lengths of casing and screens combined shall be sampled.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

## 6.0 RECORDS

None.

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number GH-2.4 | Page 1 of 7 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject IN-SITU HYDRAULIC CONDUCTIVITY TESTING | | Approved D. Senovich | |

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## 1.0 PURPOSE

This guideline is intended to describe procedures for performing in-situ hydraulic conductivity testing (slug testing) in boreholes and monitoring wells, and provide a short description of commonly used evaluation techniques for the data generated. Slug tests are used to provide data regarding the hydraulic properties of the formation tested. A variation of the slug test, called a constant-head test, is also briefly describe

## 2.0 SCOPE

Slug tests are short-term tests designed to provide approximate hydraulic conductivity values for the portion of a formation immediately surrounding the screened/open interval of a well or boring. These tests are less accurate than pumping tests, as a much more localized area is involved, so a number of slug tests are performed and averaged to determine a representative hydraulic conductivity value for the formation tested. Slug tests may be preferable to pumping tests in situations where handling of large volumes of contaminated water is a concern or when time/budget constraints preclude the more expensive and time-consuming setup and performance of a pumping test.

Constant-head tests also are used to determine hydraulic conductivity values and are similar to slug tests in regards to the quality of data obtained and time/cost considerations. A disadvantage to constant-head tests is that a significant volume of water may be added to the formation, potentially affecting short-term water quality.

## 3.0 GLOSSARY

Hydraulic Conductivity (K) - A quantitative measure of the ability of porous material to transmit water. Volume of water that will flow through a unit cross sectional area of porous material per unit time under a head gradient. Hydraulic conductivity is dependent upon properties of the medium and fluid. Common units of expression include centimeters per second (cm/sec), feet per day (ft/day), and gallons per day per foot$^2$ (gpd/ft$^2$).

Transmissivity (T) - A quantitative measure of the ability of an aquifer to transmit water. The product of the hydraulic conductivity x saturated thickness.

Slug-test - A rising head or falling head test used to measure hydraulic conductivity. A slug test consists of instantaneously changing the water level within a well and measuring the rate of recovery of the water level to equilibrium conditions. Slug tests are performed by either withdrawing a slug of water (rising head test) or adding a slug of water (falling head test), then measuring recovery over time. A solid slug of known volume can be used to displace a volume of water, thereby simulating the addition or removal of water.

## 4.0 RESPONSIBILITIES

The project geologist shall evaluate the type(s) and extent of hydraulic testing required for a given project during the planning process, and design the field program accordingly. The project geologist also shall ensure that field personnel have the necessary training and guidance to properly perform the tests, and oversee data reduction activities, including selecting the appropriate evaluation techniques and checking calculations for accuracy.

The field geologist is responsible for performing the planned field tests as specified in the planning documents, or as directed by the project geologist shall the field program require modification, and generally assists in the data evaluation process. The field geologist shall be knowledgeable in the testing methodologies required and is responsible for obtaining the necessary support equipment required to perform the field tests. All applicable data regarding testing procedures, equipment used, well construction, and geologic/hydrogeologic conditions shall be recorded by the field geologist. The field geologist shall be familiar enough with testing procedures/requirements to be able to recommend changes in methodology, should unanticipated field conditions be encountered.

## 5.0 PROCEDURES

### 5.1 IN-SITU HYDRAULIC CONDUCTIVITY TESTING IN WELLS

Slug tests are commonly performed in completed wells. Prior to testing, the well shall be thoroughly developed and allowed to stabilize, in order to obtain accurate results. Once the water level within the well has stabilized, it shall be quickly raised or lowered and the rate of recovery measured.

One of the basic assumptions of slug testing is that the initial change in water level is instantaneous; therefore, an effort shall be made to minimize the time involved in raising or lowering the water level initially. Various methods can be used to induce instantaneous (or nearly instantaneous) changes in water level within the well. A rise in water levels can be induced by pouring water into the well. A solid slug of known volume, quickly lowered below the water level within the well, will displace an equivalent volume of water and raise the water level within the well. The slug can be left in place until the water level restabilizes at the static water level, then suddenly removed to create a drop in water level within the well. An advantage of using a solid cylinder of known volume to change the water level (slug test) is that no water is removed or added to the monitoring well. This eliminates the need to dispose of contaminated water and/or add water to the system, which might raise doubts regarding the representativeness of future groundwater samples. A bailer or pump can be used to withdraw water from the well. (If a pump is used, pumping shall not continue for more than several seconds so that a cone of depression is not created which would adversely impact testing results. The pump hose shall also be removed from the well during the recovery period, as data analysis techniques involve volume of recovery versus time, and leaving the hose within the well would distort the calculated testing results by altering the apparent volume of recovery.) Falling head slug tests should only be performed in wells with fully submerged screens, while rising head slug tests can be performed in wells with either partially or fully submerged screens/open intervals.

Other methods that can be used to change water levels within a well include creating a vacuum or a high pressure environment within the well. The vacuum method will raise water levels within the well, while the pressure method will depress the water level in the well. These methods are particularly useful in highly permeable formations where other methods are ineffective in creating measurable changes in water levels. Both methods are limited to wells which have completely submerged screens.

Rate of recovery measurements shall be obtained from time zero (maximum change in water level) until water level recovery exceeds 90 percent of the initial change in water level. In low permeability formations, the test may be cut off short of 90 percent recovery due to time constraints. Time intervals between water level readings will vary according to the rate of recovery of the well. For a moderately fast recovering well, water level readings at 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1.0, 1.25, 1.5, 2.0, 2.5, 3.0, 4.0, . . . minutes may be required. With practice, readings at down to 0.05-minute (3 seconds) time intervals can be obtained with reasonable accuracy, using a pressure transducer and hand held readout. For wells which recover very fast, a pressure transducer and data logger may be required to obtain representative data. Time intervals between measurements can be extended for slow

recovering wells. A typical schedule for measurements for a slow recovering well would be 0, 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0, 10.0, 15.0, 20.0, 30.0, . . . minutes from the beginning the test. Measurements shall be taken from the top of the well casing.

Water level measurements can be obtained using an electric water level indicator, popper, or pressure transducer. Steel tape, coated with chalk or water sensitive paste although very accurate, is a slower method of obtaining water levels and is generally not recommended for use due to the frequency at which water levels need to be taken during the performance of a slug test.

The following data shall be recorded when performing slug tests in wells or borings:

- Well/boring ID number
- Total depth of well/boring
- Screened/open interval depth and length
- Gravel pack interval depth and length
- Well and boring radii
- Well stickup above ground surface
- Gravel pack radius
- Static water level
- Aquifer thickness
- Depth to confining layer
- Time/recovery data
- Gravel pack porosity

A variation of the slug test is a test in which water is added to the well at a measured rate sufficient to maintain the water level in the well at a constant height above the static water level, and is called a constant-head test. Once a stable elevated water level has been achieved, discharge (pumping) rate measurements shall be recorded in place of time/recovery data for approximately 10 to 20 minutes, then the hydraulic conductivity calculated from this. This type of test is generally not recommended for monitoring wells as large volumes of water may be introduced into the screened formation, potentially impacting later sampling events.

## 5.2 IN-SITU HYDRAULIC CONDUCTIVITY TESTING IN BORINGS

Slug tests can be performed in borings while the boring is being advanced. This permits testing of formations at different depths throughout the drilling process. Boreholes to be tested shall be drilled using casing, so that discrete depths may be investigated. Various tests and testing methods are described below. The most appropriate test and testing method to be used in a situation varies with drilling, geologic, and general site conditions and shall be selected after a careful evaluation of the above factors.

Rising head or falling head slug tests can be performed in saturated and unsaturated formations during drilling. There are two ways that the tests can be performed. One way entails setting the casing flush with the bottom of the boring when the desired testing depth has been reached. The hole is then cleaned out to remove loose materials, the drill bit and rods are carefully withdrawn from the boring, and a few feet of sand (of higher permeability than the surrounding formation) is added to the bottom of the boring. After the water level in the boring has stabilized (for saturated formations), the static water level shall be measured and recorded. The water level shall then be raised (falling head test) or lowered (rising head test) and the change in water level measured at time intervals as determined by the field hydrogeologist. Only falling head tests can be performed for depth intervals within the unsaturated (vadose) zone. As described for wells, time intervals for water-level measurements will vary according to the formation's hydraulic conductivity. The faster the rate

of recovery expected, the shorter the time intervals between measurements shall be. A predetermined pattern of time intervals shall be used during each test. The rate of change of water level will be used to calculate hydraulic conductivity. The test shall be conducted until the water level again stabilizes, or for a minimum of 20 minutes. In low permeability formations, it is not always practical to run the test until the water level stabilizes, as it may take a long time to do so. The top of the casing shall be used as the reference point for all water level measurements.

The second method consists of placing a temporary well with a short screen into the cleaned out boring, pulling the drilling casing back to expose the screen, allowing the formation to collapse around the screen (or placing a sand/gravel pack around the screen), and performing the appropriate hydraulic conductivity test in the well, as described for the first method. Again, the test shall be conducted until the water level stabilizes or for a minimum of 20 minutes. this method allows for testing a larger section of the formation and results in more reliable hydraulic conductivity estimates.

Constant head tests may also be performed in borings. As described for monitoring wells, once a stable elevated level has been achieved, the discharge rate into the boring is measured for a period of time, usually 10 to 20 minutes, and the hydraulic conductivity calculated from this. This method is the most accurate method depicted in this section and shall be given preference over others if the materials are available to perform the test and the addition of water to the boring does not adversely impact project objectives. Once the test is over, additional information can be gathered by measuring the rate of the drop in water level in the boring (for saturated formations). A limitation of the test is that foreign water is introduced into the formation which must be removed from the well area by natural or artificial means before a representative groundwater sample can be obtained.

Detailed descriptions regarding the performance of borehole hydraulic conductivity tests and subsequent data analysis techniques are provided in Ground Water Manual (1981).

## 5.3 DATA ANALYSIS

There are a number of data analysis methods available for use to reduce and evaluate slug testing data. The determination of which method is most appropriate shall be made based on the testing conditions (including physical setup of the well/boring tested, hydrogeologic conditions, and testing methodology) and the limitations of each test analysis method. Well construction details, aquifer type (confined or unconfined), and screened/open interval (fully or partially penetrating the aquifer) shall be taken into account in selecting an analysis method. Cooper, et al. (1967), and Papadapulos, et al. (1973), have developed test interpretation procedures for fully penetrating wells in confined aquifers. Hvorslev (1951) developed a relatively simple analytical procedure for point piezometers in an infinite isotropic medium. In Cedergren (1967), Hvorslev presents a number of analytical procedures which cover a wide variety of hydrogeologic conditions, testing procedures, and well/boring/ piezometer configurations. Bouwer and Rice (1976) developed an analytical technique applicable to both unconfined and confined conditions, factors in partial/full penetration, and discusses well screen gravel pack considerations. The Ground Water Manual (1981) presents a number of testing and test analysis procedures for wells and borings open above or below the water table, and for both falling-head and constant-head tests. The methods described above do not represent a complete listing of test analysis methods available, but are some of the more commonly used and accepted methods. Other methods can be used, at the discretion of the project hydrogeologist.

One consideration to be noted during data analysis is the determination of the screened/open interval of a tested well. If a well with a fully submerged screen is installed in a relatively low permeability formation, and a gravel pack which is significantly more permeable is installed around the screen, the length of the gravel pack (if longer than the screened interval) may be used as the

screened/open length, rather than the screen length itself. In situations where the formation permeability is judged to be comparable to the gravel pack permeability (within about an order of magnitude) this adjustment is not required.

All data analysis applications and calculations shall be reviewed by technical personnel thoroughly familiar with testing and test analysis procedures. Upon approval of the calculations and results, the calculation sheets shall be initialed and dated by the reviewer. Distribution copies shall be supplied to appropriate project personnel and the original copy stored in the project file.

## 6.0 REFERENCES

Cedergren, H. R., 1967. Seepage, Drainage, and Flow Nets. John Wiley and Sons Inc., New York, pp. 78-76.

Cooper, H. H., Jr., J. D. Bredehoeft, and I. S. Papadopulos, 1967. Response of a Finite-Diameter Well to an Instantaneous Change of Water. Water Resources Research, V. 3, No. 1, pp. 263-269.

Hvorslev, M. J., 1951. Time Lag and Soil Permeability in Ground Water Observations. U.S. Army Corps of Engineers, Waterways Experiment Station, Washington, D.C., Bull. No. 36.

Papadopulos, I. S., J. D. Bredehoeft, and H. H. Cooper, 1973. On the Analysis of Slug Test Data. Water Resources Research, V. 9, No. 4, pp. 1087-1089.

Bouwer, H. and R. C. Rice, 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research, 12:423-28.

United States Department of the Interior, 1981. Ground Water Manual. U.S. Government Printing Office, Denver, Colorado.

## 7.0 RECORDS

Field data shall be recorded on the data sheet included as Attachment A*. Any notes regarding testing procedures, problems encountered, and general observations not included on the data sheet shall be noted in the field logbook. The boring log and well construction diagrams for each well/boring tested shall be used as references during testing and data analysis activities. Original data sheets shall be placed in the project file, along with the field logbook.

* If an automated data recorder is used, the data may be displayed using the printer output from the unit. Such printouts should be annoted to include the relevant data form, or attached to the form shown as Attachment A.

## ATTACHMENT A
## HYDRUALIC CONDUCTIVITY TESTING DATA SHEET

***HYDRAULIC CONDUCTIVITY TESTING DATA SHEET*** ***NUS CORPORATION***

PROJECT NAME: ..... WELL/BORING NO.: .....
PROJECT NO.: ..... GEOLOGIST: .....
WELL DIAMETER: ..... SCREEN LENGTH/DEPTH: ..... TEST NO.: .....
STATIC WATER LEVEL (Depth/Elevation): ...../..... DATE: .....
TEST TYPE (Rising/Falling/Constant Head): ..... CHECKED: .....
METHOD OF INDUCING WATER LEVEL CHANGE: ..... PAGE ___ OF ___

| TIME | ELAPSED TIME (min. or sec.) | MEASURED DEPTH TO WATER (ft.) | CORRECTION | DEPTH TO WATER (ft.) | DRAWDOWN OR HEAD (ft.) | REMARKS |
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Rev 3/88

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number GH-3.1 | Page 1 of 16 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 1 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject RESISTIVITY AND ELECTROMAGNETIC INDUCTION | | Approved D. Senovich | |

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7.0 RECORDS

## 1.0 PURPOSE

The purpose of this guideline is to provide a general description of, and technical management guidance on, the use of Resistivity and Electromagnetic Induction (Ground Conductivity) surveys during hazardous waste site investigations.

## 2.0 SCOPE

This guideline provides a description of the principles of operation, instrumentation, applicability, and implementability of geophysical methods used during hazardous waste site investigations to determine subsurface resistivity or conductivity. Measurements of subsurface conductivity or resistivity can be used to determine the presence and approximate extent of subsurface contaminants, buried drums and metal containers. In addition, the depth to the water table, and structural characteristics of the subsurface environment can be determined.

The document is intended to help develop an understanding of each method sufficient to permit work planning and scheduling, resource planning, subcontractor procurement and evaluation, and manipulation and use of the technical data during remedial investigations and feasibility studies. This guidance is not intended to provide a detailed description of methodology and operation. The highly specialized nature of the methods requires inclusion of project-specific, site-specific, and subcontractor-specific information prior to development of detailed operating procedures. Specialized expertise during both planning and execution of these geophysical methods is also required.

The description focuses on methods and equipment that are readily available and typically applied; it is not intended to provide a complete discussion of the state-of-the art.

## 3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Resistivity - Intrinsic property of a substance, equal to the resistance of a body multiplied by its cross-sectional area and divided by its length.

Resistivity Survey - A geophysical exploration method whereby an electrical current is transmitted into the ground and the resultant potential field is measured to deduce the apparent subsurface resistivity.

Potential - Intrinsic property of electrical fields, equating to the ability to do work. A potential field can induce a potential difference (voltage) between two electrodes.

Current - The quantity of charge transmitted per unit time.

Conductivity - Intrinsic property of a substance, equal to the reciprocal of resistivity.

Apparent Resistivity - The quantity actually deduced during a resistivity survey; proportional to the actual resistivities of subsurface materials.

Apparent Conductivity - The quantity measured during an electromagnetic induction survey; proportional to the actual conductivities of subsurface materials.

## 4.0 RESPONSIBILITIES

Site Manager - responsible for the scoping of geophysical surveys during development of the Work Plan, with the help of the RI leader, site geologist, and site geophysicist.

Site Geophysicist - as a specialist in this field, the site geophysicist plays a central role in determining the appropriateness of these techniques for providing necessary data. Field work for these surveys is supervised by the site geophysicist.

## 5.0 PROCEDURES

### 5.1 ELECTROMAGNETICS

The electromagnetic induction (EM) method provides a means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Electrical conductivity is a function of the type of soil and rock, its porosity, its permeability, and the fluid composition and saturation. In most cases the conductivity of the pore fluids will be responsible for the measurement. Accordingly, the EM method applies both to assessment of natural geohydrologic conditions and to mapping of many types of contaminant plumes. In addition, trench boundaries, buried wastes, drums, and utility lines can be located with EM techniques.

#### 5.1.1 Applicability

Although EM is not a definitive technique, it is useful for several reasons. First, an EM survey can be conducted over an entire site very quickly. In addition, EM methods are generally inexpensive, even for coverage of large areas. Often, 100 acres or more may be surveyed in just a few days time (depending on desired detail). More importantly, EM data can be used to direct the more expensive phases of an investigative project, potentially resulting in a large cost savings. For example, rather than drilling several dozen monitoring wells while searching for groundwater contamination, an EM conductivity unit may be used to survey for a conductive (or resistive) plume. Several EM survey lines may be run to provide definition of the plume and an indication of its source area, reducing the number of exploratory wells required. This approach could potentially result in better well placement at a cost savings. Another reason why EM should be considered is to fill in data gaps and to reduce the risk of missing a facet of the investigation, such as the presence of undetected refuse trenches, buried drums, or changing hydrologic conditions.

Electromagnetic methods may be used in many situations for a variety of purposes. The following list includes major uses related to investigations of hazardous waste sites:

- Defining the location of a contaminant plume (This could lead to the identification of downgradient receptors, source areas, and flow directions if the conductivity of the plume (target) is distinct in comparison to the host (background), hydrogeologic setting.)

- Locating buried metal objects (e.g., drums, tanks, pipelines, cables, monitoring wells).

- Addressing the presence or location of bedrock fault/fracture systems (This is important for identification of preferential pathways of water flow in bedrock.)
- Mapping grain size distributions in unconsolidated sediments.
- Mapping buried trenches.
- Defining lithological (unit) boundaries.
- Determining the rate of plume movements by conducting multiple surveys over time.

The above list is only partial; in fact, EM methods may be used wherever a significant change in conductance can be measured. EM should be considered for use when a suspected target is anticipated to have a conductivity significantly different from background values. Factors such as cost, site-specific conditions, and equipment availability should also be evaluated before deciding to proceed with an EM survey.

### 5.1.2 General

**Objectives**

The geophysicist should evaluate the objectives of the site investigation in light of EM capabilities. If the purpose of the site study is to confirm the presence of contaminants with minimal effort, EM methods may provide too much detail and no direct evidence; direct methods, such as installing monitoring wells with limited sampling, may be more suitable. If a site is to be characterized in detail and if assessment of geohydrologic conditions and identification of all source areas, plumes, and receptors are a priority, then EM (and other geophysical methods) may be a cost-effective way of selecting strategic locations for monitoring wells, directing test pit operations, efficiently selecting sampling points, and providing information between site sampling points.

**Existing Data**

If EM equipment is identified as capable of providing the type of information desired, the user should further evaluate the equipment to determine whether it is appropriate for use under the conditions found at a particular site. Evaluation of existing data can identify problems that may be encountered in the field:

- Variations in geohydrologic conditions (e.g., varied water table conditions or changes in rock or sediment) can result in a conductivity range that envelopes the response of the target (e.g., plume) and effectively masks or blocks out any signals.
- Scattered, near-surface metal may mask buried targets such as drums or trenches.
- Near-surface layers of extreme conductivity (high or low) such as a clay lens or surficial frost zone may mask the signal from a deeper target.

An analysis of the site history might more closely define a survey area, thereby cutting survey costs by reducing the size of the survey. Deep targets may be out of the penetration range of many EM units, and specialized equipment may be required. It is difficult for EM systems to detect a groundwater contaminant plume through 100 feet of unsaturated overburden. A site reconnaissance should be conducted to identify other site conditions that may affect the data. Drastic topography changes can

affect the quality of EM data obtained with some systems, and this possibility should be considered at each site.

### 5.1.3 Survey Design

Once the EM survey objectives have been defined, existing information has been reviewed, and reconnaissance of the site has been conducted, attention should be given to the design of the geophysical survey. The detail required of an EM survey is a primary factor in designing and planning fieldwork. If the purpose of performing EM work onsite is to define a large geologic feature, then a grid using a wide (100- to 1,000-foot) line spacing may be needed. Some instruments are capable of providing a continuous data profile, which makes it less likely to miss small conductors than the typical discrete measurement EM instruments. The importance of designing and implementing a grid system tied into existing "permanent" features (such as roads and buildings) cannot be overstated. This permanent feature will allow the grid to be reoccupied in the field to place drill holes and monitoring wells. Furthermore, additional surveys may be conducted on the site using other geophysical techniques or the same technique to provide an indication of plume movement. These surveys will help in orienting maps and diagrams that are produced later and in defining targets.

**Background Noise**

Background noise can be a significant factor in the success of an EM survey. Evaluation of existing data and a site reconnaissance will help to identify the probable background noise level. A high noise level can make interpretation difficult and may actually cause an anomaly to be overlooked. It is difficult to delineate a conductive contaminant plume contained in overburden that has a wide natural variation in conductivity.

Noise sources can be divided into two groups: (1) natural, such as changing grain size distributions, steeply dipping strata, undetected mafic dikes, Karstic topography, unexpected fault zones; and (2) cultural, such as power lines, houses, railroads, surface metal debris, cars, and radio transmission towers. Some instruments are more sensitive to certain types of noise sources than others. Because there is little published information on this subject, experience is important.

**Limitations**

All EM instruments have varying limitations with regard to sensitivity and penetration. Published references, operator's manuals, and field experience should be used to evaluate instrumentation versus capability. Table GH-3.1-1 lists several commercially available instruments along with factors that control their productivity.

**Instrumentation**

Table GH-3.1-2 provides guidance for EM equipment selection. These instruments may not be suitable to specific site conditions and investigation objectives. The decision to use a specific instrument is dependent upon site factors.

Electromagnetic techniques have also been adapted for downhole applications. These techniques can be useful in defining the vertical extent of a contaminant zone. Some systems work inside polyvinyl chloride (PVC) or Teflon monitoring well casings. Table GH-3.1-3 compares some of the more common EM systems.

**TABLE GH-3.1-1**

**FACTORS CONTROLLING PRODUCTIVITY OF SOME COMMONN EM UNITS**

| Instrument | Manufacturer | No. Operators | Typical Daily Line Miles (50-ft readings) | Notes |
|---|---|---|---|---|
| EM-16-R | Geonics | 2 | 2 | 2 |
| EM-16 | Geonics | 1 | 3-4 | 2 |
| EM-31-D | Geonics | 1 or 2 | 3 | 2 |
| EM-34-3 | Geonics | 2 | 2 | 2 |
| VLF-3 | Scintrex | 1 | 3 | 2 |
| Genie (SE-88) | Scintrex | 2 | N/A | 1 |
| Radem-VLF | Crone | 1 | 3-4 | 2 |
| CEM | Crone | 2 | 2 | 1 |
| Max Min II | Apex | 2 | 3 | 1 |
| EM-38 | Geonics | 1 | 3 | 2 |

Notes:

(1) Primarily useful for geologic features only.
(2) Useful for geological and cultural features.

Designations such as ME-16 or EM-13 are the manufacturer's model numbers and do not imply equipment complexity or capability.

**TABLE GH-3.1-2**

**APPLICATION GUIDELINES FOR EQUIPMENT USE**

| Equipment Use | EM-16 | EM-16R | EM-31 | EM-34 |
|---|---|---|---|---|
| Locate single shallow buried drum | 3 | 3 | 1 | 3 |
| Locate many shallow buried drums | 2 | 3 | 1 | 2 |
| Locate single deep buried drum | 3 | 3 | 3 | 3 |
| Locate many deep buried drums | 2 | 3 | 2 | 2 |
| Define shallow fault zone | 1 | 2 | 2 | 2 |
| Define deep fault zone | 1 | 3 | 3 | 2 |
| Delineate shallow contaminant plume | 3 | 1 | 1 | 1 |
| Delineate deep contaminant plume | 3 | 1 | 2 | 1 |
| Locate shallow pipeline | 1 | 3 | 1 | 2 |

1. Good success rate.
2. Moderate success rate.
3. Poor success rate-not applicable.

Shallow is only several meters.
deep is several tens of meters.

Note: This table is based primarily on field experience. Designations such as EM-16 or EM-31 are the manufacturer's model numbers and do not imply equipment complexity or capability.

**TABLE GH-3.1-3**

**COMPARISON OF COMMON EM SYSTEMS**

| | VLF-3 | EM-16 | EM-31 | EM-34 | EM-38 |
|---|---|---|---|---|---|
| Operators | 1 | 1 or 2 | 2 | 2 | 1 |
| Typical penetration in saturated sands (meters) | 20-30 | 20-30 | less than 5 | see below | Less than 2 |
| Source (Tx) | Navigational signals continuously broadcast by U.S. Navy | | self-contained coil | self-contained coil | Self-contained coil |
| Receiver (Rx) | Entire is RX (2-anetennae) | | self-contained coil | self-contained coil | Self-contained coil |
| Frequency | Interchangeable Rx crystals 15-25 KHz | | 9.8 Khz | 10 meter 6.4 kHz<br>20 meter 1.6 kHz<br>40 meter 0.4 kHz | 13.2 kHz |
| Tx-Rx spacing | Unlimited | | 3.6 meters | 10,20,40 meters | 1 meter |
| Notes | Receives only specified frequencies Will not read most noise. Penetration depends on formation resistivity. Maximum penetration is over 100 meters. | | Continuous reading with a strip chart recorder. Can be used as a horizontal or vertical dipole for control of penetration. | Penetration varies with coil separation and with orientation. Maximum penetration is 50 meters. | Lightweight. |

## 5.2 ELECTRICAL RESISTIVITY

Electrical resistivity surveys provide information about the subsurface distribution of the ground resistivity. The information can be used to infer groundwater quality, lithologic, and geologic information. Both horizontal and vertical changes in ground resistivity can be mapped by resistivity surveys. In practice, resistivity surveys are mostly used to determine the vertical resistivity changes. Lateral resistivity changes are more easily mapped by electromagnetic surveys.

### 5.2.1 Applicability

Electrical resistivity (ER) data are subject to interpretation; therefore, ER field results should be checked periodically and confirmed by direct methods, such as sampling or drilling.

Although ER is not a definitive technique, the data are useful for several reasons. Typical productivity with conventional resistivity equipment is several thousand line-feet per day. This high productivity rate allows a large amount of useful data to be collected in a relatively short period of time. For example, rather than drilling several dozen monitoring wells or test borings to develop a complete picture of the site stratigraphy and structure, a few wells can be drilled (for control) and information about the rest of the site can be obtained by using resistivity methods. Method integration such as this can reduce the amount of time and the costs required for a project.

Resistivity methods may be used in a wide array of situations and for a variety of purposes. The following is a partial list of major uses related to investigations of hazardous waste sites:

- Definition of a contaminant plume. (This could lead to the identification of downgradient receptors and source areas.)
- Waste pit delineation.
- Definition of bedrock fault/fracture systems.
- Water table mapping (for contour maps).
- Stratigraphic mapping of soil layers (particularly useful in overburden, discriminating clays from sands and establishing their thicknesses).
- Defining bedrock topography (valleys).

Resistivity methods may be used whenever the feature to be mapped has a contrasting resistivity with the background material.

### 5.2.2 General

Electrodes are typically arranged in one of several patterns, called electrode arrays, depending on the desired information. Electrical resistivity techniques can determine the vertical subsurface resistivity distribution beneath a point. In this type of survey, called vertical electrical soundings, the electrode array is expanded systematically and symmetrically about a point. For each set of electrode spacings, apparent resistivity is determined from measurements of potential and input current. The resultant plot of apparent resistivity versus electrode spacing is interpreted to provide the subsurface resistivity with depth distribution at that one particular point. Examples of three common arrays are given in Figure GH-3.1. The Wenner and Schlumberger arrays are somewhat more common than the Dipole-Dipole and other arrays. These arrays (Wenner, Schlumberger) start with a small electrode spacing that is increased to permit deeper penetration for sounding.

The manner in which the apparent resistivity changes with the electrode separation can be used to determine formation conductivity and layer thickness. To increase accuracy, the user should evaluate the interpretation of resistivity data against the existing subsurface information. With any set of apparent resistivity readings, a number of solutions are possible, so existing data must be used to select the one that fits best. A formation resistivity may be assigned, but without geological control the material is not known. Resistivity electrode arrays can also be used with constant inner-electrode spacing to develop a lateral picture of the site through profiles. Stratigraphic control is even more important when mapping lateral changes with constant electrode spacings, because layer thickness changes alone can cause changes in apparent resistivity. The desired resolution is a major factor in deciding how closely to space measurements for a given survey.

In practical application, a resistivity survey target (such as a plume or clay lens) should have a resistivity contrast (positive or negative) 20 percent from background. This change in resistivity should be 50 percent or more to provide proper detection and delineation. For example, if a resistivity survey were being conducted to delineate a groundwater contaminant plume (in overburden) with a resistivity of 200 ohm-meters, a background, saturated overburden resistivity of over 400 ohm-meters (for a conductive plume) or under 100 ohm-meters (for a resistive plume) would probably be detected, providing other factors (such as depth) are not detrimental.

When depth sounding, resolution of individual layers has an accuracy generally around 20 percent; accuracy can be substantially more or less depending on the site conditions and operator expertise. Vertical resistivity sounding is usually less accurate than seismic refraction work, which is often conducted within a 10 percent error tolerance. However, geologic units may be distinguishable (by geophysics) only with the use of resistivity methods at some sites.

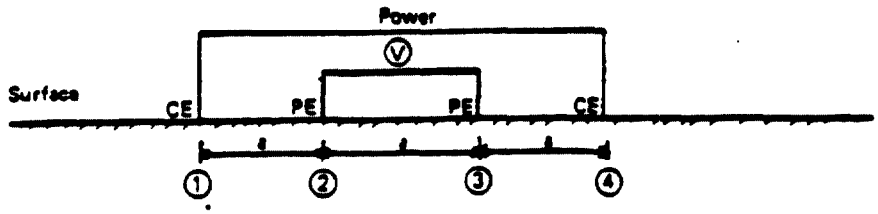
### 5.2.3 Survey Design

Data can be collected at randomly located stations or along survey lines. If vertical electrical soundings are performed to obtain resistivity changes with depth, then the soundings are positioned where the information is most useful. If measurements are made to map lateral resistivity changes, then the soundings are positioned where the information is most useful. If measurements are made to map lateral resistivity changes, then the survey is best performed on a grid or on survey lines. The station spacing will be determined form the target size.

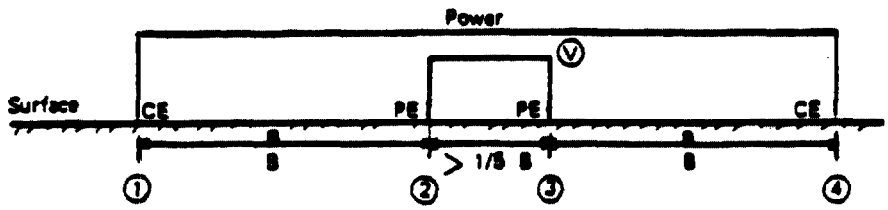
## FIGURE GH-3.1

## EXAMPLES OF COMMON ER ARRAYS

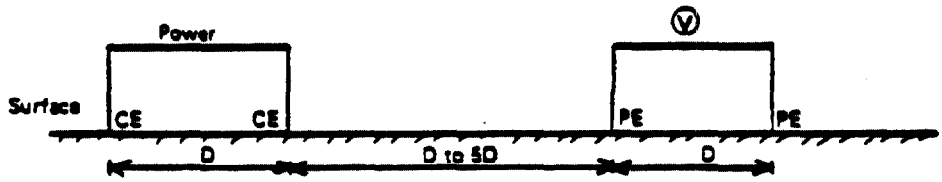
### WENNER ARRAY




### SCHLUMBERGER ARRAY




### DIPOLE-DIPOLE ARRAY




1 Electode Number
PE Potential Electrode
CE Current Electrode
V Voltmeter

SOURCE: Based in part on W. M. Telford et al., Applied Geophysics, 1976, and R. E. Sheriff, Encyclopedic Dictionary of Exploration Geophysics, 1984.

**Background Noise**

Evaluation of existing data and a site reconnaissance will help to identify the possible background noise level. A high noise level can make interpretation difficult and may mask an anomaly. It would be difficult to delineate a slightly conductive contaminant plume contained in overburden that has wide natural variations in conductivity. Noise sources can be divided into two groups: natural, such as discontinuous clay layers, undetected mafic dikes, Karstic topography, unexpected fault zones, variable water table, and lightning; and cultural, such as power lines, railroad tracks, and radio transmission towers. Since there is little published information on instrument noise sensitivity, experience is important.

**Depth of Investigation**

As a rule of thumb when lateral resistivity is being conducted , the array should be spaced four or five times the distance from the ground surface down to the desired target. For vertical sounding, this suggested spacing should be about ten times the anticipated target depth. These suggestions should be used only as general guidance.

### 5.2.4 Miscellaneous Considerations

**Instrumentation**

For most shallow work at hazardous waste sites, most resistivity systems will suffice. Generally, equipment capability becomes important only when the desired investigative depth exceeds 70 to 100 feet. Larger power sources are needed to provide a measurable electrical potential with a wider electrode spacing. Some newer resistivity units are capable of electronic data storage, and other features. Often, the peripheral capabilities of an ER system may be the deciding factor when purchase is considered.

Borehole resistivity equipment has been used (in uncased boreholes) to determine relative formation porosity and other factors. For more information on this equipment, the reader should refer to the borehole geophysics subsection of this compendium.

**Calibration**

ER equipment requires calibration, either in the field or in the laboratory; dated records of this calibration should be kept in the equipment management file and in the appropriate project file. Calibration is used to establish the reliability and accuracy of the equipment; calibration typically includes an internal circuit check or actual field trials (e.g., tests over a known target). Equipment that historically exhibits fluctuations in calibration should not be used. The equipment serial number should be recorded on the calibration records. If the manufacturer recalls equipment, this fact should be explained and documented for instrument maintenance in the proper file. The current source and potentiometer must be calibrated on any type of resistivity equipment. The instrument's current source may be calibrated by placing a reference ammeter in series with the electrode cables. The reading obtained on the reference ammeter is compared with the value read from the instrument's current source ammeter. The current source ammeter is then adjusted accordingly.

The potentiometer is calibrated by either of two methods. The preferred field method, which is similar to the calibration of the current source, is done by comparing the instrument's indicated potential to that potential measured with an independent voltmeter. An alternative means of calibration,which can be performed in the laboratory, involves placing a precision resistor of a known

value in series with the current load. A potentiometer is then placed across the resistor. The potential measured should be equal to the product of the known resistance and indicated current.

**Data Reduction**

The raw data are the measured potential produced by a known current. To calculate the P (apparent resistivity), these known quantities are used. The electrode configuration is also used in the determination of apparent resistivity, which is defined by:

$$Papp = (2\pi \times V/I) / (1/r_1 - 1/r_2 - 1/R_1 + 1/R_2)$$

where:

V = The circuit potential (voltage)
I = Applied current (amperage)
$r_1$ = Distance between electrode #1 and #2 (meters)
$r_2$ = Distance between electrode #2 and #4 (meters)
$R_1$ = Distance between electrode #1 and #3 (meters)
$R_2$ = Distance between electrode #3 and #4 (meters)
Papp = Apparent resistivity

Apparent resistivity is the resistivity measured at the ground surface and usually has units of ohm-meters or ohm-feet. The apparent resistivity is a function of the distribution of actual ground resistivities and the electrode geometry. Interpretation and reduction of the resistivity sounding are very specialized and are beyond the scope of this guideline; interpretation and reduction often involve curve matching or computer analysis. For further information, the reader should refer to the references listed in Section 6, particularly Zohdy (1975).

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Grant, F. S., and G. F. West. Interpretation Theory in Applied Geophysics. McGraw-Hill Book Company. 1955.

Griffiths, D. H., and R. F. King. Applied Geophysics for Geologists and Engineers. Pergamon Press. 1981.

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Telford, W. M., L. P. Geldard, R. E. Sheriff, and D. A. Kays. Applied Geophysics. Cambridge University Press.

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### 6.1.2 EM General Manuals

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Rudy, R. J., and J. A. Caoile. "Utilization of Shallow Geophysical Sensing at Two Abandoned Municipal/Industrial Waste Landfills on the Missouri River Floodplain." Ground Water Monitoring Review. Fall issue, 1984.

Slaine, D. D., and J. P. Greenhouse. "Case Studies of Geophysical Contaminant Mapping at Several Waste Disposal Sites." Presented at the NWWA Second National Symposium on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. 1982.

Steward, M. T. "Evaluation of Electromagnetic Methods for Rapid Mapping of Salt-Water Interfaces in Coastal Aquifers." Groundwater, Vol. 20. September-October 1982.

### 6.1.3 Manufacturers

Aerodat Limited
3883 Nashua Drive
Mississauga, Ontario L5V 1R3
416/671-2446 (airborne EM systems)

Crone Geophysics Limited
3607 Wolfedale Road
Mississauga, Ontario L5C 1V8
416/270-0096 (surface EM systems)

Geonics Limited
1745 Meyerside Drive
Mississauga, Ontario L5T 1C5
416/676-9580 (borehole and surface EM systems)

Phoenix Geophysics Limited
200 Yorkland Boulevard
Willowdale, Ontario M2J 1R5
416/493-6350 (surface EM systems)

Scintrex
222 Snidercroft Road
Concord, Ontario L4K 1B5
416/669-2280 (surface EM systems)

## 6.2 ELECTRICAL RESISTIVITY

### 6.2.1 Electrical Resistivity (ER) Theory and Interpretation Textbooks

Griffith, D. H., and R. F. King. Applied Geophysics for Geologists and Engineers. Pergamon Press. 1981.

Grant, F. S., and F. G. West. Interpretation Theory in Applied Geophysics. McGraw-Hill. 1965.

Telford, W. M., et al. Applied Geophysics. Cambridge University Press. 1976.

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Technos, Incorporated. Application Guidelines for Selected Contemporary Techniques for Subsurface Investigations. (No publication date given.)

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Ringstad, C. A., and D. C. Bugenig. "Electrical Resistivity Studies to Delimit Zones of Acceptable Ground Water Quality." Ground Water Monitoring Review. Fall 1984.

Underwood, J. W., K. J. Laudon, and T. S. Laudon. "Seismic and Resistivity Investigations near Norway, Michigan." Ground Water Monitoring Review. Fall 1984.

### 6.2.5 Manufacturers

ABEM-Atlas Copco
Distributed by Geotronic Corp.
10317 McKalla Place
Austin, Texas 78758

Bison Instruments, Inc.
570-8 West 36th Street
Minneapolis, Minnesota 55416

BRGM-Syscal
Distributed by EDA Instruments
5151 Ward Road
Wheat Ridge, Colorado 80033

Phoenix Geophysics Limited
200 Yorkland Boulevard
Willowdale, Ontario M2J 1R5

Scintrex Limited
222 Snidercroft Road
Concord (Toronto), Ontario L4K 1B5

## 7.0 RECORDS

The following information will be recorded in the field log book.

- Date
- Equipment operators
- Name and project number of site
- Position and instrument readings
- Position specific information

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number HS-02 | Page 1 of 29 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 3 |
| | | Applicability EMG | |
| | | Prepared Health and Safety | |
| Subject DECONTAMINATION | | Approved D. Senovich | |

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- 5.4 CLOSURE OF CRC

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## 1.0 PURPOSE

To establish general decontamination procedures and guidelines for developing site and activity specific decontamination procedures.

## 2.0 SCOPE

Applies to all EMG activities where exposu: hazardous materials may occur.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Office Health and Safety Officer (OHSS) - The OHSS shall ensure that the site Health and Safety Officer (HSO) develops adequate decontamination procedures to prevent contamination of individuals or the environment beyond the exclusion zone.

Site Manager (SM) - The SM will ensure that sufficient information has been provided to the OHSS to prepare adequate decontamination procedures for inclusion in the site-specific Health and Safety Plan (HASP).

## 5.0 PROCEDURES

### 5.1 INTRODUCTION

Personnel responding to hazardous-substance incidents may become contaminated during the course of their work on a site. Protective clothing and respirators help prevent the wearer from becoming contaminated or inhaling contaminants, while good work practices help to reduce the contamination of protective clothing, instruments, and equipment.

Even with these safeguards, contamination may occur. Harmful materials can be transferred into clean areas, exposing unprotected personnel. In removing contaminated clothing, personnel may come in direct contact with and/or inhale the contaminants. To prevent such occurrences, contamination reduction and decontamination procedures must be developed and implemented. Such procedures must be in place before anyone enters a hazardous area and they must continue (modified as necessary) throughout the period of operation.

Decontamination involves physically removing contaminants and/or converting them chemically into innocuous substances. How extensive decontamination must be depends on a number of factors, the most important being the types of contaminants involved. The more harmful the contaminant, the more extensive and thorough decontamination must be. Combining decontamination, the correct donning of protective clothing, and the zoning of the site work areas minimizes cross-contamination from protective clothing to wearer, equipment to personnel, and one area to another. Only general guidance can be given on methods and techniques for decontamination. The exact procedure is determined by evaluating a number of factors specific to the incident.

The Health and Safety Officer (HSO) must exercise professional judgment in determining how the Contamination Reduction Corridor (CRC) will be organized and what decontaminants will be used. Factors that must be considered include: (1) the extent and type of hazard expected, (2) explosive

potential, (3) meteorological conditions, (4) topography, (5) levels of protection selected, and (6) availability of equipment and supplies.

## 5.2 PRELIMINARY CONCERNS

### 5.2.1 Initial Planning

The initial decontamination plan is based on the assumption that all personnel and equipment leaving the Exclusive Zone (area of potential contamination) are grossly contaminated. The plan includes a system for washing; rinsing; removal; and, when applicable; disposal of the protective clothing and equipment utilized. The washing and rinsing are done in combination with a sequential removal of equipment and clothing, starting at the first station with the most heavily contaminated article and progressing to the last station with the least contaminated article. Each piece of clothing or operation requires a separate decontamination station. These individual stations are to be spaced at about 3-foot intervals.

### 5.2.2 Contamination Avoidance

Contamination avoidance is the first and best method for preventing the transfer of contamination to personnel, or to uncontaminated areas. While planning site operations, methods are to be developed to prevent the contamination of personnel and equipment. Each person involved in site operations must regularly practice the basic methods, listed below, of contamination avoidance.

- Know the limitations of all protective equipment being used.
- Do not enter a contaminated area unless it is necessary to carry out a specific objective.
- When in a contaminated area, avoid touching anything unnecessarily.
- Walk around pools of liquids, discolored areas, or any area that shows evidence of possible contamination.
- Walk upwind of contamination, if possible.
- Do not sit or lean against anything in a contaminated area. In cases where you have to kneel (e.g., to take samples) use a plastic ground sheet.
- Before sampling any hazardous waste, read the label and manifest (if available) for all containers to determine as best you can the identity of the substance to be sampled and the potential contamination hazard. Be cautious - the label may not accurately reflect contents.
- While checking for waste contents, the field personnel should also check for potential incompatibility of wastes. These conditions might be caused by heat, fire, gas, and explosion; the contact of water and alkali metals; violent polymerization; or solubilization of toxic substances. Check waste containers for evidence of these conditions such as bulged drums, blistered paint, exploded drums, bubbles, dead vegetation, and melted or corroded surfaces.

- If at all possible, do not set sampling equipment directly on contaminated areas. Place equipment on a protective cover such as a ground cloth.

- Use the proper tools necessary to safely conduct the study.

In addition, it is necessary to plan for use of very specific methods to help reduce the potential for contamination transfer. For example, using remote sampling techniques, opening containers by nonmanual means, bagging monitoring instruments, using drum grapplers, watering down dusty areas, and avoiding areas of obvious contamination. All reduce the possibility of contamination and preclude a more elaborate decontamination procedure.

### 5.2.3 Site Organization

An area within the Contamination Reduction Zone (see Attachment A) is designated the Contamination Reduction Corridor (CRC). The CRC controls access into and out of the Exclusive Zone and confines personnel decontamination activities to a limited area. The size of the corridor depends on the wind direction (up or side wind), number of stations in the decontamination procedure, the overall dimension of work control zones, and the amount of space available at the site. A corridor of 75 feet by 15 feet should be adequate for the most extensive decontamination. Whenever possible, it should be a straight path.

The CRC boundaries must be conspicuously marked, with entry and exit restricted. The far end is the hotline -- the boundary between the Exclusion Zone and the Contamination Reduction Zone. Personnel exiting the Exclusion Zone must go through the CRC. Anyone in the CRC must be wearing the appropriate protection designated for the decontamination crew. Another corridor may be required for the entrance and exit of heavy equipment needing decontamination. Within the CRC, distinct areas are set aside for the decontamination of personnel, portable field equipment, removed clothing, etc. These areas must be marked and restricted to those personnel wearing the appropriate protection. All activities within the corridor are confined to decontamination. The level of decontamination must be spelled out in the Site Health and Safety Plan (HASP).

Protective clothing, respirators, monitoring equipment, sampling supplies, and other equipment are all maintained outside of the CRC. Personnel dress into their protective equipment away from the CRC and enter the Exclusion Zone through a separate access control point at the hotline.

## 5.3 DECONTAMINATION GUIDANCE

The protection selected for a site study and the specific pieces of clothing worn in the Exclusive Zone dictate the items required and layout to the decontamination line. Different degrees of protection present different situations with respect to the type of decontamination procedure required. Attachments B-1, B-2, and B-3 outline the decontamination line organization for standard levels of protection; A, B, and C respectively.

The reason for leaving the Exclusion Zone determines the need for and extent of decontamination. Also, the time required for personnel decontamination must be ascertained and incorporated in the scheduling of site activities. A worker leaving the Exclusion Zone to pick up or drop off tools or instruments and immediately returning may not require full decontamination. A worker leaving to get a new air cylinder or change a respirator or canisters, however, would require some degree of decontamination. Personnel wearing self-contained breathing apparatuses must leave their work areas with sufficient air to walk to the CRC and go through decontamination. Individuals departing the CRC at breaktime, lunchtime, or the end of the day must be thoroughly decontaminated.

The type of decontamination equipment, materials, and supplies are generally selected on the basis of availability. The ease of equipment decontamination and disposability is also considered. Most equipment and supplies can be easily procured. Soft-bristle scrub brushes or long-handled brushes are used to remove contaminants. Buckets of water or garden sprayers are used for rinsing. Large galvanized wash tubs, stock tanks, or children's wading pools can also be used as containers for wash and rinse solutions. Large plastic garbage cans or similar containers lined with plastic bags are useful for the storage of contaminated clothing and equipment, and metal or plastic cans or drums are convenient for the temporary storage of contaminated liquids. Other gear includes paper or cloth towels for drying protective clothing and equipment. Heavy equipment such as bulldozers, trucks, backhoes, and drilling equipment are difficult to decontaminate. The methodology generally employed involves washing the equipment on a sloped concrete or plastic covered pad with a soapy water solution followed by a thorough water rinse. The wash and rinse solutions are applied through the use of a high pressure spray unit. Particular attention should be given to tires, scoop, and other components which directly contact the contaminated areas. Wipe test should be employed to determine the effectiveness of the decontamination procedure. The wash water must also be collected for proper disposal unless expressly waived by the governing agency.

Protective equipment, sampling tools, and other equipment are usually decontaminated by scrubbing with detergent water using a soft-bristle brush followed by rinsing with copious amounts of water. While this process may not be fully effective in removing some contaminants (in some cases, the contaminants may react with water), it is a relatively safe option compared to the use of a decontamination solution. The contaminant must be identified before a decontamination chemical is selected for use, as reactions of such a chemical with unidentified substances or mixtures may present additional hazard potentials. A decontamination solution must be selected in consultation with an experienced chemist. Some suggested decontaminating solutions are outlined in Attachment C.

Once decontamination procedures have been established, all personnel requiring decontamination must be given precise instructions and practice moving through the decontamination line. Progress through the decontamination line must be deliberate, organized, and exceptionally thorough to minimize hazard potentials for personal exposures and contamination transfer.

Decontamination station detail for various protection levels are outlined in Attachment D.

## 5.4 CLOSURE OF CRC

When the CRC is no longer needed, it must be closed down by the operators. All disposable items used and generated during the operation must be double-bagged and either contained on the site or removed to an approved off-site disposal facility. Decontamination and rinse solutions may be discarded on site if approved by regulatory agencies. Otherwise, they must be removed to an approved disposal facility. Reusable rubber clothing should be dried and prepared for future use. If gross contamination had occurred, additional decontamination or disposal of these items may be required. Cloth items must be bagged and removed from the site for final cleaning or disposal. All wash tubs, pails, containers, etc., must be thoroughly washed, rinsed, and dried to removal from the site.

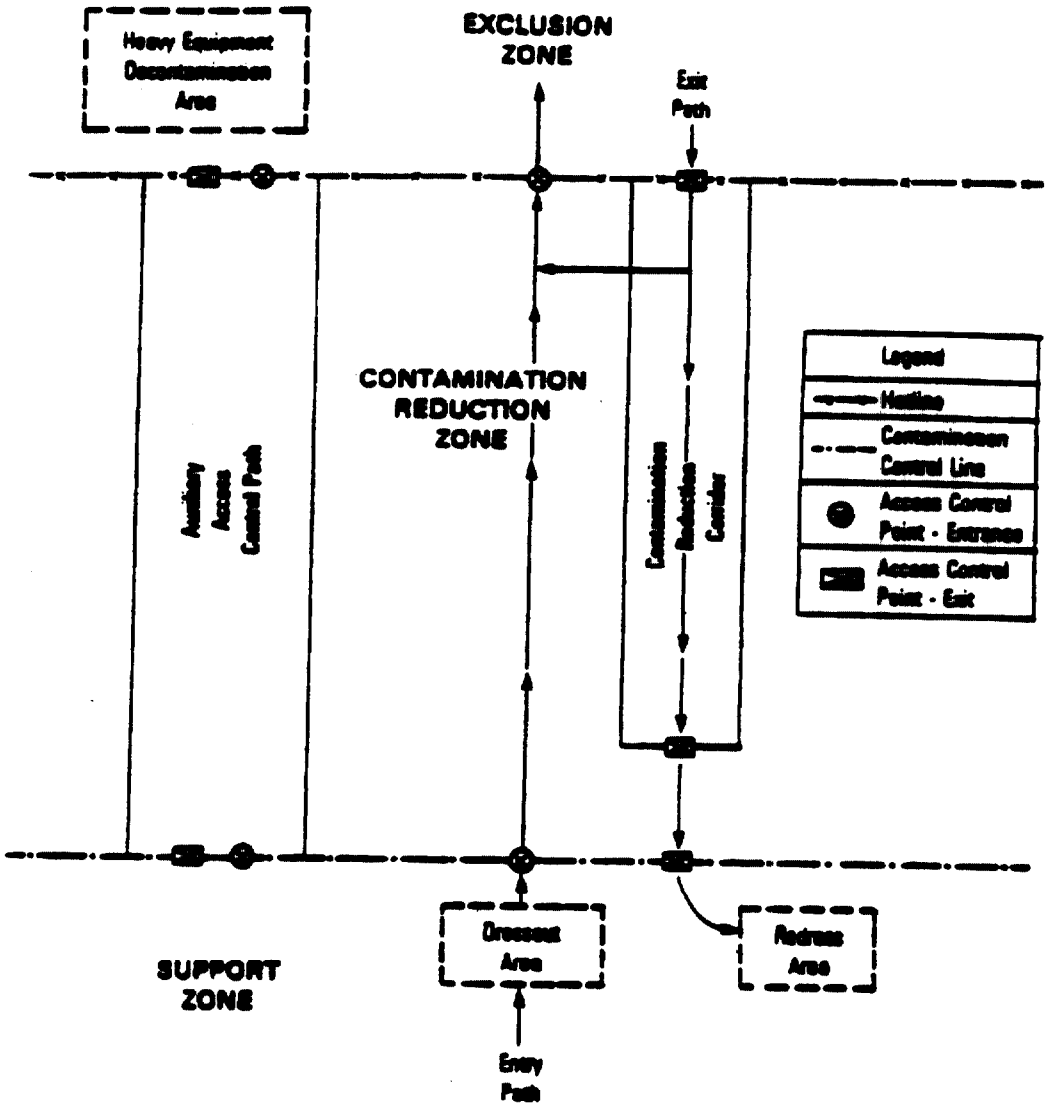
## 6.0 REFERENCES

None.

## 7.0 ATTACHMENTS

Attachment A - Contamination Reduction Zone Layout
Attachment B-1 - Decontamination Layout - Level A Protection
Attachment B-2 - DecontaminationLaytout - Level B Protection
Attachment B-3 - Decontamination Layout - Level C Protection
Attachment D - Suggested Decontaminating Solutions
Attachment D - Decontamination Station Detail (18 Sheets)

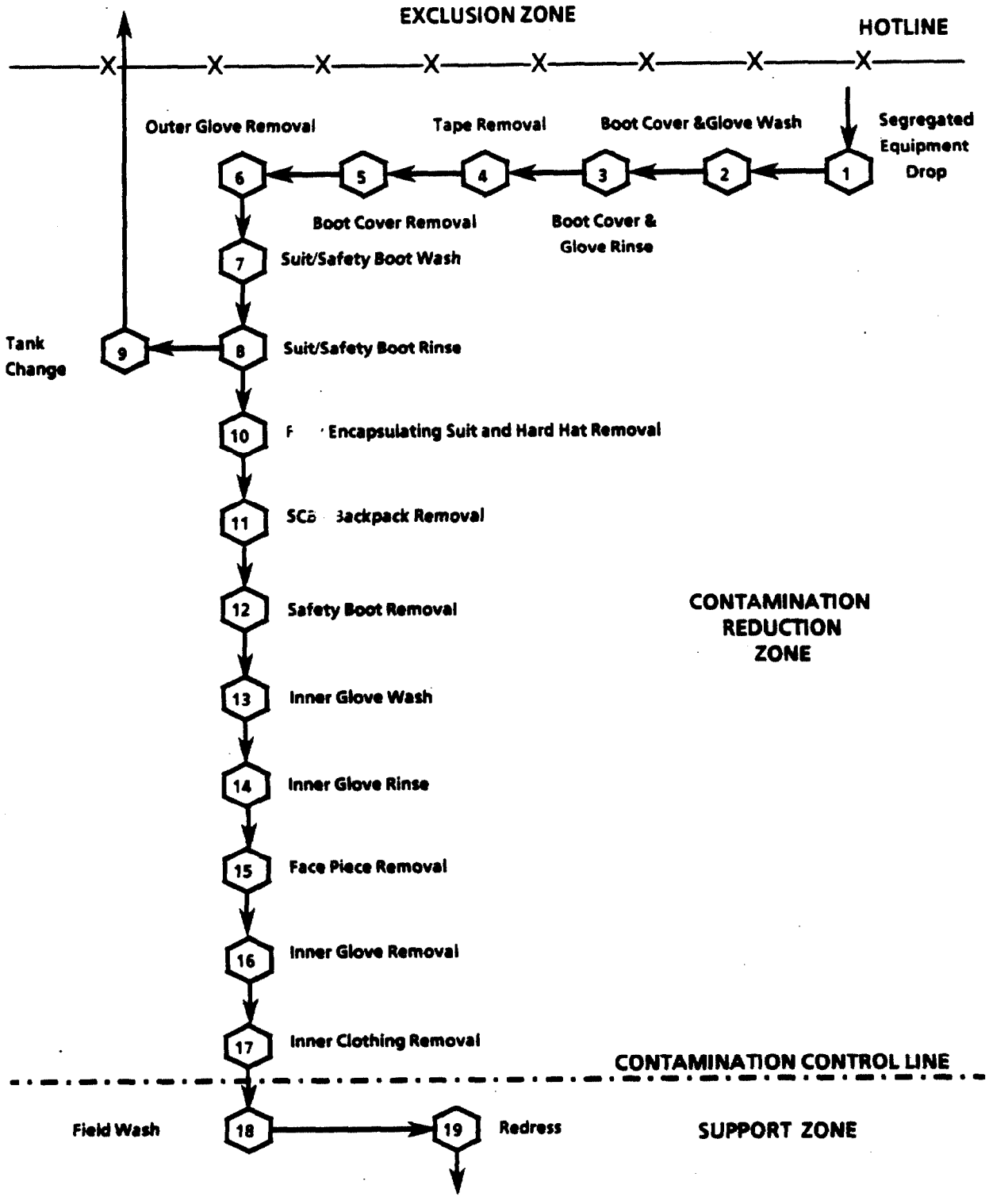
## ATTACHMENT A




**Contamination Reduction Zone Layout**

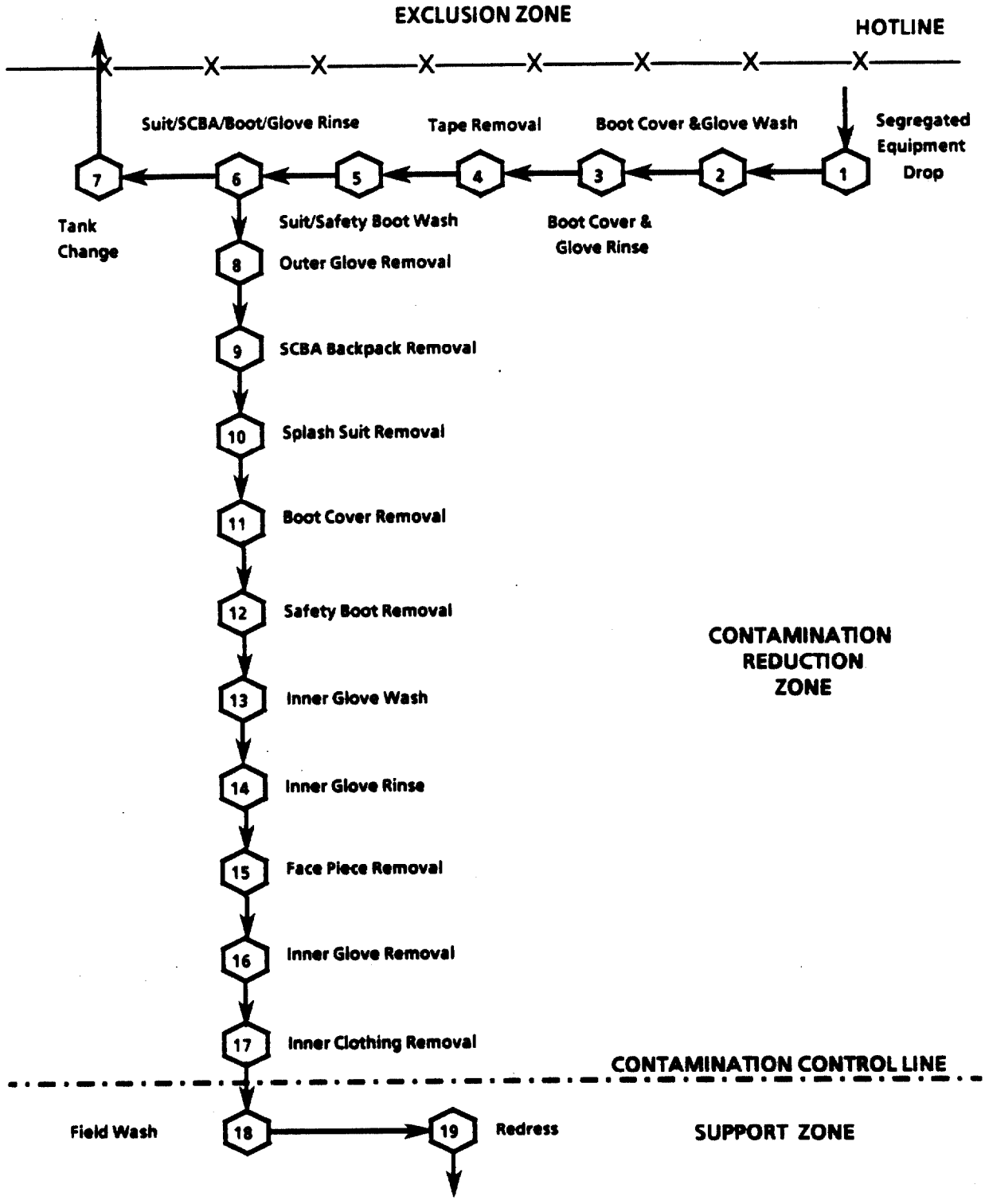
## ATTACHMENT B-1

## DECONTAMINATION LAYOUT - LEVEL A PROTECTION



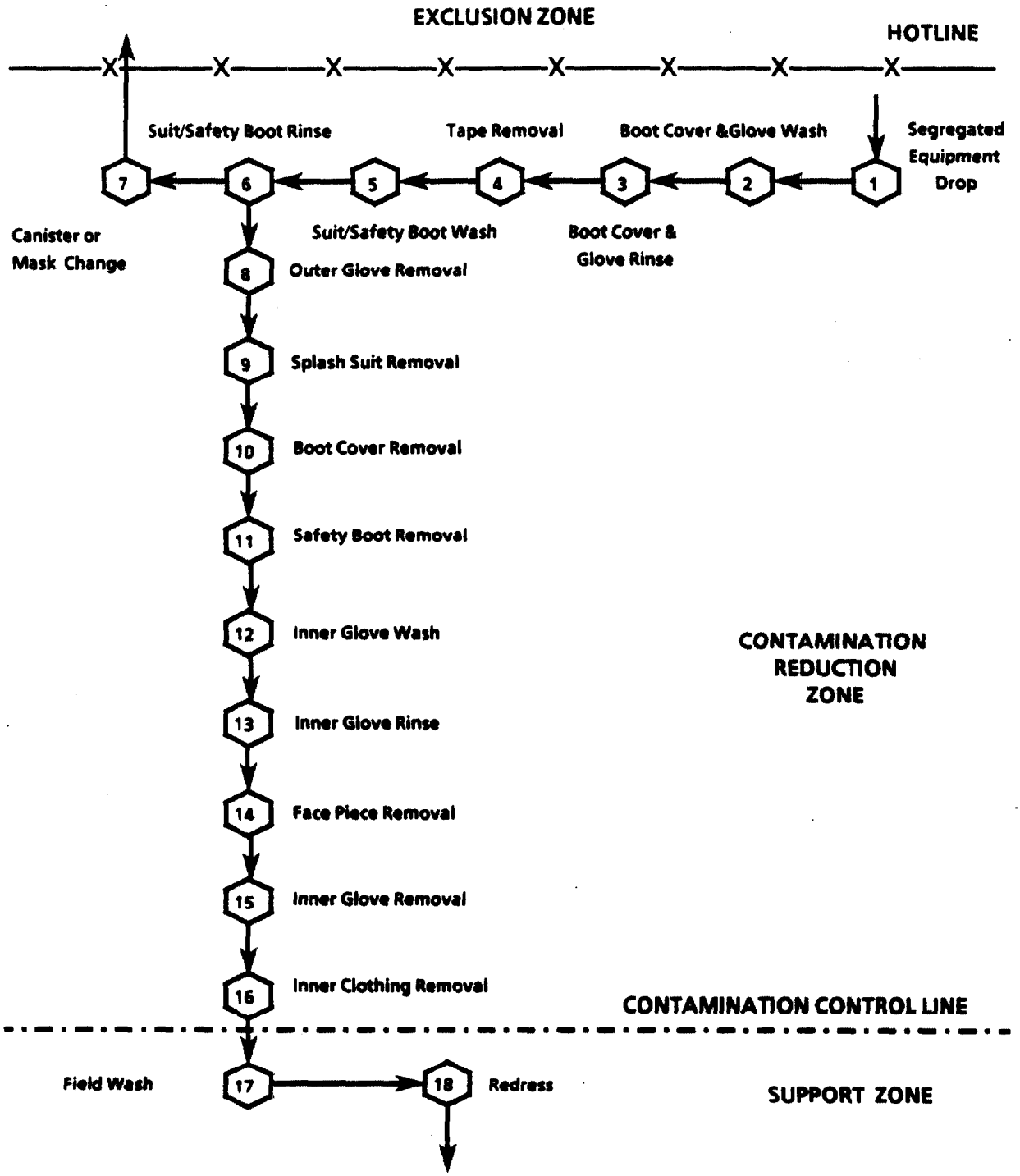
## ATTACHMENT B-2

## DECONTAMINATION LAYOUT - LEVEL B PROTECTION



## ATTACHMENT B-3

## DECONTAMINATION LAYOUT - LEVEL C PROTECTION



## ATTACHMENT C

## SUGGESTED DECONTAMINATING SOLUTIONS

| Decon Solution | Mixing Solutions | Uses/Remarks |
|---|---|---|
| A. An aqueous solution containing a low-sudsing detergent. | Follow the mixing instructions written on the particular product label. | Generally has the widest range of use. Best choice on sites where contaminants are unknown or a wide range of contaminants exists. |
| B. An aqueous solution containing 5% sodium carbonate ($NA_2CO_3$) washing soda. | To ten gallons of water, add four pounds of sodium carbonate. | Decon solution of choice for base labile compounds such as the organophosphate pesticides. Effective in neutralizing inorganic acids. Since sodium carbonate is a water softening agent, this characteristic is an aid in physical removal of contaminants. |
| C. An aqueous solution containing 5% sodium bicarbonate ($NaHCO_3$) baking soda. | To ten gallons of water, add four pounds of sodium bicarbonate. | Sodium bicarbonate can be used to neutralize either base or acid contaminants. Good decon for base labile compounds. |
| D. An aqueous solution containing 2% trisodium phosphate ($Na_3PO_4$) TSP. | To ten gallons of water, add two pounds of trisodium phosphate. | See uses/remarks for Decon Solution B above. |
| E. An aqueous solution containing 10% calcium hypochlorite ($CaCl_2O_2$) HTH. | To ten gallons of water, add eight pounds of calcium hypochlorite. | Cyanide salts. |
| F. Ethylenediaminetetra-acetic acid (EDTA, versene, sesquesterene) | Commercial product, follow product label. | EDTA is a chelating agent and is decon of choice for heavy metal contaminants. |
| G. An aqueous solution containing 3 to 5% citric, tartaric, oxalic acids, of their respective sodium salts. | To ten gallons of water, add four pounds citric, tartaric or oxalic acid. | These compounds are chelating agents and are a decon of choice for heavy metal contaminants. |

## ATTACHMENT D

## DECONTAMINATION STATION DETAIL

### 3A.1 Level A Decontamination

**Equipment Worn**

The full decontamination procedure outlined is for workers wearing Level A protection (with taped joints between gloves, boots, and suit). Such protection consist of

1. Fully encapsulating suit with integral boots and gloves
2. Self-contained breathing apparatus (SCBA)
3. Hard hat (optional)
4. Chemical-resistant boots with steel toe and shank
5. Boot covers
6. Inner and outer gloves

**Procedure for Full Decontamination**

Station 1: Segregated Equipment Drop

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each drop area shall be designated for items suspected of being contaminated to different degrees. Segregation at the drop reduces the probability of cross-contamination.

Equipment necessary is

1. Containers of various sizes
2. Plastic liners
3. Plastic drop cloths

Station 2: Boot Cover and Glove Wash

Scrub outer boot covers and gloves with decon solution or detergent/water solution.

Equipment necessary is

1. Container (20 to 30 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE TWO**

Station 3: Boot Cover and Glove Rinse

Rinse off decon solution from Station 2 using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Two or three long-handled, soft-bristle scrub brushes

Station 4: Tape Removal

Remove tape abound boots and gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 5: Boot Cover Removal

Remove boot covers and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool

Station 6: Outer -Glove Removal

Remove outer gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE THREE**

Station 7: Suit/Safety Boot Wash

Thoroughly wash fully encapsulating suit and boots. Scrub suit and boots with long-handled, soft-bristle scrub brush and copious amounts of decon solution or detergent/water solution. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes

Station 8: Suit/Safety Boot Rinse

Rinse off decon solution or detergent/water solution using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Two or three long-handled, soft-bristle scrub brushes

Section 9: Tank Change

If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, and joints taped. Worker then returns to duty.

Equipment necessary is

1. Air tanks
2. Tape
3. Boot covers
4. Gloves

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE FOUR**

Station 10: Fully Encapsulating Suit and Hard Hat Removal

With assistance of helper, remove fully encapsulating suit and hard hat. Hang suits on rack or lay out on drop cloths.

Equipment necessary is

1. Rack
2. Drop cloths
3. Bench or stool

Station 11: SCBA Backpack Removal

While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.

Equipment necessary is a table.

Station 12: Safety Boot Removal

Remove safety boots and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool
4. Boot jack

Station 13: Inner-Glove Wash

Wash with decon solution or detergent/water solution that will not harm skin. Repeat as many times as necessary.

Equipment necessary is

1. Basin or bucket
2. Decon solution
3. Detergent/water solution
4. Small table

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE FIVE**

Station 14: Inner-Glove Rinse

Rinse with water. Repeat as many times as necessary.

Equipment necessary is

1. Water
2. Basin or bucket
3. Small table

Station 15: Facepiece Removal

Remove facepiece. Deposit in container with plastic liner. Avoid touching face with fingers.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

Station 16: Inner-Glove Removal

Remove inner gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 17: Inner-Clothing Removal

Remove clothing soaked with perspiration. Place in container with plastic liner. Do not wear inner clothing off the site, since there is a possibility that small amounts of contaminants have been transferred in removing fully encapsulating suit.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE SIX**

Station 18: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shoer is not available.

Equipment necessary is

1. Water
2. Soap
3. Small table
4. Basin or bucket
5. Field Showers
6. Towels

Station 19: Redress

Put on clean clothes. A dressing trailer is needed in inclement weather.

Equipment necessary is

1. Tables
2. Chairs
3. Lockers
4. Clothes

Full Decontamination (Situation 1) and Three Modifications

The preceding description outlines each station that is included in a complete worst-case decontamination protocol. It is obvious that different sites will present different hazard levels and thus that site-specific modifications of this protocol will be required. The following table illustrates the modifications that can be made in response to a variety of conditions.

| SIT* | STATION NUMBER | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 1 | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x |
| 2 | x | x | x | x | x | x | x | x | x | | | | | | | | | | |
| 3 | x | | | | | | x | x | | x | x | x | | x | x | x | x | x | |
| 4 | x | | | | | | x | x | x | | | | | | | | | | |

*SIT- Situation Number

**ATTACHMENT D**
**CONTAMINATION STATION DETAIL**
**PAGE SEVEN**

Situation 1: The individual entering the Contamination Reduction Corridor (CRC) is observed to be grossly contaminated, or extremely toxic substances are known or suspected to be present.

Situation 2: Some as Situation 1 except that individual needs new air tank and will return to Exclusion Zone

Situation 3: Individual entering the CRC is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. No outer gloves or boot covers are worn. Inner gloves re not contaminated.

Situation 4: Same as situation 3 except that individual needs new air tank and will return to Exclusion Zone.

### 3A.2 Level B Decontamination

**Equipment Worn**

The full decontamination procedure outlined is for workers wearing Level B protection (with taped joints between gloves, boot, and suit). Such protection consists of

1. One-piece, hooded, chemical-resistant splash suit
2. Self-contained breathing apparatus
3. Hard hat
4. Chemical-resistant boots with steel toe and shank
5. Boot covers
6. Inner and outer gloves

**Procedure for Full Decontamination**

Station 1: Segregated Equipment Drop

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross-contamination.

Equipment necessary is

1. Containers of various sizes
2. Plastic liners
3. Plastic drop cloths

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE EIGHT**

Station 2: Boot Cover and Glove Wash

Scrub outer boot covers and gloves with decon solution or detergent/water solution.

Equipment necessary is

1. Container (20 to 30 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes

Station 3: Boot Cover and Glove Rinse

Rinse off decon solution from Station 2 using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Two or three long-handled, soft-bristle scrub brushes

Station 4: Tape Removal

Remove tape around boots and gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 5: Suit/Safety Boot Wash

Thoroughly wash chemical-resistant splash suit, SCBA, gloves, and safety boots. Scrub with long-handled, soft bristle scrub brush and copious amounts of decon solution or detergent/water solution.

Equipment necessary is

1. Container (30 to 50 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes
5. Small buckets
6. Sponges or cloths

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE NINE**

Station 6: Suit/SCBA/Boot/Glove Rinse

Rinse off decon solution or detergent/water solution using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Small buckets
5. Two or three long-handled, soft-bristle scrub brushes
6. Sponges or cloths

Station 7: Tank Change

If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer glove and boot covers donned, and joints taped. Worker returns to duty.

Equipment necessary is

1. Air tanks
2. Tape
3. Boot covers
4. Gloves

Station 8: Outer-Glove Removal

Remove outer gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 9: SCBA Backpack Removal

While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.

Equipment necessary is a table.

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE TEN**

Station 10: Splash Suit Removal

With assistance of helper, remove splash suit. Deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool

Station 11: Boot Cover Removal

Remove boot covers and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool

Station 12: Safety Boot Removal

Remove safety boots and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool
4. Boot jack

Station 13: Inner-Glove Wash

Wash inner gloves with decon solution or detergent/water solution that will not harm skin. Repeat as many times as necessary.

Equipment necessary is

1. Decon solution
2. Detergent/water solution
3. Basin or bucket
4. Small table

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE ELEVEN**

Station 14: Inner-Glove Rinse

Rinse inner gloves with water. Repeat as many times as necessary.

Equipment necessary is

1. Water
2. Basin or bucket
3. Small table

Station 15: Facepiece Removal

Remove facepiece. Avoid touching face with gloves. Deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

Station 16: Inner-Glove Removal

Remove inner gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 17: Inner-Clothing Removal

Remove clothing soaked with perspiration. Place in container with plastic liner. Do not wear inner clothing off the site since there is a possibility that small amounts of contaminants have been transferred in removing fully encapsulating suit.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE TWELVE**

Station 18: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.

Equipment necessary is

1. Water
2. Soap
3. Small tables
4. Basins or buckets
5. Field showers

Station 19: Redress

Put on clean clothes. A dressing trailer is needed in inclement weather.

Equipment necessary is

1. Tables
2. Chairs
3. Lockers
4. Clothes

Full Decontamination (Situation 1) and Three Modifications

The preceding description outlines each station that is included in a complete worst-case decontamination protocol. It is obvious that different sites will present different hazard levels and thus that site-specific modifications of this protocol will be required. The following table illustrates the modifications that can be made in response to a variety of conditions.

| SIT* | STATION NUMBER | | | | | | | | | | | | | | | | | | |
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| 1 | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x |
| 2 | x | x | x | x | x | x | x | x | x | | | | | | | | | | |
| 3 | x | | | | | | x | x | | x | x | x | | | x | x | x | x | |
| 4 | x | | | | | | x | x | x | | | | | | | | | | |

*SIT- Situation Number

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE THIRTEEN**

Situation 1: The individual entering the CRC is observed to be grossly contaminated, or extremely toxic substances are known or suspected to be present.

Situation 2: Some as Situation 1 except that individual needs new air tank and will return to Exclusion Zone

Situation 3: Individual entering the CRC is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. No outer gloves or boot covers are worn. Inner gloves are not contaminated.

Situation 4: Same as situation 3 except that individual needs new air tank and will return to Exclusion Zone.

### 3A.3 Level C Decontamination

**Equipment Worn**

The full decontamination procedure outlined is for workers wearing Level C protection (with taped joints between gloves, boot, and suit). Such protection consists of

1. One-piece, hooded, chemical-resistant splash suit
2. Canister-equipped full-face mask
3. Hard hat
4. Chemical-resistant boots with steel toe and shank
5. Boot covers
6. Inner and outer gloves

**Procedure for Full Decontamination**

Station 1: Segregated Equipment Drop

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross-contamination.

Equipment necessary is

1. Containers of various sizes
2. Plastic liners
3. Plastic drop cloths

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE FOURTEEN**

Station 2: Boot Cover and Glove Wash

Scrub outer boot covers and gloves with decon solution or detergent/water solution.

Equipment necessary is

1. Container (20 to 30 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes

Station 3: Boot Cover and Glove Rinse

Rinse off decon solution from Station 2 using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Two or three long-handled, soft-bristle scrub brushes

Station 4: Tape Removal

Remove tape around boots and gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 5: Suit/Safety Boot Wash

Thoroughly wash splash suit and safety boots. Scrub with long-handled, soft bristle scrub brush and copious amounts of decon solution or detergent/water solution. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. Decon solution
3. Detergent/water solution
4. Two or three long-handled, soft-bristle scrub brushes

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE FIFTEEN**

Station 6: Suit/SCBA/Boot/Glove Rinse

Rinse off decon solution or detergent/water solution using copious amounts of water. Repeat as many times as necessary.

Equipment necessary is

1. Container (30 to 50 gal)
2. High-pressure spray unit
3. Water
4. Two or three long-handled, soft-bristle scrub brushes

Station 7: Canister or Mask Change

If worker leaves Exclusion Zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer glove and boot covers donned, and joints taped. Worker returns to duty.

Equipment necessary is

1. Canister (or mask)
2. Tape
3. Boot covers
4. Gloves

Station 8: Outer-Glove Removal

Remove outer gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 9: Splash Suit Removal

With assistance of helper, remove splash suit. Deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Bench or stool
3. Plastic liner

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE SIXTEEN**

Station 10: Boot Cover Removal

Remove boot covers and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool

Station 11: Safety Boot Removal

Remove safety boots and deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners
3. Bench or stool
4. Boot jack

Station 12: Inner-Glove Wash

Wash inner gloves with decon solution or detergent/water solution that will not harm skin. Repeat as many times as necessary.

Equipment necessary is

1. Decon solution
2. Detergent/water solution
3. Basin or bucket

Station 13: Inner-Glove Rinse

Rinse inner gloves with water. Repeat as many times as necessary.

Equipment necessary is

1. Water
2. Basin or bucket
3. Small table

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE SEVENTEEN**

Station 14: Facepiece Removal

Remove facepiece. Avoid touching face with gloves. Deposit in container with plastic liner.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

Station 15: Inner-Glove Removal

Remove inner gloves and deposit in container with plastic liner.

Equipment necessary is

1. Container (20 to 30 gal)
2. Plastic liners

Station 16: Inner-Clothing Removal

Remove clothing soaked with perspiration. Place in container with plastic liner. Do not wear inner clothing off the site since there is a possibility that small amounts of contaminants have been transferred in removing fully encapsulating suit.

Equipment necessary is

1. Container (30 to 50 gal)
2. Plastic liners

Station 17: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.

Equipment necessary is

1. Water
2. Soap
3. Tables
4. Wash basins or buckets
5. Field showers

**ATTACHMENT D**
**DECONTAMINATION STATION DETAIL**
**PAGE EIGHTEEN**

Station 18: Redress

Put on clean clothes. A dressing trailer is needed in inclement weather.

Equipment necessary is

1. Tables
2. Chairs
3. Lockers
4. Clothes

Full Decontamination (Situation 1) and Three Modifications

The preceding description outlines each station that is included in a complete worst-case decontamination protocol. It is obvious that different sites will present different hazard levels and thus that site-specific modifications of this protocol will be required. The following table illustrates the modifications that can be made in response to a variety of conditions.

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| 2 | x | x | x | x | x | x | x | x | x | | | | | | | | | | |
| 3 | x | | | | | | x | x | | x | x | | | | x | x | x | | |
| 4 | x | | | | | | x | x | x | | | | | | | | | | |

*SIT- Situation Number

Situation 1: The individual entering the CRC is observed to be grossly contaminated, or extremely toxic substances are known or suspected to be present.

Situation 2: Some as Situation 1 except that individual needs new air tank and will return to Exclusion Zone.

Situation 3: Individual entering the CRC is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. No outer gloves or boot covers are worn. Inner gloves are not contaminated.

Situation 4: Same as situation 3 except that individual needs new air tank and will return to Exclusion Zone.

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number ME-01 | Page 1 of 12 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Health and Safety | |
| Subject HNU PI-101 ORGANIC VAPOR METER | | Approved D. Senovich | |

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- 5.3 CALIBRATION
- 5.4 SPECIALIZED USES
- 5.5 INSTRUMENT ADVANTAGES
- 5.6 CAUTIONS

**6.0 REFERENCES**

**7.0 ATTACHMENTS**

## 1.0 PURPOSE

To establish procedures for the use, maintenance, and calibration of the HNU PI-101 Organic Vapor Meter.

## 2.0 SCOPE

Applies to each usage of the HNU PI-101 photoionization detector by NUS/EMG personnel.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Office Health and Safety Supervisor (OHSS) - The OHSS shall insure that the user has been appropriately trained and certified in the usage of the HNU instrument. He/she shall also insure that the instrument is properly maintained and calibrated prior to its release for field service.

Instrument User - The user should be personally secure that he/she has been adequately trained and understands the operation and limitations of the instrument. He/she is further responsible to insure that the appropriate probe(s) have been selected for compounds to be found on site and that the instrument has been calibrated and is working properly.

## 5.0 PROCEDURES

### 5.1 PRINCIPLE OF OPERATION

The HNU System portable photoionizer detects the concentration of many organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which is energetic enough to ionize many gaseous compounds. The molecule is transformed into charged-ion pairs, creating a current between two electrodes. Each molecule has a characteristic ionization potential, which is the energy required to remove an electron from the molecule, yielding a positively-charged ion and the free electron. The instrument measures this energy level.

### 5.2 INSTRUMENT CONFIGURATION

Three probes, each containing a different UV light source, are available for use with the HNU. Probe energies are 9.5, 10.2, and 11.7eV. All three detect many aromatic and large-molecule hydrocarbons. The 10.2 and 11.7eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2eV probe is the most useful for environmental response work, since it is more durable than the 11.7eV probe and detects more compounds than the 9.5eV probe.

### 5.3 CALIBRATION

The primary HNU calibration gas is benzene (or isobutylene, a benzene equivalent). The span potentiometer knob is adjusted for benzene calibration. A knob setting of zero increases the sensitivity to benzene approximately ten-fold. The instrument's response can be adjusted to give more accurate readings for specific gases and eliminate the necessity for calibration charts. Daily calibration is to be performed in accordance with Attachment G.

## 5.4 SPECIALIZED USES

While the HNU is used primarily as a qualitative instrument, it can also be used to detect certain contaminants or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionizing potential may be such that the 9.5eV probe produces no response, but the 10.2 and 11.7eV probes do elicit a response. Also, HNU does not detect methane or hydrogen cyanide.

## 5.5 INSTRUMENT ADVANTAGES

The HNU is easy to use in comparison to many other types of monitoring instrumentation. Its range detection limit is also in the low parts per million range. Response time is rapid; the meter needle reaches 90 percent of the indicated concentration in 3 seconds for benzene. HNU can be zeroed in a contaminated atmosphere.

## 5.6 CAUTIONS

The instrument can monitor only certain vapors and gases in air. Nonvolatile liquids, toxic solids, particulates, and many other toxic gases and vapors cannot be detected. Because the types of compounds that the HNU can detect is only a fraction of the chemicals possibly present at a field site, a zero reading does not necessarily signify the absence of air contaminants.

The instrument is nonspecific, and its response to different compounds is relative to the calibration setting. Instrument readings may be higher or lower then the true concentration. These discrepancies can be especially serious problems when monitoring for total contaminant concentrations, if several different compounds are being detected at once. In addition, the response of this instrument is not linear over the entire detection range. Care must, therefore, be taken when interpreting the data. All identifications should be reported as tentative until they can be confirmed by more precise analysis. Concentrations should be reported in terms of the calibration gas and span potentiometer of the gas-select-knob setting.

The instrument cannot be used as an indicator for combustible gases or oxygen deficiency.

## 6.0 REFERENCES

HNU Systems, Inc. Instruction Manual for Model PI 101 Photoionization Analyzer, 1975.

E. & E. FIT Operation and Field Manual: HNU Systems PI 101 Photoionization Detector and Century Systems (Foxboro) Model OVA-128 Organic Vapor Analyzer.

Personal Communication with Fran Connel, HNU Systems, Inc., January 4, 1984.

## 7.0 ATTACHMENTS

Attachment A - Start-up and Shutdown Procedures
Attachment B - Maintenance and Calibration Schedule
Attachment C - Calibration Procedure
Attachment D - Cleaning the UV Light Source Window
Attachment E - Cleaning the Ionization Chamber
Attachment F - Troubleshooting
Attachment G - Daily Calibration

## ATTACHMENT A

## START-UP AND SHUTDOWN PROCEDURES

### Start-up

1. Attach the probe to the readout unit. Match the alignment key, then twist the connector clockwise until a distinct locking is felt.

2. Turn the FUNCTION switch to the battery check position. Check to ensure that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged prior to using.

3. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15-20 seconds to ensure that the zero adjustment is stable. If not, then readjust.

4. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used. Follow procedures in Attachment G in the performance of daily calibrations.

5. Set the FUNCTION switch to the desired ppm range.

6. Listen for the fan operation to verify fan function.

7. Check instrument with an organic point source (such as a magic marker) prior to usage to verify instrument function.

### Shut Down

1. Turn FUNCTION switch to OFF.

2. Place the instrument on the charger.

## ATTACHMENT B

## MAINTENANCE AND CALIBRATION SCHEDULE

| Function | Frequency |
| --- | --- |
| • Routine Calibration | Prior to each use* |
| • Factory Check-out and Calibration | Yearly or when malfunctioning |
| • Wipe Down Read-Out Unit | After each use |
| • Clean UV Light Source Window | Every month or as use and site conditions dictate |
| • Clean the Ionization Chamber | Monthly |
| • Recharge Battery | After each use |

* In accordance with the specifications identified in Attachment G.

## ATTACHMENT C

## CALIBRATION PROCEDURE

Calibration Procedure 1

1. Run through start-up procedures as per Attachment 1.
2. Fill a sampling bag with HNU calibration gas of known contents.
3. Allow sample bag contents to be drawn into the probe and check response in ppm.
4. If the reading deviates ± 15 percent from the concentration of the calibration gas, the instrument requires maintenance.
5. Each office must develop a mechanism for the documentation of calibration results. This documentation includes:
   a. date inspected
   b. person who calibrated the instrument
   c. the instrument number (Serial number or Other ID number)
   d. the result of the calibration (ppm, probe ev, span pot setting)
   e. identification of the calibration gas (source, type, concentration)

Calibration Procedure 2 (for HNU Calibration Canisters Equipped with a Regulator)

1. Run through start up procedures as per Attachment 1.
2. Connect a sampling hose to the regulator outlet and the other end to the sampling probe of the HNU.
3. Crack the regulator valve.
4. Take reading after 5-10 seconds.
5. If the reading deviates ± 15 percent from the concentration of the calibration gas, the instrument requires maintenance.
6. Calibration documentation should be as in No. 5 above.

## ATTACHMENT D

## CLEANING THE UV LIGHT SOURCE WINDOW

1. Turn the FUNCTION switch to the OFF position and disconnect the sensor/probe from the Read Out/Control unit.

2. Remove the exhaust screw located near the base of the probe. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.

3. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp housing, taking care that the lamp does not fall out of this housing.

4. Tilt the lamp housing with one hand over the opening, so that the lamp slides out of the housing into your hand.

5. The lamp window may now be cleaned with any of the following compounds using lens paper:

   a. HNU Cleaning Compound-All lamps except the 11.7 eV
   b. Carbon tetrachloride-All lamps except the 11.7 eV
   c. Methanol-All lamps

6. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

7. Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the O-ring. Do Not Overtighten.

8. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell. It will only fit one way.

## ATTACHMENT E

## CLEANING THE IONIZATION CHAMBER

1. Turn the FUNCTION switch to the OFF position and disconnect the sensor/probe from the Read Out/Control unit.

2. Remove the exhaust screw located near the base of the probe. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.

3. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp housing, taking care that the lamp does not fall out of this housing.

4. The ion chamber may now be cleaned according to the following sequence:

   a. acetone rinse with agitation (10 min.), then dry (preferably with oven at 100°C).

   b. methanol rinse with agitation (10 min.), then dry (preferably with oven at 100°C).

5. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

7. Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the O-ring. Do Not Overtighten.

8. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell. It will only fit one way.

## ATTACHMENT F

## TROUBLESHOOTING

To be performed by qualified technician only.

1. No meter response in any switch position (including BATT CHK).

   A. Broken meter movement.

      (1) Tip instrument rapidly from side to side. Meter needle should move freely and return to zero.

   B. Electrical connection to meter is broken.

      (1) Check all wires leading to meter and clean the contacts of quick-disconnects.

   C. Battery is completely dead.

      (1) Disconnect battery and check voltage with a volt-ohm meter.

   D. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others.

   A. Power supply defective.

      (1) Check power supply voltages per Figure 11 of the HNU owner's manual. If any voltage is out of specification, consult the factory.

   B. Input transistor or amplifier has failed.

      (1) Rotate zero control; meter should deflect up/down, as control is turned.

      (2) Open probe. Both transistors should be fully seated in sockets.

   C. Input signal connection broken in probe or readout.

      (1) Check input connector on printed circuit board. The input connector should be firmly pressed down.

      (2) Check components on back side of printed circuit board. All connections should be solid and no wires should touch any other object.

      (3) Check all wires in readout for solid connections.

## ATTACHMENT G

### DAILY CALIBRATION OF HNU PI-101

HNU PI-101 organic vapor meters are to be field calibrated at the beginning of each work day, prior to actual on site usage.

In order to accomplish this, HNUs assigned to jobs shall be accompanied with a calibration gas cylinder, an appropriate fitting, and a flexible connecting hose. The procedure for performing field calibration is as follows:

1. Connect the probe to the instrument and turn it on.
2. Attach the eight-inch extension to the probe.
3. Set the Span Potentiometer to the setting specified on the calibration cylinder.
4. Connect the cylinder fitting to the cylinder.
5. Connect the cylinder and the instrument together with the flexible tubing.
6. Open the cylinder valve and wait 15 seconds.
7. Instrument reading should coincide with the designed reading stated on the calibration cylinder label.
8. If item number 7 does not coincide, adjust the Span Potentiometer until the desired reading is achieved. Any such adjustments must be within the following limits:

| Probe | Initial Span Pot. Setting | Maximum Acceptable Span Pot. Adjustment |
| --- | --- | --- |
| 9.5 eV | 5.0 | 1.0 |
| 10.2 eV | 9.8 | 8.5 |
| 11.7 eV | 5.0 | 2.0 |

If these limits are exceeded, the sensitivity and accuracy of the instrument is hindered. At these points, the instruments are to be returned to the NUS Equipment Manager for inspection, necessary cleaning and maintenance, and recalibration.

The manufacturer also recommends that the lamp inside of the probe be checked twice per week (16 hours of use) and cleaned at least weekly. This involves removing any noticeable obstructions or contamination from the lamp by wiping it off with a clean, soft cloth being careful not to scratch the circular window.

**ATTACHMENT G**
**DAILY CALIBRATION OF HNU PI-101**
**PAGE TWO**

In using this instrument to protect NUS employees and subcontractors, it is imperative that it is accurately responding to airborne substances present at the work site. By implementing these procedures, this end will be better achieved.

Additionally, all calibration activities must be documented in field log books, instrument calibration log sheets, or equivalent. This information must include the date inspected, the person calibrating the instrument, the instrument serial or identification number, the probe lamp eV (9.5 , 10.2, or 11.7), identification of calibration gas (gas source stated on the cylinder label), the initial and final Span Potentiometer settings, and the instrument resultant reading. This information must be submitted to the Site Safety officer at the completion of the job.

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number ME-02 | Page 1 of 18 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 1 |
| | | Applicability EMG | |
| | | Prepared Health and Safety | |
| Subject OVA 128 ORGANIC VAPOR ANALYZER | | Approved D. Senovich | |

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## 1.0 OBJECTIVE

To establish procedures for the use, maintenance, and calibration of the OVA 128 Vapor Analyzer.

## 2.0 SCOPE

Applies to each usage of the OVA instrument in implementation of the NUS/EMG Program.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Office Health and Safety Supervisor (OHSS) - The OHSS shall insure that the user has been appropriately trained and certified in the usage of the OVA. He shall also insure that the instrument is properly maintained and calibrated prior to its release for field service.

Instrument User - The user should be personally secure that he or she has been adequately trained, understands the operation of the OVA, and limitations of the instrument. He or she should also be sure that the instrument has been calibrated and is working properly.

## 5.0 PROCEDURES

### 5.1 PRINCIPLE OF OPERATION

The OVA operates in two different modes. In the survey mode, it can determine the approximate concentration of all detectable species in air. With the gas chromatograph option, individual components can be detected and measured independently, with some detection limits as low as a few parts per billion.

### 5.2 GAS CHROMATOGRAPH FUNCTION

In the Gas Chromatograph (GC) mode, a small sample of ambient air is injected into a chromatographic column and carried through the column by a stream of hydrogen gas. Contaminants with different chemical structures are retained on the column for different lengths of time (known as retention times) and, hence, are detected separately by the flame ionization detector. A strip chart recorder can be used to record the retention times, which are then compared to the retention times of a standard with known chemical constituents. The sample can be injected into the column either from the air-sampling hose or directly from a gas-tight syringe.

### 5.3 CALIBRATION

The OVA is internally calibrated to methane by the manufacturer. When measuring methane, it indicates the true concentration. In response to all other detectable compounds, however, the instrument reading may be higher or lower than the true concentration. Relative response ratios for substances other than methane are available. To interpret the readout correctly, it is necessary either to make calibration charts relating the instrument readings to the true concentrations or to adjust the instrument, so that it reads correctly. This second procedure is done by turning the 10-turn, gas-select knob, which adjusts the response of the instrument. The knob is normally set at 300 when calibrated

to methane. Secondary calibration to another gas is done by sampling a known concentration of the gas and adjusting the gas-select knob, until the instrument reading equals the true concentration.

## 5.4 LIMITATIONS

The OVA has an inherent limitation in that it can detect only organic molecules. Also, it should not be used at temperatures lower than about 40°F, because gases condense in the pump and column. It has no temperature control and, since retention times vary with ambient temperatures for a given column, absolute determinations of contaminants are difficult. Despite these limitations, the GC mode can often provide tentative information on the identity of contaminants in air without relying on costly, time-consuming laboratory analysis.

## 5.5 CAUTIONS

The instrument can monitor only certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates, and other toxic gases and vapors cannot be detected. Because the types of compounds that the OVA can potentially detect are only a fraction of the chemicals possibly present at an incident, a zero reading does not necessarily signify the absence of air contaminants.

The instrument is nonspecific, and its response to different compounds is relative to the calibration setting. Instrument readings may be higher or lower than the true concentrations. These discrepancies can be especially serious problems when monitoring for total contaminant concentrations, if several different compounds are being detected at once. In addition, the response of this instrument is not linear over the entire detection range. Care must, therefore, be taken when interpreting the data. All identifications should be reported as tentative until they can be confirmed by more precise analysis. Concentrations should be reported in terms of the calibration gas and span potentiometer or gas-select knob setting.

This instrument cannot be used as an indicator for combustible gases or oxygen deficiency.

## 6.0 REFERENCES

Century Systems (Foxboro). Service Procedures: Organic Vapor Analyzer; 128GC.

## 7.0 ATTACHMENTS

Attachment A – Start-up and Shutdown Procedures (2 Sheets)
Attachment B – Maintenance and Calibration Schedule
Attachment C – Calibration Procedure (2 Sheets)
Attachment D – Pump System Checkout
Attachment E – Burner Chamber Cleaning
Attachment F – Quad Ring Service
Attachment G – Troubleshooting (2 Sheets)
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Attachment K – Hydrogen Recharging
Attachment L – Particle Filter Servicing
Attachment M – Flow Diagram - Gas Handling System

## ATTACHMENT A

## START-UP AND SHUTDOWN PROCEDURES

### START-UP

1. Connect the probe/read out connectors to the side-pack assembly.

2. Check battery condition and hydrogen supply.

3. For measurement taken as methane equivalent, check that the GAS SELECT Dial is set at 300.

4. Turn the electronics on by moving the INSR switch to the ON position and allow five (5) minutes for warm-up.

5. Set CALIBRATE switch to X10, use CALIBRATE knob to set indicator at 0.

6. Open the $H_2$ tank valve and the $H_2$ supply valve all the way. Check that the hydrogen supply gauge reads between 8.0 and 12.0 psig.

7. Turn the PUMP switch ON and check the flow system, according to the procedures in Attachment D.

8. Check that the BACKFLUSH and INJECT valves are in the UP position.

9. To light the flame, depress the igniter switch until a meter deflection is observed. The igniter switch may be depressed for up to five (5) seconds. Do not depress for longer than five (5) seconds, since it may burn out the igniter coil. If the instrument does not light, allow it to run several minutes and repeat ignition attempt.

10. Confirm OVA operational state by sniffing an organic source, such as a magic marker.

11. Establish a background level in a clean area, by using the charcoal scrubber (depress the sample inject valve) and recording measurements referenced to background.

12. Set the alarm level, if desired.

### SHUT DOWN

1. Close $H_2$ supply valve and $H_2$ tank valve (Do Not Overtighten Valves).

2. Turn INSTR switch to OFF.

3. Wait until $H_2$ supply gauge indicates system is purged of $H_2$, then switch off pump.

4. Put instrument on electrical charger at completion of day's activities.

## ATTACHMENT B

## MAINTENANCE AND CALIBRATION SCHEDULE

| | |
| --- | --- |
| • Check Particle Filters | Weekly or as-needed |
| • Check Quad Rings | Monthly or as-needed |
| • Clean Burner Chamber | Monthly or as-needed |
| • Secondary Calibration Check | Prior to project start-up |
| • Primary Calibration Check | Monthly or if secondary check is off by more than ± 10% |
| • Check Pumping System | Prior to project start-up |
| • Replace Charcoal | 120 hours of use or when background readings are higher with the inject valve down than with the inject valve up, in a clean environment. |
| • Factory Service | At least annually |

* Instruments which are not in service for extended periods of time need not meet the above schedule. However, they must be given a complete check-out prior to their first use addressing the above maintenance items.

## ATTACHMENT C

## CALIBRATION PROCEDURE

### PRIMARY CALIBRATION

1. Remove instrument components from the instrument shell.
2. Turn on Electronics and Zero instrument on X10 scale. Gas select dial to 300.
3. Turn on Pump and Hydrogen. Ignite Flame. Go to Survey Mode.
4. Introduce a Methane Standard near 100 ppm.
5. Adjust R-32 Trimpot on Circuit Board to make meter read to standard.
6. Turn off hydrogen flame and adjust meter needle to read 40 ppm (calibrate @ X10) using the calibration adjust knobs.
7. Switch to X100 Scale. The meter should indicate 0.4 on the 1-10 meter markings (0.4 x 100 = 40 ppm). If the reading is off, adjust with R33 Trimpot.
8. Return to X10 Scale and adjust meter needle to 40 ppm with calibration adjust knob, if necessary.
9. At the X10 Scale, adjust meter to read 0.4 on the 1-10 meter markings using the calibration adjust. Switch to X1 scale. The meter should read 4 ppm. If the reading is off, adjust using the R-31 Trimpot.

### SECONDARY CALIBRATION

1. Fill an air sampling bag with 100 ppm (Certified) methane calibration gas.
2. Connect the outlet of the air sampling bag to the air sampling line of the OVA.
3. Record the reading obtained off the meter onto the calibration record.

### DOCUMENTATION

Each office shall develop a system, whereby the following calibration information is recorded.

a. Instrument calibrated (I.D. or Serial No.)

b. Date of calibration

c. Method of calibration

d. Results of the calibration

e. Identification of person who calibrated the instrument

f. Identification of the calibration gas (source, type, concentration, Lot No.)

## ATTACHMENT D

## PUMP SYSTEM CHECKOUT

1. With pump on hold unit upright and observe flow gauge.
2. Ball level significantly below a reading of 2 is inadequate flow.
3. Check connections at the sample hose.
4. Clean or replace particle filters, if flow is impaired or it is time for scheduled service.
5. Reassemble and retest flow.
6. If flow still inadequate, replace pump diaphragm and valves.
7. If flow normal, plug air intake. Pump should slow and stop.
8. If no noticeable change in pump, tighten fittings and retest.
9. If still no change, replace pump diaphragm and valves.
10. Document this function in the maintenance records.

## ATTACHMENT E

## BURNER CHAMBER CLEANING

1. Remove plastic exhaust port cover.
2. Unscrew exhaust port.
3. Use wire brush to clean burner tip and electrode. Use wood stick to clean Teflon.
4. Brush inside of exhaust port.
5. Blow out chamber with a gentle air flow.
6. Reassemble and test unit.
7. Document this function in the maintenance records.

## ATTACHMENT F

## QUAD RING SERVICE

1. Remove OVA guts from protective shell.
2. Remove clip ring from bottom of valve.
3. Unscrew nut from top of valve.
4. Gently pull valve shaft upward and free of housing.
5. Observe rings for signs of damage - replace as necessary.
6. Lightly grease rings with silicone grease.
7. Reassemble valve - do not pinch rings during shaft insertion.
8. Document this function in the maintenance records.

## ATTACHMENT G

## TROUBLESHOOTING

| Indication | Possible Causes |
| --- | --- |
| • High Background Reading (More than 10 ppm) | 1. Contaminated Hydrogen<br>2. Contaminated Sample Line |
| • Continual Flameout | 1. Hydrogen Leak<br>2. Dirty Burner Chamber<br>3. Dirty Air Filters |
| • Low Air Flow | 1. Dirty Air Filter<br>2. Pump Malfunction<br>3. Line Obstruction |
| • Flame Will Not Light | 1. Low Battery<br>2. Ignitor Broken<br>3. Hydrogen Leak<br>4. Dirty Burner Chamber<br>5. Air Flow Restricted |
| • No Power to Pump | 1. Low Battery<br>2. Short Circuit |
| • Hydrogen Leak (Instrument Not in Use) | 1. Leak in Regulator<br>2. Leak in Valves |

**ATTACHMENT G**
**TROUBLESHOOTING**
**PAGE TWO**

To be performed by qualified technician only.

1. No meter response in any switch position (including BATT CHK).

   A. Broken meter movement.
      (1) Tip instrument rapidly from side to side. Meter needle should move freely and return to zero.

   B. Electrical connection to meter is broken.
      (1) Check all wires leading to meter and clean the contacts of quick-disconnects.

   C. Battery is completely dead.
      (1) Disconnect battery and check voltage with a volt-ohm meter.

   D. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others.

   A. Power supply defective.
      (1) Check power supply voltages per Figure 11 of the HNU owner's manual. If any voltage is out of specification, consult the factory.

   B. Input transistor or amplifier has failed.
      (1) Check input connector on printed circuit board. The input connector should be firmly pressed down.
      (2) Check components on back side of printed circuit board. All connections should be solid and no wires should touch any other object.
      (3) Check all wires in readout for solid connections.

## ATTACHMENT H

## SHIPPING

Since the OVA-128 contains hydrogen, it is subject to shipping restrictions.

**As Personal Luggage**

The OVA-128 can be taken on a plane as luggage, since a permit has been issued from the Department of Transportation to the manufacturer (Foxboro). Please refer to the original permit (Attachment 9) and the extended permit (Attachment 10).

**Air Express**

The following labels must be affixed to both sides of the OVA case when shipping OVA by Air Express.

- Danger - Peligro
- Flammable Gas
- Inside Container Complies with D.O.T. Regulations
- Hydrogen UN #1049
- Name and Address of Recipient

A hazardous air bill must be filled out. The following information is requested.

| | |
| --- | --- |
| Proper Shipping Name | Hydrogen |
| Classification | Flammable Gas |
| I.D. No. | UN 1049 |
| Net Quantity | 75 Cubic Centimeters |

In addition, the shipping's certification must be signed and marked CARGO AIRCRAFT ONLY.

ATTACHMENT I
D.O.T. EXEMPTION PERMIT

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

DRAFT

DOT-E 7607
(FIRST REVISION - CORRECTED COPY)

1. Century Systems Corporation, Arkansas City, Kansas, is hereby granted an exemption from these provisions of this Department's Hazardous Materials Regulations specified in paragraph 5 below to offer packages prescribed herein of a flammable gas for transportation in commerce subject to the limitations and special requirements specified herein. This exemption authorizes the shipment of hydrogen in certain non-DOT specification cylinders as described in paragraph 7 below, and provides no relief from any regulation other than as specifically stated. Each of the following is hereby granted the status of a party to this exemption:

U.S. Department of Health, Education and Welfare, Rockville, Maryland - PTE-1.

2. BASIS. This exemption is based on Century Systems Corporation's application dated March 10, 1978, submitted in accordance with 49 CFR 107.105 and the public proceeding thereon. The granting of party status is based on the following application submitted in accordance with 49 CFR 107.111 and the public proceeding thereon:

The U.S. Department of Health, Education and Welfare's application dated March 13, 1978.

3. HAZARDOUS MATERIALS (Descriptor and class). Hydrogen, flammable gas.

4. PROPER SHIPPING NAME (49 CFR 172.101). Hydrogen.

5. REGULATION AFFECTED. 49 CFR 172.101, 173.3.

6. MODE OF TRANSPORTATION AUTHORIZED. Passenger-carrying aircraft.

7. SAFETY CONTROL MEASURES. Packaging prescribed is a non-DOT specification seamless stainless steel cylinder of not more than 7.22 cubic inch water capacity; each cylinder to be pressure tested to at least 4000 psig, and charged to not more than 2100 psig at 70°F. The cylinder is a component part of a portable gas chromatograph.

8. SPECIAL PROVISIONS.

a. Each device must be shipped in a strong outside packaging as prescribed in 49 CFR 173.301(h).

b. A copy of this exemption must be carried aboard each aircraft used to transport packages covered by this exemption.

c. The pilot in command must be advised when the gas chromatograph is placed on board the aircraft.

d. The gas chromatograph must be appropriately secured.

Continuation of 1st Rev. DOT-E 7607 corrected copy

DRAFT

9. REPORTING REQUIREMENTS. Any incident involving loss of contents or the package must be reported to the Office of Hazardous Materials Regulation as soon as practicable.

10. EXPIRATION DATE. May 1, 1980.

ued at Washington, D.C.:

9-7-78
(DATE)

Alan I. Roberts
Associate Director for
Hazardous Materials Regulation
Materials Transportation Bureau

Address all inquiries to: Associate Director for Hazardous Materials Regulation, Materials Transportation Bureau, Research and Special Programs Administration, Department of Transportation, Washington, D.C., 20590. Attention: Exemptions Branch.

Dist: 3 of 3, FAA

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

DOT-E 7607
(PTE)

In accordance with 49 CFR 107.111 of the Department of Transportation (DOT) Hazardous Materials Regulations the party(s) listed below are granted the status of party to DOT-E 7607.

The expiration date of the exemption is March 31, 1983 for the party(s) listed below. This authorization forms part of the exemption and must be attached to it.

13 JUN 1980
(DATE)

Alan I. Roberts
Associate Director for
Hazardous Materials Regulation
Materials Transportation Bureau

Dist: FAA

| EXEMPTION HOLDER | APPLICATION DATE |
|---|---|
| Clayton Environmental Consultants, Inc.<br>Southfield, Michigan | December 5, 1979 |
| Foxboro Company<br>Burlington, MA | March 24, 1980 |

ATTACHMENT J

D.O.T. EXEMPTION PERMIT EXTENSION

U.S. Department of Transportation
Research and Special Programs Administration

400 Seventh Street, S.W.
Washington, D.C. 20590

DOT-E 7607
(EXTENSION)

In accordance with 49 CFR 107.105 of the Department of Transportation (DOT) Hazardous Materials Regulations DOT-E 7607 is hereby extended by changing the expiration date in paragraph 10 from December 1, 1983 to September 1, 1985.

This extension applies only to party(s) listed below based on the application received in accordance with 49 CFR 107.105. All other terms of the exemption remain unchanged. This extension forms part of the exemption and must be attached to it.

J.R. Grothe for

Alan I. Roberts
Associate Director for
Hazardous Materials Regulation
Materials Transportation Bureau

OCT 27 1983
(DATE)

Dist: FAA

| EXEMPTION HOLDER | APPLICATION DATE |
|---|---|
| Foxboro Company<br>South Norwalk, Ct. | September 16, 1983 |

## ATTACHMENT K

## HYDROGEN RECHARGING

1. High-grade hydrogen (99.999%) is required.
2. Connect the fill hose to the REFILL FITTING on the side Pack Assembly, with the FILL/BLEED valve in the OFF position.
3. Open $H_2$ supply bottle valve.
4. Place FILL/BLEED valve on fill hose in BLEED position momentarily to purge any air out of the system.
5. Crack the instrument TANK VALVE.
6. Open REFILL valve on instrument.
7. Place FILL/BLEED valve in FILL position until the instrument PRESSURE GAUGE equalizes with the $H_2$ SUPPLY BOTTLE PRESSURE GAUGE.
8. Shut REFILL valve, FILL/BLEED valve, and $H_2$ SUPPLY BOTTLE valve, in quick succession.
9. Turn FILL/BLEED valve to BLEED until hose pressure equalizes to atmospheric pressure.
10. Turn FILL/BLEED valve to FILL Position, then to BLEED position, then to OFF.
11. Close TANK on instrument.
12. Disconnect the FILL HOSE and replace protective nut on the REFILL FITTING.

## ATTACHMENT L

## PARTICLE FILTER SERVICING

There are two points in the air sampling line of the OVA where filters have been placed to keep particulates from entering the instrument. The location of these filters are indicated on the figure in Attachment M. The first filter is located in the probe assembly and the second filter (primary filter) is located on the side pack assembly. Cleaning procedures are as follows:

1. Detach the probe assembly from the readout assembly.

2. Disassemble the probe (the components unscrew).

3. The particle filter located within the probe can be cleaned by blowing air through the filter.

4. Reassemble the probe.

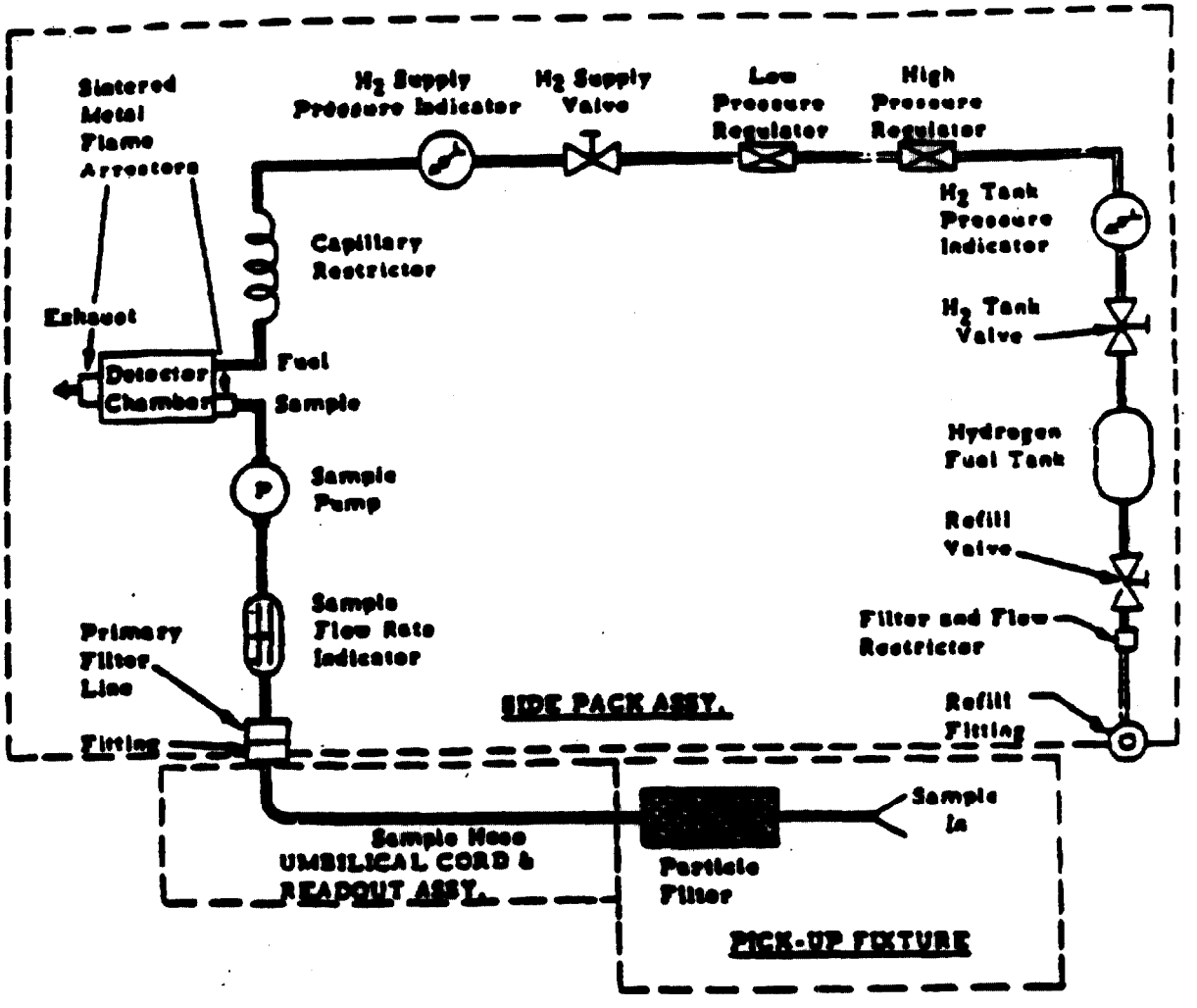
5. The primary filter, located behind the sample inlet connector on the side pack assembly, is accessed by removing the sample inlet connector with a thin-walled 7/16 inch socket wrench. Remove the filter and clean as above.

6. Reassemble the sample inlet fitting and filter to the side pack assembly.

7. Check sample flow rate.

## ATTACHMENT M

## FLOW DIAGRAM - GAS HANDLING SYSTEM



| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number SA-1.1 | Page 1 of 14 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject GROUNDWATER SAMPLE ACQUISITION | | Approved D. Senovich | |

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## 1.0 PURPOSE

The purpose of this procedure is to provide general reference information on the sampling of groundwater wells. The methods and equipment described are for the collection of water samples from the saturated zone of the subsurface.

## 2.0 SCOPE

This procedure provides information on proper sampling equipment and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methodology.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Site Hydrogeologist or Geochemist - responsible for selecting and detailing the specific groundwater sampling techniques and equipment to be used, documenting these in the Project Operations Plan (POP), and properly briefing the site sampling personnel.

Site Geologist - The Site Geologist is primarily responsible for the proper acquisition of the groundwater samples. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians).

Site Manager - The Site Manager is responsible for reviewing the sampling procedures used by the field crew and for performing in-field spot checks for proper sampling procedures.

## 5.0 PROCEDURES

### 5.1 GENERAL

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of testing in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged to dryness with the sampling equipment being used, the well shall be evacuated and allowed to recover prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is preferred.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

- A submersible pump, intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level decreases. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished a bailer may be used to collect the sample for chemical analysis.

- The inlet line of the sampling pump (or the submersible pump itself) shall be placed near the bottom of the screened section, and approximately one casing volume of water shall be pumped from the well at a rate equal to the well's recovery rate.

Stratification of contaminants may exist in the aquifer formation, both in terms of a concentration gradients due to mixing and dispersion processes in a homogeneous layer, and in layers of variable permeability into which a greater or lesser amount of the contaminant plume has flowed. Excessive pumping can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column at that point, and thus result in the collection of a non-representative sample.

## 5.2 SAMPLING, MONITORING, AND EVACUATION EQUIPMENT

Sample containers shall conform with EPA regulations for the appropriate contaminants.

The following equipment shall be on hand when sampling ground water wells:

- Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, appropriate packing containers and filler, ice, labels and chain-of-custody documents.

- Field tools and instrumentation - Thermometer; pH paper/meter; camera and film; tags; appropriate keys (for locked wells); engineers rule; water-level indicator; where applicable, specific-conductivity meter.

- Pumps

  - Shallow-well pumps--Centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.

  - Deep-well pumps--submersible pump and electrical power generating unit, or air-lift apparatus where applicable.

- Other sampling equipment - Bailers and monofilament line with tripod-pulley assembly (if necessary). Bailers shall be used to obtain samples for volatile organics from shallow and deep groundwater wells.

- Pails - Plastic, graduated.

- Decontamination solutions - Distilled water, Alconox, methanol, acetone.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, sterilized, and reused, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection.

## 5.3 CALCULATIONS OF WELL VOLUME

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the field logbook and on the field data form (Attachment A):

- Obtain all available information on well construction (location, casing, screens, etc.).

- Determine well or casing diameter.

- Measure and record static water level (depth below ground level or top of casing reference point).

- Determine depth of well (if not known from past records) by sounding using a clean, decontaminated weighted tape measure.

- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

- Calculate one static well volume in gallons ($V = 0.163Tr^2$).

  where:

  | | | |
  | --- | --- | --- |
  | V | = | Static volume of well in gallons. |
  | T | = | Thickness of water table in the well measured in feet, i.e., linear feet of static water. |
  | r | = | Inside radius of well casing in inches. |
  | 0.163 | = | A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi. |

- Determine the minimum amount to be evacuated before sampling.

## 5.4 EVACUATION OF STATIC WATER (PURGING)

### 5.4.1 General

The amount of flushing a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, electrical conductance, and pH have stabilized. Onsite measurements of these parameters shall be recorded on the field data form.

For defining a contaminant plume, a representative sample of only a small volume of the aquifer is required. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce significant groundwater flow from other areas. Generally three to five well volumes are considered effective for purging a well.

The site hydrogeologist, geochemist and risk assessment personnel shall define the objectives of the groundwater sampling program in the Work Plan, and provide appropriate criteria and guidance to the sampling personnel on the proper methods and volumes of well purging.

### 5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment B provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

#### 5.4.2.1 Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- There is minimal outgassing of volatile organics while the sample is in the bailer.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

#### 5.4.2.2 Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump (therefore not suitable for well purging) that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics. In addition, the complex internal components of these pumps may be difficult to decontaminate.

#### 5.4.2.3 Gas-Lift Samplers

This group of samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Gas lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation or loss of volatile organics.

#### 5.4.2.4 Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components is difficult and time-consuming.

## 5.5 SAMPLING

### 5.5.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the POP prior to the field work:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

- Sample preservation requirements.

- Working schedule.

- List of team members.

- List of observers and contacts.

- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

### 5.5.2 Sampling Methods

The collection of a groundwater sample is made up of the following steps:

1. HSO or designee will first open the well cap and use volatile organic detection equipment (HNU or OVA) on the escaping gases at the well head to determine the need for respiratory protection.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data in a well sampling data sheet (Attachment A); then calculate the fluid volume in the well pipe.

3. Calculate well volume to be removed as stated in Section 5.3.

4. Select appropriate purging equipment (see Attachment B). If an electric submersible pump with packer is chosen, go to Step 10.

5. Lower purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner. Lower the purging device, as required, to maintain submergence.

6. Measure rate of discharge frequently. A bucket and stopwatch are most commonly used; other techniques include using pipe trajectory methods, weir boxes or flow meters.

7. Observe peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics. Never collect volatile organics samples using a vacuum pump.

8. Purge a minimum of three-to-five casing volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice.

9. If sampling using a pump, lower the pump intake to midscreen or the middle of the open section in uncased wells and collect the sample. If sampling with a bailer, lower the bailer to sampling level before filling (this requires use of other than a 'bucket-type' bailer)

Purged water shall be collected in a designated container and disposed of in an acceptable manner.

10. (For pump and packer assembly only). Lower assembly into well so that packer is positioned just above the screen or open section and inflate. Purge a volume equal to at least twice the screened interval or unscreened open section volume below the packer before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

11. In the event that recovery time of the well is very slow (e.g., 24 hours), sample collection can be delayed until the following day. If the well has been bailed early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record in the logbook.

12. Add preservative if required. Label, tag, and number the sample bottle(s).

13. Replace the well cap. Make sure the well is readily identifiable as the source of the samples.

14. Pack the samples for shipping. Attach a custody seal to the front and back of the shipping package. Make sure that traffic reports and chain-of-custody forms are properly filled out and enclosed or attached.

15. Decontaminate all equipment

### 5.5.3 Sample Containers

For most samples and analytical parameters, either glass or plastic containers are satisfactory.

### 5.5.4 Preservation of Samples and Sample Volume Requirements

Sample preservation techniques and volume requirements depend on the type and concentration of the contaminant and on the type of analysis to be performed. Procedure SF-1.2 describes the sample preservation and volume requirements for most of the chemicals that will be encountered during hazardous waste site investigations. Procedure SA-4.3 describes the preservation requirement for microbial samples.

### 5.5.5 Handling and Transporting Samples

After collection, samples shall be handled as little as possible. It is preferable to use self-contained "chemical" ice (e.g., "blue ice") to reduce the risk of contamination. If water ice is used, it shall be bagged and steps taken to ensure that the melted ice does not cause sample containers to be submerged and thus possibly become cross-contaminated. All sample containers shall be enclosed in plastic bags or cans to prevent cross-contamination. Samples shall be secured in the ice chest to prevent movement of sample containers and possible breakage. Sample packing and transportation requirements are described in SA-6.2.

### 5.5.6 Sample Holding Times

Holding times (i.e. allowed time between sample collection and analysis) for routine samples are given in Procedure SF-1.2.

## 5.6 RECORDS

Records will be maintained for each sample that is taken. The sample log sheet will be used to record the following information:

- Sample identification (site name, location, project number; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Sample source and source description.
- Purge data - prior to removal of each casing volume and before sampling, pH, electrical conductance, temperature, color, and turbidity shall be measured and recorded.
- Field observations and measurements (appearance; volatile screening; field chemistry; sampling method).
- Sample disposition (preservatives added; lab sent to, date and time; lab sample number, EPA Traffic Report or Special Analytical Services number, chain-of-custody number.
- Additional remarks - (e.g., sampled in conjunction with state, county, local regulatory authorities; samples for specific conductance value only; sampled for key indicator analysis; etc.).

## 5.7 CHAIN-OF-CUSTODY

Proper chain-of-custody procedures play a crucial role in data gathering. Procedure SA-6.1 describes the requirements for a correct chain-of-custody.

## 6.0 REFERENCES

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Johnson Division, UOP, Inc. 1975. Ground Water and Wells, A Reference Book for the Water Well Industry. Johnson Division, UOP, Inc., Saint Paul, Minnesota.

Barcelona, M. J., J. P. Gibb and R. A. Miller, 1983. A guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling. ISWS Contract Report 327, Illinois State Water Survey, Champaign, Illinois.

Scalf, M. R., J. F. McNabb, W. J. Dunlap, R. L. Crosby and J. Fryberger, 1981. Manual of Ground Water Sampling Procedures. R. S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. EPA, Ada, Oklahoma.

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## 7.0 ATTACHMENTS

Attachment A - Well Sampling Data Sheet
Attachment B - Purging Equipment Selection

## ATTACHMENT A
## SAMPLE LOG SHEET

NUS CORPORATION
A Halliburton Company

# SAMPLE LOG SHEET

☐ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Page _____ of _____
Case # _____
By _____

Project Site Name _____ Project Site Number _____
NUS Source No. _____ Source Location _____

| Total Well Depth: | Purge Data | | | | |
|---|---|---|---|---|---|
| Well Casing Size & Depth: | Volume | pH | S.C. | Temp. (°C) | Color & Turbidity |
| | | | | | |
| Static Water Level: | | | | | |
| One Casing Volume: | | | | | |
| Start Purge (hrs.): | | | | | |
| End Purge (hrs.): | | | | | |
| Total Purge Time (min.) | | | | | |
| Total Amount Purged (gal.): | | | | | |
| Monitor Reading: | | | | | |
| | | | | | |
| Purge Method: | | | | | |
| Sample Method: | | | | | |
| Depth Sampled: | | | | | |
| Sample Date & Time: | Sample Data | | | | |
| | pH | S.C. | Temp. (°C) | Color & Turbidity | |
| Sampled By: | | | | | |

Signature(s):

Observations / Notes:

Type of Sample
- ☐ Low Concentration
- ☐ High Concentration
- ☐ Grab
- ☐ Composite
- ☐ Grab - Composite

| Analysis: | Preservative | | Organic | Inorganic |
|---|---|---|---|---|
| | | Traffic Report # | | |
| | | Tag # | | |
| | | | | |
| | | AB # | | |
| | | Date Shipped | | |
| | | Time Shipped | | |
| | | Lab | | |
| | | | | |
| | | Volume | | |
| | | | | |

## ATTACHMENT B
## PURGING EQUIPMENT SELECTION

Purging Equipment Selection

| Diameter Casing | Bailer | Peristaltic Pump | Vacuum Pump | Airlift | Diaphragm "Trash" Pump | Submersible Diaphragm Pump | Submersible Electric Pump | Submersible Electric Pump w/Packer |
|---|---|---|---|---|---|---|---|---|
| **1.25-inch** | | | | | | | | |
| Water level <25 ft | | X | X | X | X | | | |
| Water level >25 ft | | | | X | | | | |
| **2-inch** | | | | | | | | |
| Water level <25 ft | X | X | X | X | X | X | | |
| Water level >25 ft | X | | | X | | X | | |
| **4-inch** | | | | | | | | |
| Water level <25 ft | X | X | X | X | X | X | X | X |
| Water level >25 ft | X | | | X | | X | X | X |
| **6-inch** | | | | | | | | |
| Water level <25 ft | | | | X | X | | X | X |
| Water level >25 ft | | | | X | | | X | X |
| **8-inch** | | | | | | | | |
| Water level <25 ft | | | | X | X | | X | X |
| Water level >25 ft | | | | X | | | X | X |

| Manufacturer | Model name/ number | Principle of operation | Maximum outside diameter/length (inches) | Construction materials (w/lines & tubing) | Lift range (ft) | Delivery rates or volumes | 1982 price (dollars) | Comments |
|---|---|---|---|---|---|---|---|---|
| BarCad Systems, Inc. | BarCad Sampler | dedicated; gas drive (positive displacement) | 1.5/16 | PE, brass, nylon, aluminum oxide | 0-150 with std. tubing | 1 liter for each 10-15 ft of submergence | 220-350 | requires compressed gas; custom sizes and materials available; acts as piezometer |
| Cole-Parmer Inst. Co. | Master Flex 7570 Portable Sampling Pump | portable; peristaltic (suction) | <1.0/NA | (not submersible) Tygon®, silicone Viton® | 0-30 | 670 mL/min with 7015-20 pump head | 500-600 | AC/DC; variable speed control available; other models may have different flow rates |
| ECO Pump Corp. | SAMPLifier | portable; venturi | <1.5 or <2.0/NA | PP, PE, PVC, SS, Teflon®, Tefzel® | 0-100 | 0-500 mL/min depending on lift | 400-700 | AC, DC, or gasoline driven motors available; must be primed |
| Geltek Corp. | Bailer 219-4 | portable; grab (positive displacement) | 1.66/38 | Teflon® | no limit | 1075 mL | 120-135 | other sizes available |
| GeoEngineering, Inc. | GEO-MONITOR | dedicated; gas drive (positive displacement) | 1.5/16 | PE, PP, PVC, Viton® | probably 0-150 | app. 1 liter for each 10 ft of submergence | 185 | acts as piezometer; requires compressed gas |
| Industrial and Environmental Analysts, Inc. (IEA) | Aquarius | portable; bladder (positive displacement) | 1.75/43 | SS, Teflon®, Viton® | 0-250 | 0-2800 mL/min | 1500-3000 | requires compressed gas; other models available; AC, DC, manual operation possible |
| IEA | Syringe Sampler | portable; grab (positive displacement) | 1.75/43 | SS, Teflon® | no limit | 850 mL sample vol. | 1100 | requires vacuum and/or pressure from hand pump |
| Instrument Specialties Co. (ISCO) | Model 2600 Well Sampler | portable; bladder (positive displacement) | 1.75/50 | PC, silicone, Teflon®, PP, PE, Delrin® acetal | 0-150 | 0-7500 mL/min | 990 | requires compressed gas (40 psi minimum) |
| Keck Geophysical Instruments, Inc. | SP-81 Submersible Sampling Pump | portable; helical rotor (positive displacement) | 1.75/25 | SS, Teflon®, PP, EPDM, Viton® | 0-160 | 0-4500 mL/min | 3500 | DC operated |
| Leonard Mold and Die Works, Inc. | GeoFilter Small Dia. Well Pump (#0500) | portable; bladder (positive displacement) | 1.75/38 | SS, Teflon®, PC, Neoprene® | 0-400 | 0-3500 mL/min | 1400-1500 | requires compressed gas (55 PSI minimum); pneumatic or AC/DC control module |
| Oil Recovery Systems, Inc. | Surface Sampler | portable; grab (positive displacement) | 1.75/12 | acrylic, Delrin® | no limit | app. 250 mL | 125-160 | other materials and models available; for measuring thickness of "floating" contaminants |
| O E D Environmental Systems, Inc. | Well Wizard® Monitoring System (P-100) | dedicated; bladder (positive displacement) | 1.66/36 | PVC | 0-230 | 0-2000 mL/min | 300-400 | requires compressed gas; piezometric level indicator; other materials available |

Source: Barcelona et al., 1983

| Manufacturer | Model name/ number | Principle of operation | Maximum outside diameter/length (inches) | Construction materials (w/lines & tubing) | Lift range (ft) | Delivery rates or volumes | 1982 price (dollars) | Comments |
|---|---|---|---|---|---|---|---|---|
| Randolph Austin Co. | Model 500 Vari-Flow Pump | portable; peristaltic (suction) | <0.5/N/A | (not submersible) rubber, Tygon®, or Neoprene® | 0-30 | see comments | 1200-1300 | flow rate dependent on motor and tubing selected, AC operated; other models available |
| Robert Bennett Co. | Model 180 | portable; piston (positive displacement) | 1.8/22 | SS, Teflon®, Delrin®, PP, Viton®, acrylic, PE | 0-500 | 0-1800 mL/min | 2600-2700 | requires compressed gas; water level indicator and flow meter; custom models available |
| Slope Indicator Co. (SINCO) | Model 514124 Pneumatic Water Sampler | portable; gas drive (positive displacement) | 1.9/18 | PVC, nylon | 0-1100 | 250 mL/flushing cycle | 250-350 | requires compressed gas; SS available; piezometer model available; dedicated model available |
| Solinst Canada Ltd. | 5W Water Sampler | portable; grab (positive displacement) | 1.9/27 | PVC, brass, nylon, Neoprene® | 0-330 | 500 mL | 1300-1800 | requires compressed gas; custom models available |
| TIMCO Mfg. Co., Inc. | Std. Bailer | portable; grab (positive displacement) | 1.66/ custom | PVC, PP | no limit | 250 mL/ft of bailer | 20-60 | other sizes, materials, models available; optional bottom-emptying device available; no solvents used |
| TIMCO | Air or Gas Lift Sampler | portable; gas drive (positive displacement) | 1.66/30 | PVC, Tygon®, Teflon® | 0-150 | 350 mL/flushing cycle | 100-200 | requires compressed gas; other sizes, materials, models available; no solvents used |
| Tote Devices Co. | Sampling Pump | portable; bladder (positive displacement) | 1.38/48 | SS, silicone, Delrin®, Tygon® | 0-125 | 0-4000 mL/min | 800-1000 | compressed gas required; DC control module; custom built |

**Construction Materials Abbreviations**

- PE Polyethylene
- PP Polypropylene
- PVC Polyvinyl Chloride
- SS Stainless Steel
- PC Polycarbonate
- EPDM Ethylene-Propylene Diene (synthetic rubber)

**Other Abbreviations**

- NA Not Applicable
- AC Alternating Current
- DC Direct Current

NOTE: Other manufacturers market pumping devices which could be used for ground-water sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983

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**6.0 REFERENCES**

**7.0 ATTACHMENTS**

## 1.0 PURPOSE

This procedure describes methods and equipment commonly-used for collecting environmental samples of surface water and aquatic sediment for either on-site examination and chemical testing or for laboratory analysis.

## 2.0 SCOPE

The information presented in this guideline is generally applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.4), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions and equipment different from those described herein.

## 3.0 GLOSSARY

Environmental Sample - low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling or CLP handling as a high concentration sample.

Hazardous Waste Sample - medium to high concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and CLP handling as a high concentration sample.

## 4.0 RESPONSIBILITIES

Field Operations Leader - has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging, documentation (sample label and log sheet, chain-of-custody record, CLP traffic reports, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

## 5.0 PROCEDURES

### 5.1 INTRODUCTION

Collecting a representative sample from surface water or sediments is difficult because of water movement, stratification or patchiness. To collect representative samples, one must standardize sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are not better than the confidence that can be placed in the representativeness of the samples.

## 5.2 DEFINING THE SAMPLING PROGRAM

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives; accessibility; site topography; flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom [illegible] or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The hydrologist developing the sampling plan must therefore, know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

### 5.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition are: (a) overland runoff; (b) leachate influx to the waterbody; (c) direct waste disposal (solid or liquid) into the water body; and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to be absorbed by particulate matter. Nitrogen, phosphorus, and the heavy metals may also be transported by particulates. Samples will be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

### 5.2.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance will apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrologist shall explore the possibility of obtaining streamflow data by direct or indirect methods.

### 5.2.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the work plan. For single-event site- or area-characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples shall be collected at a pre-established and constant interval as specified in the work plan (often monthly or quarterly) and during droughts and floods. Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water-quality data shall be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

## 5.3 SURFACE WATER SAMPLE COLLECTION

### 5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the river's transports. The greater number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well-mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected.

### 5.3.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have as much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

### 5.3.3 Estuaries

Estuarine areas are by definition zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e. when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1 to 5 foot increments coupled with vertical dissolved oxygen and temperature profiles.

### 5.3.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube
- Dip sampler
- Hand pump
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for:

- Specific conductance
- Temperature
- pH (optional)
- Dissolved oxygen (optional)

as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

#### 5.3.4.1 Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

#### 5.3.4.2 Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stoppered glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).

- Pull out the stopper with a sharp jerk of the sampler line.

- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.

- Raise the sampler and cap the bottle.

- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

#### 5.3.4.3 Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. "Messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

### 5.3.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

- The most representative samples are obtained from mid-channel at 0.6 stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that results in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics, analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces in after the bottle is filled and capped. The bottle can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the month of the bottle facing upstream.

## 5.4 SEDIMENT SAMPLING

### 5.4.1 General

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site shall be approximately at the center of water body. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations

of contaminants. The shape, flow pattern, bathometry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

### 5.4.2 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers

#### 5.4.2.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

#### 5.4.2.2 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the change of metal contamination from the frame of the device.

## 6.0 REFERENCES

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## 7.0 ATTACHMENTS

None.

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number SA-6.1 | Page 1 of 14 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject SAMPLE IDENTIFICATION AND CHAIN-OF-CUSTODY | | Approved D. Senovich | |

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## 1.0 PURPOSE

This purpose of this procedure is to provide information on chain-of-custody procedures to be used under the NUS Program.

## 2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of all samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities. Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence. This procedure identifies the necessary custody records and describes their completion.

This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

## 3.0 GLOSSARY

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. A Chain-of-Custody Record Form is a controlled document, provided by the regional office of EPA.

The chain-of-custody form is a two-page carbon-copy type form. The original form accompanies the samples during shipment, and the pink carbon-copy is retained in the project file.

Controlled Document - A consecutively-numbered form released by EPA or Program Management Office (PMO) for use on a particular work assignment. All unused forms must be returned or accounted for at the conclusion of the assignment.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under your custody if:

- It is in your actual possession.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

## 4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record and maintaining custody of samples until they are relinquished to another custodian, to the shipper, or to the common carrier.

Remedial Investigation Leader - Responsible for determining that chain-of-custody procedures have been met by the sample shipper and analytical laboratory.

## 5.0 PROCEDURES

### 5.1 OVERVIEW

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom and, secondly, provide security for the evidence as it is moved and/or passes from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

### 5.2 SAMPLE IDENTIFICATION

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records, with identifying information.

#### 5.2.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment B). Sample labels are provided by the PMO. The information recorded on the sample label includes:

- **Project:** EPA Work Assignment Number (can be obtained from the Sampling Plan).
- **Station Location:** The unique sample number identifying this sample (can be obtained from the Sampling Plan).
- **Date:** A six-digit number indicating the day, month, and year of sample collection; e.g., 12/21/85.
- **Time:** A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- **Medium:** Water, soil, sediment, sludge, waste, etc.

- **Concentration**: The expected concentration (i.e., low, medium, high).
- **Sample Type**: Grab or composite.
- **Preservation**: Type of preservation added and pH levels.
- **Analysis**: VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- **Sampled By**: Printed name of the sampler.
- **Case Number**: Case number assigned by the Sample Management Office.
- **Traffic Report Number**: Number obtained from the traffic report labels.
- **Remarks**: Any pertinent additional information.

Using just the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

### 5.2.2 Sample Identification Tag

A Sample Identification Tag (Attachment F) must also be used for samples collected for CLP (Contract Laboratory Program) analysis. The Sample Identification Tag is a w[illegible]e, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or w[illegible] or attachment to the neck of the sample bottle. The Sample Tag is a controlled document, and i[illegible]ovided by the regional EPA office. Following sample analysis, the Sample Tag is retained by the la[illegible]atory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

- **Project Code**: Work Assignment Number.
- **Station Number**: The middle portion of the Station Location Number, (between the hyphens).
- **Month/Day/Year**: Same as Date on Sample Label.
- **Time**: Same as Time on Sample Label.
- **Designate - Comp/Grab**: Composite or grab sample.
- **Station Location**: Same as Station Location on Sample Label.
- **Samplers**: Same as Sampled By on Sample Label.
- **Preservative**: Yes or No.
- **Analyses**: Check appropriate box(es).

- **Remarks**: Same as Remarks on Sample Label (make sure the Case Number and Traffic Report numbers are recorded).

- **Lab Sample Number**: For laboratory use only.

The tag is then tied around the neck of the sample bottle.

If the sample is to be split, it is aliquoted into similar sample containers. Identical information is completed on the label attached to each split.

Blank, duplicate, or field spike samples shall not be identified as such on the label, as they may compromise the quality control function. Sample blanks, duplicates, spikes, and splits are defined in Procedure SA-6.6.

## 5.3 CHAIN-OF-CUSTODY PROCEDURES

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

### 5.3.1 Field Custody Procedures

- Samples are collected as described in the site-specific Sampling Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the sample log sheet and Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

### 5.3.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. Chain-of-Custody Record Forms used in EPA Regions I-IV are shown in Attachments A through D. The appropriate form shall be obtained from the EPA Regional Office. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as follows:

- Enter header information (project number, samplers, and project name -- project name can be obtained from the Sampling Plan).

- Sign, date, and enter the time under "Relinquished by" entry.

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).
- Check composite or grab sample.
- Enter station location number (the same number as the station location on the tag and label).
- Enter the total number of containers per station number and the type of each bottle.
- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.
- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.
- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.
- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment G is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.
- Place the seal across the shipping container opening so that it would be broken if the container is opened.
- Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

### 5.3.3 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party or agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by" space. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time. This form must be completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

## 6.0 REFERENCES

U.S. EPA, 1984. User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, Washington, D.C.

## 7.0 ATTACHMENTS

Attachment A - Chain-of-Custody Record Form for use in Region I
Attachment B - Chain-of-Custody Record Form for use in Region II
Attachment C - Chain-of-Custody Record Form for use in Region III
Attachment D - Chain-of-Custody Record Form for use in Region IV
Attachment E - Sample Label
Attachment F - Sample Identification Tag
Attachment G - Chain-of-Custody Seal

## ATTACHMENT A
## CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION I
(Original is 8-1/2 by 11)

PROJECT NAME

SAMPLERS: *(Signature)*

| STA. NO. | DATE | TIME | COMP. | GRAB | STATION LOCATION | NO. OF CON-TAINERS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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|---|---|---|---|---|---|
| Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* | Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* |
| Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* | Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* |
| Relinquished by: *(Signature)* | Date / Time | Received for Laboratory by: *(Signature)* | Date / Time | Remarks: | |

## ATTACHMENT B
## CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION II
(Original is 8 by 10-1/2)

# CHAIN OF CUSTODY RECORD

ENVIRONMENTAL PROTECTION AGENCY – REGION II
SURVEILLANCE & ANALYSIS DIVISION
EDISON, NEW JERSEY 08837

| Name of Unit and Address | | |
|---|---|---|
| Sample Number | Number of Containers | Description of Samples |
| | | |

| Person Assuming Responsibility for Samples | Time | Date |
|---|---|---|
| | | |

| Sample Number | Relinquished By | Received By | Time | Date | Reason for Change of Custody |
|---|---|---|---|---|---|
| Sample Number | Relinquished By | Received By | Time | Date | Reason for Change of Custody |
| Sample Number | Relinquished By | Received By | Time | Date | Reason for Change of Custody |
| Sample Number | Relinquished By | Received By | Time | Date | Reason for Change of Custody |

# ATTACHMENT C
## CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

### CHAIN OF CUSTODY RECORD

| PROJ. NO. | PROJECT NAME |
|---|---|
| SAMPLERS: (Signature) | |

| STA. NO. | DATE | TIME | COMP. | GRAB | STATION LOCATION | NO. OF CON-TAINERS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Relinquished by: (Signature) | Date / Time | Received by: (Signature) | Relinquished by: (Signature) | Date / Time | Received by: (Signature) |
|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date / Time | Received by: (Signature) | Relinquished by: (Signature) | Date / Time | Received by: (Signature) |
| Relinquished by: (Signature) | Date / Time | Received for Laboratory by: (Signature) | Date / Time | Remarks | |

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

3-15966

D32801

## ATTACHMENT D
## CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION IV
(Original is 8-1/2 by 14)

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

**CHAIN OF CUSTODY RECORD**

ENVIRONMENTAL SERVICES DIVISION
COLLEGE STATION ROAD
ATHENS, GEORGIA 30613

PROJ NO | PROJECT NAME

SAMPLERS (Signature)

| STA NO | DATE | TIME | COMP | GRAB | STATION LOCATION | NO. OF CONTAINERS | Water/Wastewater | | | | | | | | | | | | | | | | Soil/Sed | | | | Solid/Waste | | Misc | REMARKS/TAG NUMBERS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Relinquished by (Signature) | Date/Time | Received by (Signature) | Relinquished by (Signature) | Date/Time | Received by (Signature) | Remarks |
|---|---|---|---|---|---|---|
| Relinquished by (Signature) | Date/Time | Received by (Signature) | Relinquished by (Signature) | Date/Time | Received by (Signature) | |

DISTRIBUTION Original and Pink copies accompany sample shipment to laboratory Pink copy returned by laboratory
Yellow copy retained by samplers Blue copy extra copy as needed

№ 4 3526

## ATTACHMENT E
## SAMPLE LABEL

NUS CORPORATION PROJECT: _____

STATION LOCATION: _____

DATE: ___/___/___ TIME: _____ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ _____ ☐

CONCENTRATION: LOW ☐ MED ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

| ANALYSIS | PRESERVATION |
|---|---|
| VOA ☐ BNA's ☐ | Cool to 4°C ☐ |
| PCB's ☐ PESTICIDES ☐ | $HNO_3$ to pH <2 ☐ |
| METALS: TOTAL ☐ DISSOLVED ☐ | NAOH to pH>12 ☐ |
| CYANIDE ☐ | _____ ☐ |
| _____ ☐ | |

Sampled by: _____

Case No.: _____ Traffic Report No.: _____

Remarks:

ACFILE: FORMS\BOTLABEL

## ATTACHMENT F
## SAMPLE IDENTIFICATION TAG

☆ GPO 505-562

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA

Designate: Grab / Comp.

Time

Month/Day/Year

Station No.

Project Code

Samplers (Signatures)

Station Location

**Preservative:**
Yes ☐ No ☐

**ANALYSES**

| | |
|---|---|
| BOD Anions Solids (TSS) (TDS) (SS) | |
| COD, TOC, Nutrients | |
| Phenolics | |
| Mercury | |
| Metals | |
| Cyanide | |
| Oil and Grease | |
| Organics GC/MS | |
| Priority Pollutants | |
| Volatile Organics | |
| Pesticides | |
| Mutagenicity | |
| Bacteriology | |
| | |

Remarks:

| Tag No. | Lab Sample No. |
|---|---|
| 3 60966 | |

**ATTACHMENT G**
**CHAIN-OF-CUSTODY SEAL**

**CUSTODY SEAL**

**Date**

**Signature**

NUS CORPORATION

NUS CORPORATION

**CUSTODY SEAL**

**Date**

**Signature**

| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number SA-6.2 | Page 1 of 12 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject SAMPLE PACKAGING AND SHIPPING | | Approved D. Senovich | |

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## 1.0 PURPOSE

This procedure provides instruction for sample packaging and shipping in accordance with U.S. Department of Transportation (DOT) regulations.

## 2.0 SCOPE

Samples collected at hazardous waste sites usually have to be transported elsewhere for analysis. This requires that the samples be appropriately preserved to prevent or minimize chemical alteration prior to analysis, and be transported to protect their integrity, as well as to protect against any detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation and described in the Code of Federal Regulations (49 CFR 171 through 177, in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the EPA has agreed through a memorandum of agreement to package, mark, label, and ship samples observing DOT procedures. The information presented here is for general guidance.

This procedure is applicable to all samples taken from uncontrolled hazardous substance sites for analysis at laboratories away from the site.

## 3.0 GLOSSARY

Carrier - A person or firm engaged in the transportation of passengers or property.

Hazardous Material - A substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce ("commerce" here to include any traffic or transportation). Defined and regulated by DOT (49 CFR 173.2) and listed in Attachment A of this guideline.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (¥261.20 et seq) or otherwise characterized as ignitable, corrosive, reactive, or EP toxic as specified under 40 CFR Subpart C (¥261.20 et seq) that would be subject to manifest requirements specified in 40 CFR 262. Defined and regulated by EPA.

Marking - Applying the descriptive name, instruction, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

n.o.i. - Not otherwise indicated.

n.o.s. - Not otherwise specified.

ORM - Other regulated material.

Packaging - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, multiunit tank car tanks.

Placard - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

Reportable Quantity (RQ) - A parenthetical note of the form "(RQ-1000/454)" following an entry in the DOT Hazardous Materials table (49 CFR 172.101) indicates the reportable quantity of the substance in pounds and kilograms. If a spill of that amount or more of the substance occurs during transit or storage, a report must be filed with DOT according to ¥171.15-15 concerning hazardous materials incidents reports. If the material spilled is a hazardous waste, a report must always be filed, regardless of the amount, and must include a copy of the manifest. If the RQ notation appears, it must be shown either immediately before or after the proper shipping name on the shipping paper (or manifest). Most shipping papers and manifests will have a column designated "HM" which may be used for this purpose.

## 4.0 RESPONSIBILITIES

Field Operations Leader or Team Sampling Leader - responsible for determining that samples are properly packaged and shipped.

Sampling Personnel - responsible for implementing the packaging and shipping requirements.

## 5.0 PROCEDURES

### 5.1 INTRODUCTION

Samples collected for shipment from a site shall be classified as either environmental or hazardous material (or waste) samples. In general, environmental samples are collected off-site (for example from streams, ponds, or wells) and are not expected to be grossly contaminated with high levels of hazardous materials. On-site samples (for example, soil, water, and materials from drums or bulk storage tanks, obviously contaminated ponds, lagoons, pools, and leachates from hazardous waste sites) are considered hazardous. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples. If there is any doubt, a sample shall be considered hazardous and shipped accordingly.
- Protect the health and safety of laboratory personnel receiving the samples. Special precautions are used at laboratories when samples other than environmental samples are received.

### 5.2 ENVIRONMENTAL SAMPLES

#### 5.2.1 Packaging

Environmental samples may be packaged following the procedures outlined in Section 5.4 for samples classified as "flammable liquids" or "flammable solids." Requirements for marking, labeling, and shipping papers do not apply.

Environmental samples may also be packed without being placed inside metal cans as required for flammable liquids or solids.

- Place sample container, properly identified and with a sealed lid, in a polyethylene bag, and seal the bag.
- Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.
- Pack with enough noncombustible, absorbent, cushioning materials to minimize the possibility of the container breaking.
- Seal large bag.
- Seal or close outside container.

### 5.2.2 Marking Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Environmental Sample." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling are required.

### 5.2.3 Shipping Papers

No DOT shipping papers are required. However, the appropriate chain-of-custody forms must be included with the shipment.

### 5.2.4 Transportation

There are no DOT restrictions on mode of transportation.

## 5.3 DETERMINATION OF SHIPPING CLASSIFICATION FOR HAZARDOUS MATERIAL SAMPLES

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

### 5.3.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101.

Unz and Company have published the following steps to help in locating a proper shipping name from the Hazardous Materials Table, 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is also called tetrachloroethylene (listed 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If your material is not listed by its technical name then. . . . . .

2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed then. . . . . .

3. Look for a generic name based on end use. For example, Paint, n.o.s or Fireworks, n.o.s. If a generic name based on end use is not listed then. . . . . .

4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then. . . . . .

5. You will have to go the the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s, or Oxidizer, n.o.s.

### 5.3.2 Unknown Substances

For samples of hazardous substances of unknown content, select the appropriate transportation category according to the DOT Hazardous Materials Classification (Attachment A), a priority system of transportation categories.

The correct shipping classification for an unknown sample is selected through a process of elimination, utilizing Attachment A. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for "radioactive material" followed.

If a radioactive material is eliminated, the sample is considered to contain "Poison A" materials (Attachment B), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquids, mixed with air is dangerous to life. Most Poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid Poison A would be found only in closed containers; however,all samples taken from closed drums do not have to be shipped as Poison A, which provides for a "worst case" situation. Based upon information available, a judgment must be made whether a sample from a closed container is a Poison A.

If Poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since few gas samples are collected, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, Poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table (Attachment A). For samples containing unknown materials, categories listed below flammable liquids/solids on Attachment A are generally not used because showing that these materials are not flammable liquids (or solids) requires flashpoint testing, which may be impractical and possibly dangerous at a site. Thus, unless the sample is known to consist of materials listed as less hazardous than flammable liquid (or solid) on Attachment A, it is considered a flammable liquid (or solid) and shipped as such.

For any hazardous material shipment, utilize the shipping checklist (Attachment C) as a guideline to ensure that all sample-handling requirements are satisfied.

## 5.4 PACKAGING AND SHIPPING OF SAMPLES CLASSIFIED AS FLAMMABLE LIQUID (OR SOLID)

### 5.4.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Collect sample in the prescribed container with a nonmetallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90 percent full.

2. Complete sample label and sample identification tag and attach securely to sample container.

3. Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position sample identification tag so that it can be read through bag. Seal bag.

4. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.4.2, below.

5. Place one or more metal cans (or single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans with noncombustible, absorbent cushioning materials for stability during transport. Mark container as indicated in Paragraph 2 of Section 5.4.2.

### 5.4.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."

Not otherwise specified (n.o.s) is not used if the flammable liquid (or solid) is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT Hazardous Materials table (49 CFR 172.101).

2. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name.
   - UN or NA number.
   - Proper label(s).
   - Addressee and sender.

   Place the following labels on the outside shipping container: "Cargo Aircraft Only" and "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label shall be used if the solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" shall also be marked on the top of the outside container, and upward-pointing arrows shall be placed on all four sides of the container.

### 5.4.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment D). Provide the following information in the order listed (one form may be used for more than one exterior container).

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."
   - "Limited Quantity" (or "Ltd. Qty.").
   - "Cargo Aircraft Only."
   - Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s.," by item, if more than one metal can is inside an exterior container.
   - "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container.

3. "Limited Quantity" of "Flammable Liquid, n.o.s." is limited to one pint per inner container. For "Flammable Solid, n.o.s.," net weight of inner container plus sample shall not exceed one pound; total package weight shall not exceed 25 pounds.

### 5.4.4 Transportation

1. Transport unknown hazardous substance samples classified as flammable liquids by rented or common carrier truck, railroad, or express overnight package services. Do not transport by any passenger-carrying air transport system, even if they have cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that only carry cargo.

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be used.

## 6.0 REFERENCES

U.S. Department of Transportation, 1983. Hazardous Materials Regulations, 49 CRF 171-177.

NUS Standard Operating Procedure SA-6.1 - Sample Identification and Chain-of-Custody

NUS Standard Operating Procedure SA-1.2 - Sample Preservation

NUS Standard Operating Procedure SF-1.5 - Compatibility Testing

## 7.0 ATTACHMENTS

Attachment A - DOT Hazardous Material Classification (49 CFR 173.2)
Attachment B - DOT List of Class "A" Poisons (49 CFR 172.101)
Attachment C - Hazardous Materials Shipping Checklist
Attachment D - Standard Industry Certification Form

## ATTACHMENT A

## DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material (except a limited quantity)
2. Poison A
3. Flammable gas
4. Nonflammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers having capacities exceeding 110 gallons [416 liters])
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons [416 liters] or less)
16. ORM-E

## ATTACHMENT B

## DOT LIST OF CLASS "A" POISON (49 CFR 172.101)

| Material | Physical State at Standard Temperature |
| --- | --- |
| Arsine | Gas |
| Bromoacetone | Liquid |
| Chloropicrin and methyl chloride mixture | Gas |
| Chloropicrin and nonflammable,nonliquefied compressed gas mixture | Gas |
| Cyanogen chloride | Gas (>13.1°C) |
| Cyanogen gas | Gas |
| Gas identification set | Gas |
| Gelatin dynamite (H. E. Germaine) | ---- |
| Grenade (with Poison "A" gas charge) | ---- |
| Hexaethyl tetraphosphate/compressed gas mixture | Gas |
| Hydrocyanic (prussic) acid solution | Liquid |
| Hydrocyanic acid, liquefied | Gas |
| Insecticide (liquefied) gas containing Poison "A" or Poison "B" material | Gas |
| Methyldichloroarsine | Liquid |
| Nitric oxide | Gas |
| Nitrogen peroxide | Gas |
| Nitrogen tetroxide | Gas |
| Nitrogen dioxide, liquid | Gas |
| Parathion/compressed gas mixture | Gas |
| Phosgene (diphosgene) | Liquid |

## ATTACHMENT C
## HAZARDOUS MATERIALS SHIPPING CHECKLIST

**PACKAGING**

1. Check DOT 172.500 table for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample, and chain-of-custody record.

**SHIPPING PAPERS**

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Offer driver proper placards for transporting vehicle.
8. Check that certification is signed by shipper.
9. Make certain driver signs for shipment.

**RCRA MANIFEST**

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

## ATTACHMENT D

## STANDARD INDUSTRY CERTIFICATION FORM

| NO PCS | SIZE | GROSS WEIGHT | H M | DOT PROPER SHIPPING NAME | HAZARD CLASS | CODE | [illegible] | CONTAINER NUMBERS | PLC | BULK |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 1 | 55 gal | 200 lbs. | s | Nitric Acid, Fuming | Oxidizer | 55-OX | C | 1 | ✓ | |
| 1 | 55 gal | 450 lbs | s | Flammable Liquid, n.o.s. | Flammable Liquid | 55-ABF | — | 2 | | ✓ |
| 1 | 55 gal | 250 lbs | s | Flammable liquid, n.o.s | Flammable liquid | 55-BN | B | 3 | ✓ | |
| 1 | 16-A | 12 lbs. | s | Bromine | Corrosive Material | 55-CR | C | 4 | ✓ | |
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**SHIPPER'S CERTIFICATION**

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper's Signature

Placards Req'd _____

Shipment Date _____ Manifest No _____

Shipper Work Order _____

Service Order No _____

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6.0 REFERENCES

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## 1.0 PURPOSE

This procedure contains examples of forms in current use for RI activities, and a brief explanation of the function of these forms. The intent of this procedure is simply to compile and introduce these forms, and not to provide detailed explanations of the Forms.

## 2.0 SCOPE

Attachment A lists the forms illustrated in this procedure. Forms identified as controlled documents are issued by EPA, are sequentially numbered, and may not be altered. Those which are not listed as controlled documents and not required documents issued by EPA may be altered or revised for project-specific needs, with notification of.

## 3.0 GLOSSARY

Controlled Document - A consecutively-numbered form released by EPA for use on a particular work assignment. All unused forms must be returned or accounted for at the conclusion of the assignment.

## 4.0 RESPONSIBILITIES

Field Operations Leader - The Field Operations Leader is responsible for ensuring that the appropriate forms illustrated in this guideline are correctly used and accurately filled out. In general, the sampling technician or Field Operations Leader will fill out forms related to sample labeling, shipment and analysis (see Section 5.1); the site geologist/geohydrologist will fill out borings logs, groundwater level and geohydrological test forms (see Section 5.2); and the Field Operations Leader, site Health and Safety Officer, or field technicians, will fill out equipment calibration and maintenance records (see Section 5.3).

## 5.0 PROCEDURES

### 5.1 SAMPLE COLLECTION, LABELING, SHIPMENT AND REQUEST FOR ANALYSIS

#### 5.1.1 Sample Label

The sample label is a 2- by 4-inch white label with black lettering and an adhesive backing. Attachment B-1 is an example of a sample label. These labels are required on every sample but are not controlled documents. Guidelines for filling out sample labels are contained in SA-6.1.

#### 5.1.2 Sample Identification Tag

The Sample Identification Tag (Attachment B-2) must be used with samples collected for Contract Laboratory Program (CLP) analysis. The tag is a white, heavy paper label that is attached to the neck of the sample bottle with a string or wire. The Sample Identification Tag is a controlled document, and is available from the Regional Sample Control Center (RSCC). Procedure SA-6.1 provides the steps in filling out Sample Identification Tags.

#### 5.1.3 Chain-of-Custody Record Form

The Chain-of-Custody Record Form accompanies a sample (or group of samples) as it is transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis, whether on-site or off-site. It is a controlled document. Each EPA Region in Zone 1 uses a

slightly different Chain-of-Custody form. Attachment B-3 illustrates a Chain-of-Custody Record form used by Region III. Chain-of-custody record forms for Regions I, II, and IV are illustrated in SA-6.1 as well as procedures for filling out forms.

### 5.1.4 Chain-of-Custody Seal

Attachment B-4 is an example of a custody seal. The Custody seal is a 1- by 3-inch adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. It is used whenever samples are shipped with an accompanying Chain-of-Custody Record form. The chain-of-custody seal is available from the RSCC. Procedure SA-6.1 describes the procedures for using chain-of-custody seals.

### 5.1.5 Bottle Delivery Order (DO) Form

If CLP analyses are requested, a Delivery Order (DO) form (Attachment B-5) is completed by the Authorized Requestor and submitted to the CLP Sample Bottle Repository (see Procedure SA-6.6). This form is required but not a controlled document.

### 5.1.6 Repository Packing List (PL) Form

The Repository Packing List form (Attachment B-6) is used for CLP analyses. This form is completed by the Sample Bottle Repository when the requested sample bottles are shipped. A copy of the PL is received with the sample bottle shipment and is retained by the Authorized Requestor.

### 5.1.8 Sample Log Sheet

A Sample Log Sheet is a notebook (3-ring binder) page that is used to record specified types of data while sampling. Attachments B-7 to B-10 are examples of Sample Log Sheets. The data recorded on these sheets are useful in describing the waste source and sample as well as pointing out any problems encountered during sampling. Guidelines for filling out the Sample Log Sheet are contained in SA-6.6. These forms are not controlled documents.

### 5.1.9 Traffic Reports (for CLP Laboratory Analyses)

A Traffic Report (TR) is a preprinted form that is provided by the EPA Sample Management Office to each Region through the Regional Sample Control Center (RSCC). These forms are obtained from the RSCC as needed for specific work assignments. These forms are part of the EPA sample-tracking system and are used to trace the shipment of samples for CLP laboratory analysis. Presently, these forms are for two types of samples: organics (OTR) and inorganics (ITR) (see Attachments B-11 and B-12, respectively). The organics and inorganics forms are used to document and identify the collection of low- and medium-concentrations samples for organic and inorganic analysis. Up to 20 samples can be recorded on each traffic report. Guidelines for filling out traffic report forms are contained in SA-6.6

### 5.1.10 Traffic Report Label

The Traffic Report Label is a small prenumbered white label with black lettering and an adhesive backing. Attachment B-13 provides examples of several traffic report labels. The number which appears on a traffic report label is uniquely numbered and used to track samples for CLP analysis. In addition to the number, each label contains a designation as to the type of analysis to be performed (VOA, etc.) or as to preservation of the sample (preserved unpreserved, etc.). Use of these labels is described in Procedure SA-6.6.

### 5.1.11 Special Analytical Services (SAS) Packing List

In addition to routine analytical services (RAS), some special analytical services (SAS) are available through the CLP. These may include quick turnaround or verification analyses, non-priority pollutant analyses, analyses requiring lower detection limits than RAS methods provide, or other specific analyses (e.g., EP toxicity testing). For all "all SAS" type of request (in contrast to "RAS plus SAS," see Procedure SA-6.6), the SAS Packing List (Attachment B-14) is used rather than a traffic report. SAS Packing Lists are provided by the SMO to each region through the RSCC, which provides forms as required. Use of the SAS form is further described in Procedure SA-6.6

### 5.1.12 Dioxin Shipment Record (DSR)

The Dioxin Shipment Record (DSR) provides a record for one shipment batch (up to 24 samples) of dioxin samples to a CLP laboratory. Samples are individually numbered using the pre-printed labels provided with the DSR (see Attachment B-15). DSRs are provided by the SMO to each region through the RSCC. DSRs must be used to track shipment of dioxin samples submitted for CLP analysis. See Procedure SA-6.6 for detailed description of the use of DSRs.

### 5.1.13 Sample Shipping Log

The sample shipping log, shown in Attachment B-16 is required by Region III EPA and is to be completed whenever samples are shipped to a CLP Laboratory. The sample shipping log is then submitted to the RSCC the week following sample collection.

## 5.2 GEOHYDROLOGICAL AND GEOTECHNICAL FORMS

### 5.2.1 Groundwater Level Measurement Sheet

A groundwater level measurement sheet, shown in Attachment C-1 should be filled out for each round of water level measurements at a site. These sheets are not controlled documents.

### 5.2.2 Data Sheet for Pumping Test (Pumping Well)

During the performance of a pumping test, a large amount of data must be recorded, often within a short time period. The pumping test data sheet (Attachment C-2) facilitates this task by standardizing the data collection format, and allowing the time interval for collection to be laid out in advance. This form is not a controlled document.

### 5.2.3 Data Sheet for Pumping Test (Observation Well) or In-Situ Hydraulic Conductivity Test

This data sheet (Attachment C-3) is similar to that described in Section 5.2.2. However, somewhat different data must be recorded for pumping test observation wells and in-situ hydraulic conductivity tests, as shown on this sheet. This form is not a controlled document.

### 5.2.4 Packer Test Reporting Forms

A packer test reporting form shown in Attachment C-4 is used for collecting data when conducting packer tests during monitoring well drilling. These sheets are not controlled documents.

### 5.2.5 Summary Log of Boring

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring (Attachment C-5) is used for this purpose. In addition, if volatile organics are monitored on cores, samples or cuttings from the borehole (using HNU or OVA detectors), the results are entered on the boring log at the appropriate depth. The boring log also provides space for entry of the laboratory sample number and the concentration of a few key analytical results. This feature allows direct comparison of contaminant concentrations with soil characteristics.

The Summary Log of Boring is not a controlled document.

### 5.2.6 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter sand and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock), different forms are used (see Attachments C-6 through C-10). The Monitoring Well Construction Details Form is not a controlled document. Guidelines on completing this form are contained in GH-1.7.

### 5.2.7 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician. Test Pit Logs (Attachment C-11) are not controlled documents.

## 5.3 EQUIPMENT CALIBRATION AND MAINTENANCE FORMS

### 5.3.1 Equipment Calibration Log

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, other infrequent. Some are calibrated by the manufacturer, other by the user.

Each instrument requiring calibration has its own Equipment Calibration Log (Attachment D-1) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. This form is not a controlled document.

## 6.0 REFERENCES

None.

## 7.0 ATTACHMENTS

Attachment A - Technical Forms in Current Use for Remedial Investigations
Attachment B-1 - Sample Label
Attachment B-2 - Sample Identification Tag
Attachment B-3 - Chain-of-Custody Record From, Region III
Attachment B-4 - Chain-of-Custody Seal
Attachment B-5 - CLP Sample Bottle Repository Order Form
Attachment B-6 - Repository Packing List Form
Attachment B-7 - Groundwater Sample Log Sheet Form
Attachment B-8 - Soil Sample Log Sheet Form
Attachment B-9 - Surface Water Sample Log Sheet Form
Attachment B-10 - Container Sample Log Sheet Form
Attachment B-11 - Organics Traffic Report Form
Attachment B-12 - Inorganics Traffic Report Form
Attachment B-13 - Traffic Report Labels
Attachment B-14 - Special Analytical Services (SAS) Packing List
Attachment B-15 - Dioxin Shipment Record Form
Attachment B-16 - Sample Shipping Log
Attachment C-1 - Groundwater Level Measurement Sheet
Attachment C-2 - Pumping Test Data Sheet
Attachment C-3 - Hydraulic Conductivity Testing Data Sheet
Attachment C-4 - Packer Testing Report Form
Attachment C-5 - Summary Log of Boring
Attachment C-6 - Overburden Monitoring Well Construction Sheet
Attachment C-7 - Confining Layer Monitoring Well Construction Sheet
Attachment C-8 - Bedrock (Open Hole) Monitoring Well Construction Sheet
Attachment C-9 - Bedrock (Well Installed) Monitoring Well Construction Sheet
Attachment C-10 - Bedrock (Well Installed) Monitoring Well Construction Sheet
Attachment C-11 - Test Pit Log Form
Attachment D-1 - Equipment Calibration Log

## ATTACHMENT A

### TECHNICAL FORMS IN CURRENT USE FOR REMEDIAL INVESTIGATIONS

| | Attachment Number | Form Usage Described in SOP Number | Controlled/ Required Document |
|---|---|---|---|
| B-1 | Sample Label | SA-6.1 | Required |
| B-2 | Sample Identification Tag | SA-6.1 | Controlled |
| B-3 | Chain of Custody Record, Region III | SA-6.1 | Controlled |
| B-4 | Chain-of-Custody Seal | SA-6.6 | Controlled |
| B-5 | CLP Sample Bottle Repository Form | SA-6.6 | Required |
| B-6 | Repository Packing List Form | SA-6.6 | Required |
| B-7 | Groundwater Sample Log Sheet | SA-6.6 | Required |
| B-8 | Soil Sample Log Sheet | SA-6.6 | Required |
| B-9 | Surface Water Sample Log Sheet | SA-6.6 | Required |
| B-10 | Container Sample Log Sheet | SA-6.6 | Required |
| B-11 | Organics Traffic Report Form | SA-6.6 | Controlled |
| B-12 | Inorganics Traffic Report Form | SA-6.6 | Controlled |
| B-13 | Traffic Report Labels | SA-6.6 | Controlled |
| B-14 | Special Analytical Services (SAS) Packing List | SA-6.6 | Required |
| B-15 | Dioxin Shipment Record Form | SA-6.6 | Required |
| B-16 | Sample Shipping Log | SA-6.4 | Required |
| C-1 | Groundwater Level Measurement Sheet | GH-2.5 | Required |
| C-2 | Pumping Test Data Sheet | GH-2.3 | Required |
| C-3 | Hydaulic Conductivity Testing Data Sheet | GH-2.4 | Required |
| C-4 | Packer Testing Report Form | GH-2.2 | Required |
| C-5 | Summary Log of Boring | GH-1.5 | Required |
| C-6 | Overburden Monitoring Well Construction Sheet | GH-1.5 | Required |
| C-7 | Confining Layer Monitoring Well Construction Sheet | GH-1.5 | Required |
| C-8 | Bedrock (Open Hole) Monitoring Well Construction Sheet | GH-1.5 | Required |
| C-9 | Bedrock (Well Installed) Monitoring Well Construction Sheet | GH-1.5 | Required |
| C-10 | Bedrock (Well Installed) Monitoring Well Construction Sheet | GH-1.5 | Required |
| C-11 | Test Pit Log | GH-1.8 | Required |
| D-1 | Equipment Calibration Log | ---- | Required |

## ATTACHMENT B-1

## SAMPLE LABEL

[redacted] PROJECT: _____

STATION LOCATION: _____

DATE: ___/___/___ TIME: _____ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ _____ ☐

CONCENTRATION: LOW ☐ MED ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

| ANALYSIS | PRESERVATION |
|---|---|
| VOA ☐ BNA's ☐ | Cool to 4°C ☐ |
| PCB's ☐ PESTICIDES ☐ | $HNO_3$ to pH <2 ☐ |
| METALS: TOTAL ☐ DISSOLVED ☐ | NAOH to pH>12 ☐ |
| CYANIDE ☐ | _____ ☐ |
| _____ ☐ | |

Sampled by: _____

Case No.: _____ Traffic Report No.: _____

Remarks:

ACFILE: FORMS\BOTLABL

## ATTACHMENT B-2

## SAMPLE IDENTIFICATION TAG

☆ GPO 505-552

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA

Designate: Grab / Comp

Time

Month/Day/Year

Station No.

Project Code

Samplers (Signatures)

Station Location

**Preservative:**
Yes ☐ No ☐

**ANALYSES**

| | |
|---|---|
| BOD Anions Solids (TSS) (TDS) (SS) | |
| COD, TOC, Nutrients | |
| Phenolics | |
| Mercury | |
| Metals | |
| Cyanide | |
| Oil and Grease | |
| Organics GC/MS | |
| Priority Pollutants | |
| Volatile Organics | |
| Pesticides | |
| Mutagenicity | |
| Bacteriology | |
| | |

Remarks:

Tag No. 3 60966

Lab Sample No.

ATTACHMENT B-3

CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

CHAIN OF CUSTODY RECORD

| PROJ. NO. | PROJECT NAME | | | | | NO. OF CON-TAINERS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLERS: (Signature) | | | | | | | | | | | | | |
| STA. NO. | DATE | TIME | COMP. | GRAB | STATION LOCATION | | | | | | | | |
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|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date / Time | Received by: (Signature) | Relinquished by: (Signature) | Date / Time | Received by: (Signature) |
| Relinquished by: (Signature) | Date / Time | Received by: (Signature) | Relinquished by: (Signature) | Date / Time | Received by: (Signature) |
| Relinquished by: (Signature) | Date / Time | Received for Laboratory by: (Signature) | Date / Time | Remarks | |

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

3-15966

D334901

**ATTACHMENT B-4**

**CHAIN-OF-CUSTODY SEAL**

**CUSTODY SEAL**

**Date**

**Signature**

**CUSTODY SEAL**

**Date**

**Signature**

**ATTACHMENT B-5**
**CLP SAMPLE BOTTLE REPOSITORY**
**SUPERFUND DELIVERY REQUEST**

**REQUEST NO.** _____

Date of Request: _____

Type of Request:
Routine [ ]
Fast Turnaround [ ] _____
Emergency [ ] _____
(Date/Time request called in)

From (Name): _____
Affiliation: _____
Telephone: _____
AR Signature: _____

TO: I-Chem Research Corporation
23787-F Eichler Street
Hayward, CA 94545
Phone: 415/782/3095

Ship the following items for arrival by: _____ (Date)
(If applicable) Ship to arrive no earlier than: _____ (Date)

| Item | | Description | No. of Items Per Case | No. of Cases Requested |
|---|---|---|---|---|
| A | 80-oz. | amber glass bottle | 6 | |
| B | 40-ml | glass vial | 72 | |
| C | 1-liter | polyethylene bottle | 12 | |
| D | 120-ml | wide-mouth glass vial | 12 | |
| E | 1-oz. | wide-mouth glass jar | 12 | |
| F | 8-oz. | wide-mouth glass jar | 12 | |
| G | 4-oz. | wide-mouth glass jar | 12 | |
| H | 1-liter | amber glass bottle | 12 | |
| J | 32-oz. | wide-mouth glass jar | 12 | |
| K | 4-liter | amber glass bottle | 4 | |
| L | 500-ml | polyethylene bottle | 24 | |

Ship To: _____
(Provide _____
street address) _____
Attention: _____
Call before delivery: _____
(Phone No.): _____

DISTRIBUTION: *White-Repository* *Yellow-Requestor* *Pink-SMO*

## ATTACHMENT B-6

### CLP SAMPLE BOTTLE REPOSITORY SUPERFUND PACKING LIST

**REPOSITORY**

I-Chem Research Corporation
23787-F Eichler Street
Hayward, CA 94545
Phone: 415/782-3905

**DELIVERY REQUEST NO.** _____

Request date: _____

Type of Request: R ☐ FTA ☐ E ☐

Required Delivery Date: _____

**DESTINATION (from Delivery Request)**

Name: _____

Address: _____

_____

_____

Telephone No: _____

The materials listed below have been shipped as requested.

Date Shipped: _____

Mode of Shipment: _____

Shipment ID No: _____

Signature: _____

Type of Shipment: ___ Complete ___ Partial ___ Partial/Completes Request

| Item No. | Description | | No. of Cases Shipped | Lot Number(s) | QC Clearance Number(s) |
|---|---|---|---|---|---|
| A | 80-oz | glass | _____ | _____ | _____ |
| B | 40-mL | glass | _____ | _____ | _____ |
| C | 1-L | poly | _____ | _____ | _____ |
| D | 120-mL | glass | _____ | _____ | _____ |
| E | 16-oz | glass | _____ | _____ | _____ |
| F | 8-oz | glass | _____ | _____ | _____ |
| G | 4-oz | glass | _____ | _____ | _____ |
| H | 1-L | glass | _____ | _____ | _____ |
| J | 32-oz | glass | _____ | _____ | _____ |
| K | 4-L | glass | _____ | _____ | _____ |
| L | 500-mL | poly | _____ | _____ | _____ |

***—AUTHORIZED REQUESTOR USE ONLY—***

Sign below and forward the yellow copy to the Sample Management Office (SMO) within 7 days of shipment receipt. Keep the pink copy for your file.

The above request was received by the designee, inspected, and accepted.

Date of Receipt: _____ Requestor Signature: _____

Send yellow copy to: USEPA Sample Management Office
P.O. Box 818
Alexandria, VA 22313

*DISTRIBUTION:* *White—Shipment Designee*
*Blue—Shipping Contractor*
*Green—SMO*
*Yellow—Requestor (for return to SMO)*
*Pink—Requestor*
*Gold—Repository*

**ATTACHMENT B-7**

NUS CORPORATION
A Halliburton Company

# SAMPLE LOG SHEET

☐ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Page _____ of _____
Case # _____
By _____

Project Site Name _____ Project Site Number _____
NUS Source No. _____ Source Location _____

| Total Well Depth: | Purge Data | | | | |
|---|---|---|---|---|---|
| Well Casing Size & Depth: | Volume | pH | S.C. | Temp. (°C) | Color & Turbidity |
| | | | | | |
| Static Water Level: | | | | | |
| One Casing Volume: | | | | | |
| Start Purge (hrs.): | | | | | |
| End Purge (hrs.): | | | | | |
| Total Purge Time (min.): | | | | | |
| Total Amount Purged (gal.): | | | | | |
| Monitor Reading: | | | | | |
| | | | | | |
| Purge Method: | | | | | |
| Sample Method: | | | | | |
| Depth Sampled: | | | | | |
| Sample Date & Time: | Sample Data | | | | |
| | pH | S.C. | Temp. (°C) | Color & Turbidity | |
| Sampled By: | | | | | |

Signature(s):

Observations / Notes:

Type of Sample
☐ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

| Analysis: | Preservative | | Organic | Inorganic |
|---|---|---|---|---|
| | | Traffic Report # | | |
| | | Tag # | | |
| | | AB # | | |
| | | Date Shipped | | |
| | | Time Shipped | | |
| | | Lab | | |
| | | Volume | | |

ATTACHMENT B-8

NUS CORPORATION
A Halliburton Company

# SAMPLE LOG SHEET

Page _____ of _____

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☐ Sediment
- ☐ Lagoon / Pond
- ☐ Other _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

| Sample Method: | Composite Sample Data | | |
|---|---|---|---|
| | Sample | Time | Color / Description |
| Depth Sampled: | | | |
| Sample Date & Time: | | | |
| Sampled By: | | | |
| Signature(s): | | | |
| Type of Sample<br>☐ Low Concentration<br>☐ High Concentration<br>☐ Grab<br>☐ Composite<br>☐ Grab - Composite | | | |

| Sample Data | |
|---|---|
| Color | Description: (Sand, Clay, Dry, Moist, Wet, etc.) |

Analysis:

Observations / Notes

| | Organic | Inorganic |
|---|---|---|
| Traffic Report # | | |
| Tag # | | |
| AB # | | |
| Date Shipped | | |
| Time Shipped | | |
| Lab | | |
| Volume | | |

**ATTACHMENT B-9**

NUS CORPORATION
A Halliburton Company

# SAMPLE LOG SHEET

Page _____ of _____

☐ Spring
☐ Lake
☐ Stream
☐ Other _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

| Sample Method: | Sample Data | | | |
|---|---|---|---|---|
| | pH | S.C. | Temp. (°C) | Color & Turbidity |
| Depth Sampled: | | | | |
| Sample Date & Time: | | | | |
| Sampled By: | | | | |
| Signatures: | | | | |

Type of Sample
☐ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

| Analysis: | Preservative |
|---|---|
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| | Organic | Inorganic |
|---|---|---|
| Traffic Report # | | |
| Tag # | | |
| AB # | | |
| Date Shipped | | |
| Time Shipped | | |
| Lab | | |
| Volume | | |

ATTACHMENT B-10

NUS CORPORATION
A Halliburton Company

# SAMPLE LOG SHEET

Container Data

Page _____ of _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

| Container Source | Container Description |
|---|---|
| ☐ Drum<br>☐ Bung Top<br>☐ Lever Lock<br>☐ Bolted Ring<br>☐ Other _____<br>☐ Bag / Sack<br>☐ Tank<br>☐ Other _____ | Color _____<br>Condition _____<br>Markings _____<br>Vol. of Contents _____<br>Other _____ |

| Disposition of Sample | Sample Description | Layer 1 | Layer 2 | Layer 3 |
|---|---|---|---|---|
| ☐ Container Sampled<br>☐ Container opened but not sampled. Reason _____<br>Container not opened. Reason _____ | Phase | ☐Sol. ☐Liq. | ☐Sol. ☐Liq. | ☐Sol. ☐Liq. |
| | Color | | | |
| | Viscosity | ☐L ☐M ☐H | ☐L ☐M ☐H | ☐L ☐M ☐H |
| | % of Total Volume | | | |
| | Other | | | |

| Monitor Reading: | Type of Sample | |
|---|---|---|
| Sample Method: | ☐ Low Concentration<br>☐ High Concentration | ☐ Grab<br>☐ Composite<br>☐ Grab - Composite |

| Sample Date & Time: | | Organic | Inorganic |
|---|---|---|---|
| | Traffic Report # | | |
| Sampled By: | Tag # | | |
| Signature(s): | AB # | | |
| | Date Shipped | | |
| Analysis: | Time Shipped | | |
| | Lab | | |
| | Volume | | |

## ATTACHMENT B-11

USEPA CONTRACT LABORATORY PROGRAM
SAMPLE MANAGEMENT OFFICE

CASE NO:

SAS NO: (IF APPLICABLE)

# ORGANIC TRAFFIC REPORT

TYPE OF ACTIVITY (CIRCLE ONE) ①
SUPERFUND—PA SI ESI RIFS RD RA ER
NPLD O&M OTHER _____
NON-SUPERFUND—_____PROGRAM

SITE NAME:

CITY, STATE: SITE SPILL ID:

REGION NO: SAMPLING COMPANY ②

SAMPLER: (NAME)

SHIP TO: ③

ATTN: _____

SAMPLING DATE: ④

BEGIN: _____ END: _____

DATE SHIPPED: _____ CARRIER: _____ ⑤

AIRBILL NO: _____

SAMPLE DESCRIPTION ⑥
(ENTER IN BOX A)
1. SURFACE WATER
2. GROUND WATER
3. LEACHATE
4. SOIL
5. SEDIMENT
6. OIL (SAS)
7. WASTE (SAS)

TRIPLE VOLUME REQUIRED FOR MATRIX SPIKE/DUPLICATE AQUEOUS SAMPLE

SHIP MEDIUM AND HIGH CONCENTRATION SAMPLES IN PAINT CANS

SEE REVERSE FOR ADDITIONAL INSTRUCTIONS

| CLP SAMPLE NUMBER (FROM LABELS) | SAMPLE DESCRIPTION ⑥ (FROM BOX 1) 1 2 3 4 5 6 7 | CONCENTRATION ⑦ L = LOW/MED M = HIGH (SAS) | RAS ANALYSIS ⑦ VOLATILE | BASE/NEUT ACID | PESTICIDE /PCB's | | SPECIAL HANDLING ⑧ | STATION LOCATION ⑨ |
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EPA Form 2075-7 (8-87)

WHITE — SMO COPY PINK — CLIENT COPY WHITE — LAB COPY FOR RETURN TO SMO YELLOW — LAB COPY

## ATTACHMENT B-12

USEPA CONTRACT LABORATORY PROGRAM
SAMPLE MANAGEMENT OFFICE

CASE NO:

SAS NO: (IF APPLICABLE)

# INORGANIC TRAFFIC REPORT

TYPE OF ACTIVITY (CIRCLE ONE) ①
SUPERFUND—PA SI ESI RIFS RD RA ER
NPLD O&M OTHER _____
NON-SUPERFUND—_____PROGRAM

SITE NAME:

CITY, STATE: SITE SPILL ID:

REGION NO: SAMPLING COMPANY ②

SAMPLER: (NAME)

SHIP TO: ③

ATTN: _____

SAMPLING DATE: ④

BEGIN: _____ END: _____

DATE SHIPPED: _____ CARRIER: _____ ⑤

AIRBILL NO: _____

SAMPLE DESCRIPTION ⑥
(ENTER IN BOX A)
1. SURFACE WATER
2. GROUND WATER
3. LEACHATE
4. SOIL
5. SEDIMENT
6. OIL (SAS)
7. WASTE (SAS)

DOUBLE VOLUME REQUIRED FOR MATRIX SPIKE/DUPLICATE AQUEOUS SAMPLE

SHIP MEDIUM AND HIGH CONCENTRATION SAMPLES IN PAINT CANS

SEE REVERSE FOR ADDITIONAL INSTRUCTIONS

| CLP SAMPLE NUMBER (FROM LABELS) | SAMPLE DESCRIPTION (FROM BOX 1) 1 2 3 4 5 6 7 ⑥ | CONCENTRATION L = LOW M = MED H = HIGH (SAS) ⑦ | RAS ANALYSIS ⑧ TOTAL METALS | CYANIDE | DISSOLVED METALS | HIGH ONLY (SAS) SUL/SOL | pH | CONDUC-TIVITY | CHLORIDES | SPECIAL HANDLING ⑨ | STATION LOCATION ⑩ |
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EPA Form 2075-8 (8-87)

WHITE — SMO COPY PINK — CLIENT COPY WHITE — LAB COPY FOR RETURN TO SMO YELLOW — LAB COPY

## ATTACHMENT B-13

## TRAFFIC REPORT LABELS

MAB 342

C 6003

AC 865 · Soil/Sediment (VOA)

ATTACHMENT B-14


**U.S. ENVIRONMENTAL PROTECTION AGENCY**
**CLP Sample Management Office**
**P.O. Box 818 - Alexandria, Virginia 22313**
**Phone: 703/557-2490 - FTS/557-2490**


**SAS Number**

**SPECIAL ANALYTICAL SERVICE**
**PACKING LIST**

| Sampling Office: | Sampling Date(s): | Ship To: | For Lab Use Only |
|---|---|---|---|
| Sampling Contact: (name) | Date Shipped: | | Date Samples Rec'd: |
| (phone) | Site Name/Code: | Attn: | Received By: |

| | Sample Numbers | Sample Description i.e., Analysis, Matrix, Concentration | Sample Condition on Receipt at Lab |
|---|---|---|---|
| 1. | | | |
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| 20. | | | |

For Lab Use Only

White - SMO Copy, Yellow - Region Copy, Pink - Lab Copy for return to SMO, Gold - Lab Copy

## ATTACHMENT B-15

USEPA Contract Laboratory Program
Sample Management Office
P O Box 818 Alexandria Virginia 22313
FTS 8-557-2490 703 557-2490

| CASE NO: | BATCH NO: |
|---|---|

### CLP DIOXIN SHIPMENT RECORD

| | | | |
|---|---|---|---|
| Site Name | Sampling Office | Ship To | FOR LAB USE ONLY<br>Date Samples Rec'd |
| City & State | City & State | Date Shipped | Received By |
| EPA Site No | Sampling Contact (name) | | |
| Latitude | Sampling Date | Transfer To | Date Samples Rec'd |
| Longitude | | Date Shipped | Received By |
| Tier 1 2 3 4 5 6 7 (circle one) | Data Turnaround 15-Day ____ 30-Day ____ | | |

| SAMPLE NUMBERS | MATRIX: SOIL SEDIMENT | MATRIX: OTHER | DESCRIPTION: FIELD SAMPLE | DESCRIPTION: SAMPLE NO DUPLICATE | DESCRIPTION: SAMPLE NO SPIKE | DESCRIPTION: BLANK | DESCRIPTION: EQUIPMENT RINSEATE | DESCRIPTION: OTHER (CLASS ONLY) | ADDL ANALYSIS: SPECIFY (CLASS ONLY) | FOR LAB USE: SAMPLE CONDITION ON RECEIPT |
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WHITE [illegible] YELLOW [illegible] PINK [illegible] GOLD [illegible]

ATTACHMENT B-16

page___ of ___ EPA SAMPLE SHIPPING LOG FOR ALL SAMPLES SENT THROUGH THE CONTRACT LAB PROGRAM (12/85 version)

CASE#_____ SAS#_____ SITE NAME:_____

Site Leader:_____ EPA Project Officer:_____

Phone:

SAS REQUEST:(details required)

| QC SAMPLE INFO AMB/BR COMMENTS | CONC. (low/med/high) | SAMPLE PHASE (aq/sol) | TYPE OF REQUEST org.dio inor. SAS | SAMPLE TRAFFIC REPORT NUMBER | ORGANICS OR INORGANICS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LAB NAME | DATE SHIPPED | DATA RECEIVED XX out items not requested | | | | | | | LAB NAME | SAS REQUEST (itemize) | DATE SHIPPED | DATA REC'D |
| | | | | | | | VOA | BNA | PEST | TCDD | METALS | CN | | | | | |
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## ATTACHMENT C-1

## GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____
Project No.: _____
Personnel: _____
Date: _____

LOCATION

Municipality: _____
County: _____
State: _____
Street or Map Location (If Off-Site) _____

WEATHER CONDITIONS

Temperature Range: _____
Precipitation: _____
Barometric Pressure: _____

Equipment No.: _____
Equipment Name: _____
Latest Calibration Date: _____

Tidally-Influenced: [ ] Yes [ ] No

| Well or Piezometer Number | Date/Time | Elevation of Reference Point (Feet)* | Water Level Indicator Reading (Feet)* | Adjusted Depth (Feet)* | Groundwater Elevation (Feet)* |
|---|---|---|---|---|---|
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* All elevations to nearest 0.01 foot.

## ATTACHMENT C-2
## PUMPING TEST DATA SHEET

***PUMPING TEST DATA SHEET*** ***NUS CORPORATION***

PROJECT NAME: _____ MEASURED WELL: _____
PROJECT NO.: _____ DATE: _____ PUMPING WELL: _____
GEOLOGIST: _____ CHECKED: _____ TEST NO. _____
DISTANCE FROM PUMPING WELL(ft.)(r): _____ PUMP SETTING, FEET BELOW MONITORING POINT: _____
STATIC $H_2O$ LEVEL (ft.)($s_0$): _____ MONITORING POINT: _____
TIME PURGE START OR STOP ($t_0$): _____ ELEVATION OF MONITORING POINT (ft. above MSL) _____

| TIME | (t) MIN. SINCE PUMP START OR STOP | WATER LEVEL MEASUREMENTS (ft.) | | | (s) DD Or RECOVERY (ft.) | PUMPING RATE (Q) GPM | REMARKS |
|---|---|---|---|---|---|---|---|
| | | READING | CORRECTION | DTW | | | |
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## ATTACHMENT C-3

***HYDRAULIC CONDUCTIVITY TESTING DATA SHEET*** ***NUS CORPORATION***

PROJECT NAME: ..... WELL/BORING NO.: .....
PROJECT NO.: ..... GEOLOGIST: .....
WELL DIAMETER: ..... SCREEN LENGTH/DEPTH: ..... TEST NO.: .....
STATIC WATER LEVEL (Depth/Elevation): ...../..... DATE: .....
TEST TYPE (Rising/Falling/Constant Head): ..... CHECKED: .....
METHOD OF INDUCING WATER LEVEL CHANGE: ..... PAGE ___ OF ___

| TIME | ELAPSED TIME (min. or sec.) | MEASURED DEPTH TO WATER (ft.) | CORRECTION | DEPTH TO WATER (ft.) | DRAWDOWN OR HEAD (ft.) | REMARKS |
|---|---|---|---|---|---|---|
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NAC 3/88

# ATTACHMENT C-4
## PACKER TESTING REPORT FORM

### PACKER TEST REPORT

PROJECT: _____
BORING NO.: _____ CASING DEPTH: _____
TEST INTERVAL: _____

PROJECT NO.: _____ TEST NO: _____
CONTRACTOR: _____
BY: _____ CHECKED: _____

PAGE _____ OF _____
STATIC WATER LEVEL _____
PACKER PRESSURE _____

| Flow Test | | | | | Calculated Results | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pressure, p (psi) | Elapsed Time (min) | Flow Reading | Δ Flow, ΔQ (ft³) | Δ Flow, ΔQ (gal) | Flow Rate Q (gal/min) | $H_1$* (ft) | Hp(ft) = 2.31 (psi) | $H_2$* (ft) | H = Hp + (H1 or H2) | Cp | K (ft/yr) = Cp·Q/H | K (ft/yr) = (9.67 x 10⁻⁷) · K (ft/yr) |
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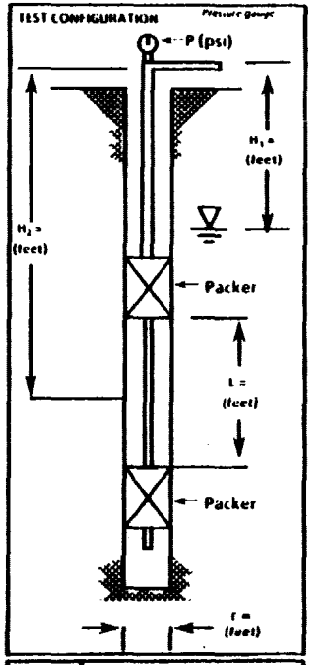


| Length of test section L (feet) | Cp (Sealing Mechanism Type) | | | |
|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] |
| 5 | [illegible] | [illegible] | [illegible] | [illegible] |
| 8 | [illegible] | [illegible] | [illegible] | [illegible] |
| 10 | [illegible] | [illegible] | [illegible] | [illegible] |
| 15 | [illegible] | [illegible] | [illegible] | [illegible] |
| 20 | [illegible] | [illegible] | [illegible] | [illegible] |

CP = (1/(2 π L)) ln(L/r) (70,315.5)
7.48 Gallons = 1 ft³
1 psi = 2.31 ft head

* $H_1$ is used when the test length is below the water table
$H_2$ is used when the test length is above the water table

Remarks: _____

## ATTACHMENT C-5

**BORING LOG** — **NUS CORPORATION**

PROJECT: ..... BORING NO.: .....
PROJECT NO.: ..... DATE: ..... DRILLER: .....
ELEVATION: ..... FIELD GEOLOGIST: .....
WATER LEVEL DATA : .....
(Date, Time & Conditions) .....

| SAMPLE NO. & TYPE OR RQD | DEPTH (ft.) OR RUN NO. | BLOWS/ 6" OR RQD (%) | SAMPLE RECOVERY /SAMPLE LENGTH | LITHOLOGY CHANGE (Depth,ft.) OR SCREENED INTERVAL | MATERIAL DESCRIPTION | | | BORE USCS ROCK | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS | COLOR | MATERIAL CLASSIFICATION | | |
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REMARKS _____

BORING _____

PAGE ____ OF ____

# ATTACHMENT C-5 (CONTINUED)

## SOIL TERMS

### UNIFIED SOIL CLASSIFICATION (USCS)

#### COARSE GRAINED SOILS

*More than half of material is LARGER than No. 200 sieve size*

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights) | | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|
| GRAVELS 50%(+)>#4 Ø | CLEAN GRAVELS Low % fines | Wide range in grain size and substantial amounts of all intermediate particle sizes. | GW | Well graded gravels, gravel sand mixtures, little or no fines |
| | | Predominantly one size or a range of sizes with some intermediate sizes missing. | GP | Poorly graded gravels, gravel sand mixtures, little or no fines |
| | GRAVELS w/FINES High % fines | Non plastic fines (for identification procedures see ML) | GM | Silty gravels, poorly graded gravel-sand-silt mixtures. |
| | | Plastic fines (for identification procedures see CL) | GC | Clayey gravels, poorly graded gravel-sand-clay mixtures. |
| SANDS 50%(+)<#4 Ø | CLEAN SANDS Low % fines | Wide range in grain size and substantial amounts of all intermediate particle sizes. | SW | Well graded sand, gravelly sands, little or no fines |
| | | Predominantly one size or a range of sizes with some intermediate sizes missing. | SP | Poorly graded sands, gravelly sands, little or no fines |
| | SANDS w/FINES High % fines | Non plastic fines (for identification procedures see ML) | SM | Silty sands, poorly graded sand-silt mixtures |
| | | Plastic fines (for identification procedures see CL) | SC | Clayey sands, poorly graded sand clay mixtures. |

#### FINE GRAINED SOILS

*More than half of material is SMALLER than No. 200 sieve size*

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights) | | | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|---|
| Identification procedures on fraction smaller than No. 40 sieve size | | | | | |
| SILTS & CLAYS Liquid limit < 50 | DRY STRENGTH (Crushing Characteristics) | DILATANCY (Reaction to Shaking) | TOUGHNESS (Consistency Near Plastic Limit) | | |
| | None to slight | Quick to slow | None | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity |
| | Medium to high | None to very slow | Medium | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | Slight to medium | Slow | Slight | OL | Organic silts and organic silt-clays of low plasticity |
| SILTS & CLAYS Liquid limit > 50 | Slight to medium | Slow to none | Slight to medium | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts |
| | High to very high | None | High | CH | Inorganic clays of high plasticity, fat clays |
| | Medium to high | None to very slow | Slight to medium | OH | Organic clays of medium to high plasticity |
| HIGHLY ORGANIC SOILS | Readily identified by color, odor, spongy feel and frequently by fibrous texture. | | | Pt | Peat and other organic soils |

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

### DENSITY OF GRANULAR SOILS

| DESIGNATION | STANDARD PENETRATION RESISTANCE - BLOWS/FOOT |
|---|---|
| Very loose | 0-4 |
| Loose | 5-10 |
| Medium dense | 11-30 |
| Dense | 31-50 |
| Very dense | Over 50 |

### CONSISTENCY OF COHESIVE SOILS

| CONSISTENCY | UNC. COMPRESSIVE STR. TONS/SQ. FT. | STANDARD PENETRATION RESISTANCE - BLOWS/FOOT | FIELD IDENTIFICATION METHODS |
|---|---|---|---|
| Very soft | Less than 0.25 | 0 to 2 | Easily penetrated several inches by fist |
| Soft | 0.25 to 0.50 | 2 to 4 | Easily penetrated several inches by thumb |
| Medium stiff | 0.50 to 1.0 | 4 to 8 | Can be penetrated several inches by thumb |
| Stiff | 1.0 to 2.0 | 8 to 15 | Readily indented by thumb |
| Very stiff | 2.0 to 4.0 | 15 to 30 | Readily indented by thumbnail |
| Hard | More than 4.0 | Over 30 | Indented with difficulty by thumbnail |

## ROCK TERMS

### ROCK HARDNESS (FROM CORE SAMPLES)

| DESCRIPTIVE TERMS | SCREWDRIVER OR KNIFE EFFECTS | HAMMER EFFECTS |
|---|---|---|
| Soft | Easily gouged | Crushes when pressed with hammer |
| Medium soft | Can be gouged | Breaks (one blow) Crumbly edges |
| Medium hard | Can be scratched | Breaks (one blow) Sharp edges |
| Hard | Cannot be scratched | Breaks conchoidally (several blows) Sharp edges |

### ROCK BROKENNESS

| DESCRIPTIVE TERMS | ABBREVIATION | SPACING |
|---|---|---|
| Very broken | (V. Br.) | 0 - 2" |
| Broken | (Br.) | 2" - 1' |
| Blocky | (Bl.) | 1' - 3' |
| Massive | (M.) | 3' - 10' |

**LEGEND**

**SOIL SAMPLES - TYPES**

S - 2" O.D. Split Barrel Sample
U - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

**ROCK SAMPLES - TYPES**

X - NX (Conventional) Core (~2-1/8" O.D.)
Q - NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

**WATER LEVELS**

12/10
▽ 12.5' Initial Level - Date & Depth

12/10
▽ 11.5' Stabilized Level - Date & Depth

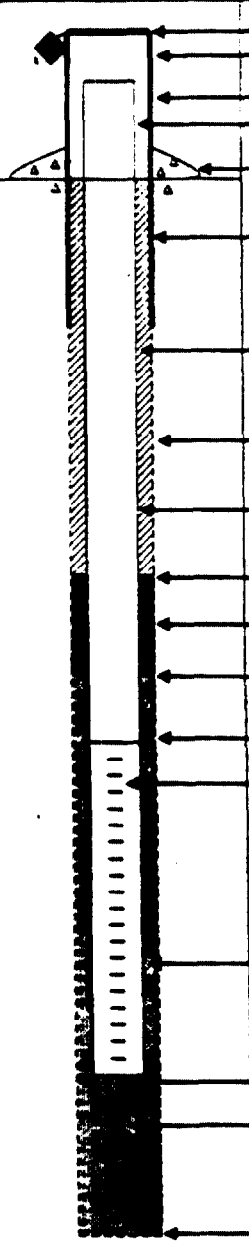
## ATTACHMENT C-6

NUS CORPORATION
A Halliburton Company

BORING NO. _____

### OVERBURDEN
# MONITORING WELL SHEET

PROJECT _____ LOCATION _____ DRILLER _____
PROJECT NO. _____ BORING _____ DRILLING METHOD _____
ELEVATION _____ DATE _____ DEVELOPMENT METHOD _____
FIELD GEOLOGIST _____




ELEVATION OF TOP OF SURFACE CASING: _____
ELEVATION OF TOP OF RISER PIPE: _____
STICK - UP TOP OF SURFACE CASING: _____
STICK - UP RISER PIPE: _____
TYPE OF SURFACE SEAL: _____
I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____
RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____
BOREHOLE DIAMETER: _____
TYPE OF BACKFILL: _____
ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____
DEPTH TOP OF SAND PACK: _____
ELEVATION / DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____
SLOT SIZE x LENGTH: _____
I.D. OF SCREEN: _____
TYPE OF SAND PACK: _____
ELEVATION / DEPTH BOTTOM OF SCREEN: _____
ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____
ELEVATION / DEPTH OF HOLE: _____

## ATTACHMENT C-7

NUS CORPORATION

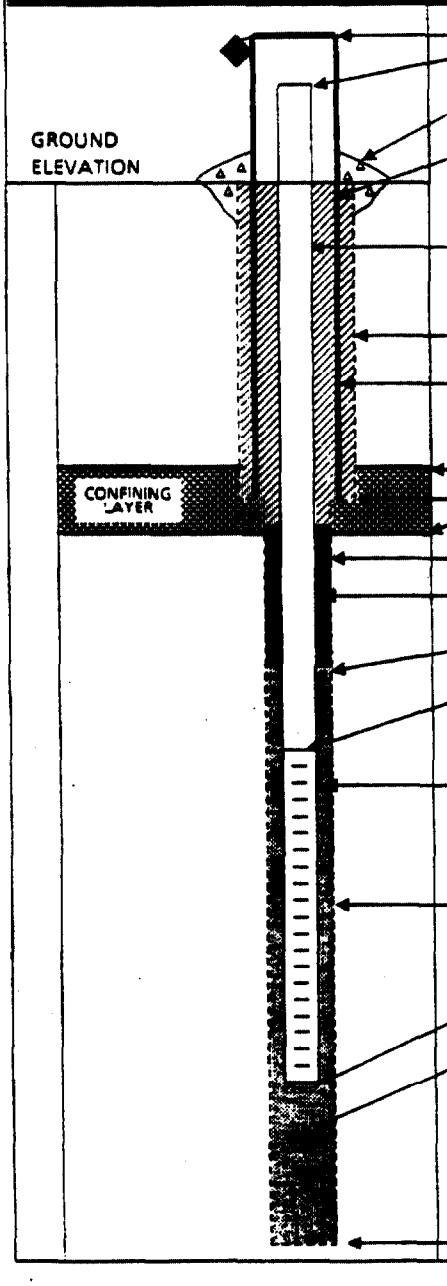
BORING NO.: _____

### CONFINING LAYER
# MONITORING WELL SHEET

11-5-87

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____




ELEVATION OF TOP OF PERM. CASING: _____
ELEVATION OF TOP OF RISER PIPE: _____

TYPE OF SURFACE SEAL: _____

I.D. OF PERM. CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TOP CONFINING LAYER: _____
ELEVATION / DEPTH BOTTOM OF CASING: _____
ELEVATION / DEPTH BOT. CONFINING LAYER: _____

ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

BOREHOLE DIA. BELOW CASING: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

## ATTACHMENT C-8

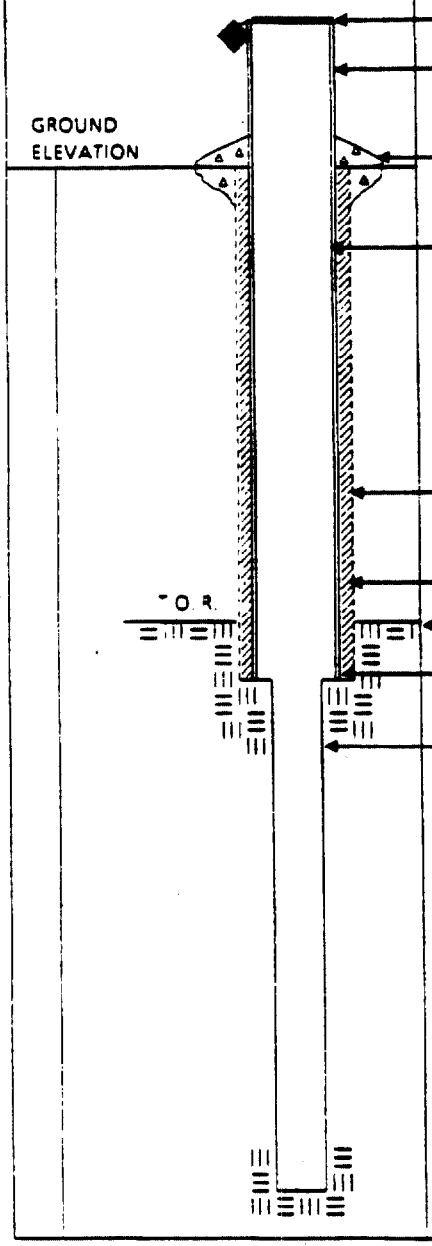
NUS CORPORATION
A Halliburton Company

BORING NO.: _____

# BEDROCK MONITORING WELL SHEET
## OPEN HOLE WELL

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____




ELEVATION OF TOP OF CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

TYPE OF SURFACE SEAL: _____

I.D. OF CASING: _____

TYPE OF CASING: _____

TEMP / PERM.: _____

DIAMETER OF HOLE: _____

TYPE OF CASING SEAL: _____

DEPTH TO TOP OF ROCK: _____

DEPTH TO BOTTOM CASING: _____

DIAMETER OF HOLE IN BEDROCK: _____

DESCRIBE IF CORE / REAMED WITH BIT:

_____

DESCRIBE JOINTS IN BEDROCK AND DEPTH:

_____

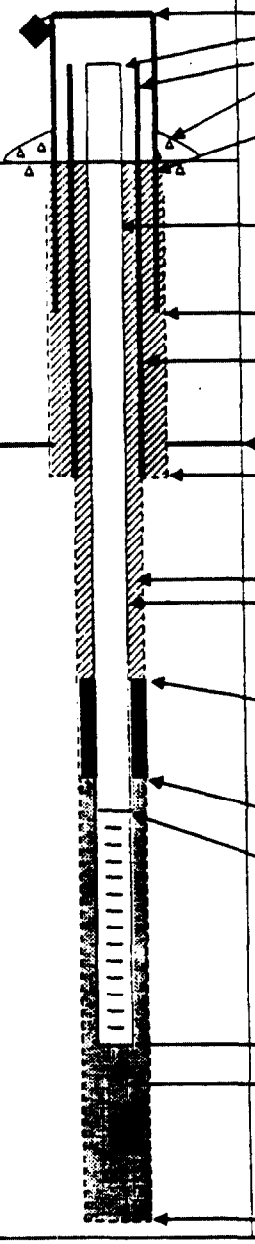
ELEVATION / DEPTH OF HOLE: _____

## ATTACHMENT C-9

BORING NO : _____

# BEDROCK
# MONITORING WELL SHEET
# WELL INSTALLED IN BEDROCK

PROJECT _____ LOCATION _____ DRILLER _____
PROJECT NO. _____ BORING _____ DRILLING METHOD _____
ELEVATION _____ DATE _____ DEVELOPMENT METHOD _____
FIELD GEOLOGIST _____




ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____
ELEVATION TOP OF PERM. CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TO BEDROCK: _____
ELEVATION/DEPTH BOTTOM OF CASING: _____

BOREHOLE DIA. BELOW CASING: _____
TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

## ATTACHMENT C-10

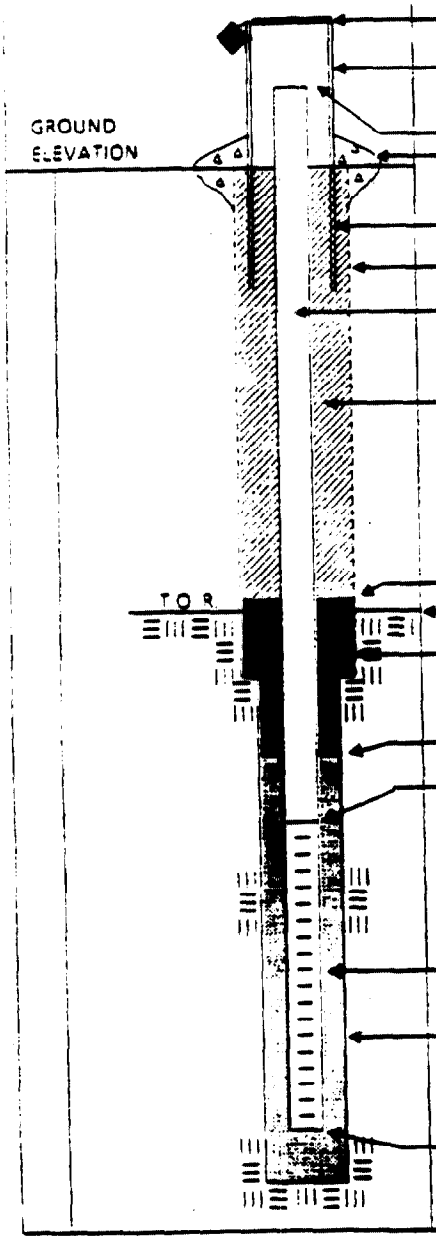
NUS CORPORATION
A Halliburton Company

BORING NO _____

# BEDROCK MONITORING WELL SHEET

## WELL INSTALLED IN BEDROCK

PROJECT _____ LOCATION _____ DRILLER _____
PROJECT NO. _____ BORING _____ DRILLING METHOD _____
ELEVATION _____ DATE _____ DEVELOPMENT METHOD _____
FIELD GEOLOGIST _____




ELEVATION OF TOP OF SURFACE CASING: _____
STICK UP OF CASING ABOVE GROUND SURFACE: _____
ELEVATION TOP OF RISER: _____
TYPE OF SURFACE SEAL: _____
I.D. OF SURFACE CASING: _____
DIAMETER OF HOLE: _____
RISER PIPE I.D.: _____
TYPE OF RISER PIPE: _____
TYPE OF BACKFILL: _____
ELEVATION / DEPTH TOP OF SEAL: _____
ELEVATION / DEPTH TOP OF BEDROCK: _____
TYPE OF SEAL: _____
ELEVATION / DEPTH TOP OF SAND: _____
ELEVATION / DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____
SLOT SIZE x LENGTH: _____
I.D. SCREEN: _____
TYPE OF SAND PACK: _____
DIAMETER OF HOLE IN BEDROCK:
CORE / REAM: _____
ELEVATION / DEPTH BOTTOM SCREEN: _____
ELEVATION / DEPTH BOTTOM OF HOLE: _____

## ATTACHMENT C-11

***TEST PIT LOG*** ***NUS CORPORATION***

PROJECT: ..... TEST PIT NO.: .....
PROJECT NO.: ..... DATE: .....
LOCATION: .....
FIELD GEOLOGIST: .....

| DEPTH (ft.) | LITHOLOGY CHANGE (Depth, ft.) | MATERIAL DESCRIPTION (Soil Density / Consistency, Color) | USCS | REMARKS |
|---|---|---|---|---|
| | | | | |
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Test Pit Cross Section and / or Plan View

REMARKS .....
.....
.....
.....

PHOTO LOG ..... TEST PIT .....
.....
..... PAGE ..... OF .....
.....

ATTACHMENT D-1

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.): _____

Manufacturer _____ Date Purchased _____

| Calibration Date | Initial Settings | Standard/Gas Used | Procedure | Adjustments Made | Final Settings | Signature | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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| NUS CORPORATION<br>ENVIRONMENTAL MANAGEMENT GROUP | STANDARD OPERATING PROCEDURES | Number SA-6.5 | Page 1 of 7 |
|---|---|---|---|
| | | Effective Date 05/04/90 | Revision 2 |
| | | Applicability EMG | |
| | | Prepared Earth Sciences | |
| Subject FIELD REPORTS | | Approved D. Senovich | |

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## 1.0 PURPOSE

This procedure describes the periodic field reports which are required to be filled out during the conduct of Remedial Investigation (RI) field studies. These reports on the progress of field assignments are not to be confused with the forms associated with boring and well installation, sampling, sample custody and equipment maintenance described in Procedure SA-6.4.

These reports serve several purposes:

- To maintain a written record of major events/accomplishments/problems related to the field work.
- To allow ongoing monitoring of the actual progress of field tasks in comparison to the planned schedule, and to allow timely corrective action (if required).
- To inform Site Managers of progress/accomplishments for inclusion in The Monthly Project Tracking System.

## 2.0 SCOPE

The reports described herein are to be used during field investgiations, but do not replace or take precedence over project-specific or subcontractor-specific required reports. Additional reporting may particularly be required at enforcement-lead sites.

## 3.0 GLOSSARY

None

## 4.0 RESPONSIBILITIES

Field Operations Leader - responsible for assuring that the appropriate reports are completed in the required time-frame. Responsibilities for filling out individual reports are identified within the description of the reports (see below).

## 5.0 PROCEDURES

### 5.1 PROGRAM DESIGN

The primary means of recording onsite activities is the site logbook (see Procedure SA-6.3) and other field logbooks (e.g. geologists notebook, health and safety officer's logbook, sample logbooks). However, these logbooks and notebooks usually contain extremely detailed information which is required for data interpretation or documentation, but not for tracking and reporting of progress. Furthermore, the field logbooks remain onsite for extended periods of time and are thus not accessible for review by project management. The reports described in this procedure are, in essence, simplified summaries of the logbooks, which are designed to provide only the information needed by project management to keep informed of the progress of field activities.

## 5.2 DAILY ACTIVITIES REPORT

### 5.2.1 Description

The Daily Activities Report documents the activities and progress for each day's field work. This report is filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors (Attachment A is an example of a Daily Activities Report).

### 5.2.2 Responsibilities

It is the responsibility of the rig geologist to complete the report and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

### 5.2.3 Submittal and Approval

At the end of the shift, the rig geologist submits the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The reports are retained by the FOL for use in preparing the site logbook and weekly Field Summaries, and are submitted to the Site Manager weekly along with the Weekly Field Summary.

## 5.3 FIELD TRIP SUMMARY

### 5.3.1 Description

The Field Trip Summary is an abstract of the Site Logbook, summarizing the major activities onsite for a particular week or field cycle (e.g., 10 days). It should be organized on a day-by-day basis, and contain the following information at a minimum (see Attachment B):

- Date (week ending)
- Personnel onsite (contractor, subcontractors, visitors)
- Weather conditions encountered during the week
- Site activities
- Number and type of samples collected (including C.O.C. form numbers)
- Issues impacting progress of the project.

### 5.3.2 Responsibilities

The Field Operations Leader or responsible individual onsite if not the FOL (e.g., geophysics team leader, sampling team leader) is responsible for completing the Weekly Field Summary at the end of each week of ongoing site activity, or at the completion of an activity (if no further activity will take place during that week).

### 5.3.3 Submittal and Approval

The summary, along with Daily Activities Reports, Health & Safety Officer's Reports, and any other documentation, must be delivered or sent to the Site Manager at the end of each week.

The Field Trip Summary is an internal informational document and is not subject to project management review or approval.

## 6.0 REFERENCES

None.

## 7.0 ATTACHMENTS

Attachment A - Rig Shift Report
Attachment B - Field Trip Summary Report (2 pages)

## ATTACHMENT A

***DAILY ACTIVITIES RECORD - FIELD INVESTIGATION*** ***NUS CORPORATION***

PROJECT NAME: _____ PROJECT NO.: _____
CLIENT: _____ LOCATION: _____
DATE: _____ ARRIVAL TIME: _____ DEPARTURE TIME: _____
CONTRACTOR: _____ DRILLER: _____
BORING NO.: _____ NUS REPRESENTATIVE: _____

| ITEM (1) | ORIGINAL QUANTITY (2) ESTIMATE | QUANTITY (2) TODAY | PREVIOUS TOTAL (2) QUANTITY | CUMULATIVE QUANTITY (2) TO DATE |
|---|---|---|---|---|
| 1. Mobilization/Demobilization | Job | | | |
| 2. Overburden Drilling/Sampling, minimum 6-inch | 100 ft. | | | |
| 3. Overburden Drilling, 10-inch | 250 ft. | | | |
| 4. Overburden Drilling 14-inch | 450 ft. | | | |
| 5. Bedrock Drilling 6-inch | 530 ft. | | | |
| 6. Bedrock Drilling 10-inch | 650 ft. | | | |
| 7. Bedrock Drilling 14-inch | 150 ft. | | | |
| 8. Temporary 6-inch Steel Casing | 250 ft. | | | |
| 9. Temporary 10-inch Steel Casing | 200 ft. | | | |
| 10. Temporary 14-inch Steel Casing | 250 ft. | | | |
| 11. Permanent 6-inch Steel Casing | 1,250 ft. | | | |
| 12. Permanent 10-inch Steel Casing | 400 ft. | | | |
| 13. PVC Well Construction/Installation | 1,120 ft. | | | |
| 14. Mine Void Sealing | 8 | | | |
| 15. Boring Backfilling | NA | | | |
| 16. Well Development | 24 hrs. | | | |
| 17. Test Borings | 200 ft. | | | |
| 18. Test Pit Excavation | 50 hrs. | | | |
| 19. Standby | 20 hrs. | | | |

COMMENTS: _____

(1) AS LISTED IN SPECS
(2) INCLUDE QUANTITY AND UNITS
(Ex. 20 ft., 6 hrs.)

APPROVED BY:

_____
NUS FIELD REPRESENTATIVE

_____
DRILLER OR REPRESENTATIVE

**ATTACHMENT B**
**PAGE 1 OF 2**
**FIELD TRIP SUMMARY REPORT**

**SUNDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**MONDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**TUESDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**WEDNESDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**ATTACHMENT B**
**PAGE 2 OF 2**
**FIELD TRIP SUMMARY REPORT**

**THURSDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**FRIDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

**SATURDAY**

Date: _____ Personnel: _____ _____

Weather: _____ Onsite: _____ _____

_____ _____

Site Activities: _____

_____

_____

_____

# APPENDIX B

# QUALITY ASSURANCE PROJECT PLAN (QAPP)

USEPA ID No. IN5 170 023 498

# RCRA FACILITY INVESTIGATION PHASE II RELEASE ASSESSMENT
# DRAFT QUALITY ASSURANCE PROJECT PLAN
# FOR
# SOLID WASTE MANAGEMENT UNITS
# #15/06, #14/00, #16/16
# NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
# CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Southern Division
Environmental Branch, Code 186 ND
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29411-0068

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Contract No. N62472-90-D-1298
Contract Task Order 0078

May 1993

PREPARED BY:

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PROJECT MANAGER
RUST ENVIRONMENT & INFRASTRUCTURE
SHEBOYGAN, WISCONSIN
Under subcontract to Halliburton NUS

APPROVED BY:

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
HALLIBURTON NUS CORPORATION

RCRA FACILITY INVESTIGATION PHASE II RELEASE ASSESSMENT
QUALITY ASSURANCE PROJECT PLAN
FOR
SOLID WASTE MANAGEMENT UNITS
#15/06, #14/00, #16/16
NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

Reviewed by: _____ Date: _____

Project Coordinator
Region V USEPA

Reviewed by: _____ Date: _____

Quality Assurance Manager
Region V USEPA

6/RP/78QAPPD/COVER

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## LIST OF ACRONYMS/ABBREVIATIONS

| | |
|---|---|
| ASTM | American Society of Testing and Materials |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| CL | Chloride |
| CLP | Contract Laboratory Program |
| COD | Chemical Oxygen Demand |
| CTO | Contract Task Order |
| DOT | Department of Transportation |
| DQO | Data Quality Objective |
| EMR | Phase I Environmental Monitoring Report |
| FTL | Field Team Leader |
| HASP | Health and Safety Plan |
| $H_2S$ | Hydrogen Sulfide |
| IATA | International Air Transport Association |
| LCSs | Laboratory Control Standards |
| MPR | Monthly Progress Report |
| MS/MSD | Matrix Spike/Matrix Spike Duplicate |
| $N_2$ | Nitrogen |
| NAVSURFWARCENDIV | Naval Surface Warfare Center, Crane Division |
| NEESA | Naval Energy and Environmental Support Activity |
| NIOSH | National Institute of Occupational Safety and Health |
| $NO_3$+$NO_2$ | Nitrate & Nitrite |
| NPL | National Priorities List |
| $O_2$ | Oxygen |
| OSHA | Occupational Safety and Health Administration |
| PARCC | Precision, Accuracy, Representativeness, Completeness, and Comparability |
| PCBs | Polychlorinated Biphenyls |
| %R | Percent Recovery |
| QAPP | Quality Assurance Project Plan |
| QA/QC | Quality Assurance/Quality Control |
| RA | Release Assessment |
| RFI | RCRA Facility Investigation |
| RPD | Relative Percent Difference |
| RPM | Remedial Project Manager |
| $SO_4$ | Sulfate |
| SOP | Standard Operating Procedures |
| SOW | Statement of Work |
| SVOC | Semi-Volatile Organic Compounds |
| SWMU | Solid Waste Management Unit |

## LIST OF ACRONYMS/ABBREVIATIONS (Continued)

| | |
|---|---|
| TDS | Total Dissolved Solids |
| TOC | Total Organic Carbon |
| TRPH | Total Recoverable Petroleum Hydrocarbons |
| USEPA | United States Environmental Protection Agency |
| VOA | Volatile Organic Analysis |
| VOC | Volatile Organic Compounds |

6/RP/78QAPPD/TOC

# 1.0 PROJECT DESCRIPTION

This document identifies the field sampling and quality assurance/quality control (QA/QC) procedures to be utilized during the RCRA Facility Investigation (RFI) Phase II Release Assessment (RA) field investigation activities to be performed at Naval Surface Warfare Center, Crane Division (NAVSURFWARCENDIV). The project is being conducted for the U.S. Navy Northern Division, Philadelphia, Pennsylvania, under CLEAN Prime Contract No. N62472-90-D-1298 held by Halliburton NUS Corporation. The information gathered during this project will be used for verification of contaminant releases at each solid waste management unit (SWMU) under investigation.

The NAVSURFWARCENDIV is located approximately 75 miles southwest of Indianapolis in south central Indiana and encompasses 63,000 acres in Martin County.

## 1.1 RFI RELEASE ASSESSMENT OBJECTIVES

The purpose of the RA is to demonstrate the absence or presence of hazardous waste or hazardous constituents released to the environment within the following SWMUs identified as posing potential threat to human health or the environment:

- SWMU #15/06: Roads and Grounds Area
- SWMU #14/00: Sanitary Landfill and Lithium Battery
- SWMU #16/16: Cast High Explosive Fill/Incinerator Building 146

The RA encompasses a multi-media study focused on verifying suspected releases of concern at each SWMU.

## 1.2 SAMPLING APPROACH AND OBJECTIVES

The Environmental Monitoring Report (EMR) completed as part of the Phase I RFI for SWMUs #15/06, #14/00, and #16/16 identified potential releases of hazardous waste or hazardous constituents. Accordingly, Phase II RFI Release Assessments for groundwater, surface water, and soil were recommended to verify suspected releases. Data presented in the EMR indicate that the primary contaminants associated with the respective SWMUs include pesticides, gasoline, fuel oil, waste oil, municipal refuse, special wastes (i.e. asbestos), landfill gas, lithium, heavy metals, explosive residues, contaminated wastewaters, and incinerator ash and residues.

Based upon evaluations of potential contaminant migration pathways and impacts as presented in Section 4.0 of the Work Plan (Figures 4-8, 4-10, and 4-12) coupled with consideration of potential primary contaminant sources within each SWMU, sampling needs specific to release verification within each SWMU have been identified. Summaries of samples to be collected during the Phase II RFI Release Assessment are presented in Tables 5-1 through 5-3 of the Work Plan. Sampling locations for the different media at the respective SWMUs are depicted on Figures 5-1 through 5-3 in the Work Plan.

The summary tables reflect a RA investigative approach focused on verification of releases attributable to identified potential primary sources. If confirmed, further characterization of such releases will be necessary in a Phase III Release Characterization. The summary tables (Tables 5-1 through 5-3 of the Work Plan) also reflect a judgmental sampling approach involving selection of sample locations based on visual evidence, operational characteristics, SWMU characteristics, and waste characteristics. Discrete grab samples will be collected for most media. Grab samples are targeted at potential hot spot contamination, coincident with areas displaying observable impacts (i.e. soil staining) or within areas considered optional with regard to past or present operations (i.e. sumps). Limited grid sampling will be conducted in conjunction with less well defined potentially impacted areas (i.e. former asphalt batch plant).

Sampling procedures, equipment, decontamination, and documentation will be consistent for each of the three SWMUs.

## 1.3 SAMPLE COLLECTION AND RATIONALE

The rationale and locations for sample collection are described in Tables 5-1 through 5-3 and Figures 5-1 through 5-3 of the Work Plan respectively.

## 1.4 PARAMETERS TO BE TESTED AND FREQUENCY

A summary of the samples to be collected and analyses to be performed is presented in Table 1-1.

# TABLE 1-1

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | FD | No. of Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #15/06 - ROADS AND GROUNDS AREA | | | | | | | | | | | | |
| Surface Soils | | SVOC | C | 30 | 2 | -- | -- | 3 | 35 | -- | 2 | 2 |
| | | Metals | C | 30 | 2 | -- | -- | 3 | 35 | 2 | 2 | -- |
| | | PCBs | C | 4 | 1 | -- | -- | 1 | 6 | -- | 1 | 1 |
| | | TRPH | C | 28 | 2 | -- | -- | 3 | 33 | 2 | -- | -- |
| | | VOC | C | 1 | 1 | -- | 1 | 1 | 4 | -- | 1 | 1 |
| | | Pesticides | C | 7 | 2 | -- | -- | 1 | 10 | -- | 1 | 1 |
| Subsurface Soils | | VOC | C | 2 | 1 | -- | 1 | 1 | 5 | -- | 1 | 1 |
| | | SVOC | C | 4 | 1 | -- | 1 | 1 | 6 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | 1 | 6 | 1 | 1 | -- |
| | | TRPH | C | 4 | 1 | -- | -- | 1 | 6 | 1 | -- | -- |
| Surface Water | Temp., pH, Specific Conductance | | EPA 1 | 4 | -- | -- | -- | -- | 4 | -- | -- | -- |
| | | Metals | C | 4 | 1 | 2 | -- | 1 | 8 | 1 | 1 | -- |
| | | COD | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | TDS | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | $SO_4$ | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | Alkalinity | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | VOC | C | 4 | 1 | 2 | 1 | 1 | 9 | -- | 1 | 1 |
| | | SVOC | C | 4 | 1 | 2 | -- | 1 | 8 | -- | 1 | 1 |
| | | $NO_2+NO_3$ | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | Cl | E | 4 | -- | 2 | -- | 1 | 7 | 1 | -- | -- |
| | | Pesticides | C | 4 | 1 | 2 | -- | 1 | 8 | -- | 1 | 1 |
| | | Cyanide | C | 1 | 1 | 2 | -- | 1 | 5 | 1 | 1 | -- |
| Sediment | | SVOC | C | 4 | 1 | -- | -- | 1 | 8 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | 1 | 8 | 1 | 1 | -- |
| | | $NO_2+NO_3$ | E | 4 | -- | -- | -- | 1 | 7 | 1 | -- | -- |
| | | TRPH | C | 4 | 1 | 2 | -- | 1 | 8 | 1 | -- | -- |
| | | Pesticides | C | 4 | 1 | -- | -- | 1 | 8 | -- | 1 | 1 |
| | | PCBs | C | 4 | 1 | 2 | -- | 1 | 8 | -- | 1 | 1 |

## TABLE 1-1 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #15/06 - ROADS AND GROUNDS AREA (Continued) | | | | | | | | | | | | |
| Groundwater from boreholes (if encountered) | Temp., pH, Specific Conductance | | EPA 1 | 2 | | | | | | | | |
| | | VOC | C | 2 | 1 | 2 | 1 | 1 | 7 | -- | -- | -- |
| | | SVOC | C | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | Metals | C | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TRPH | C | 2 | 1 | 2 | -- | 1 | 6 | -- | 1 | 1 |
| | | Cl | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | $SO_4$ | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | Alkalinity | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | COD | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TDS | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | $NO_2$ + $NO_3$ | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| | | TOC | E | 2 | 1 | 2 | -- | 1 | 6 | -- | -- | -- |
| SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY | | | | | | | | | | | | |
| Surface Water | Temp., pH, Specific Conductance | | EPA 1 | 3 | -- | -- | -- | -- | 3 | -- | -- | -- |
| | | VOC | C | 3 | 1 | -- | 1 | -- | 5 | -- | 1 | 1 |
| | | SVOC | C | 3 | 1 | -- | -- | -- | 4 | -- | 1 | 1 |
| | | Metals | C | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | Cl | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | $SO_4$ | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| | | Alkalinity | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | COD | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | TDS | E | 3 | 1 | -- | -- | -- | 4 | 1 | -- | -- |
| | | $NO_2$+$NO_3$ | E | 3 | 1 | -- | -- | -- | 4 | 1 | 1 | -- |
| Sediment | | VOC | C | 3 | 1 | -- | 1 | -- | 5 | -- | -- | -- |
| | | SVOC | C | 3 | 1 | -- | -- | -- | 4 | -- | -- | -- |
| | | Metals | C | 3 | 1 | -- | -- | -- | 4 | -- | -- | -- |
| Surface Soils | | SVOC | C | 4 | 1 | -- | -- | 1 | 6 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | 1 | 6 | 1 | 1 | -- |
| | | Lithium | C | 1 | 1 | 2 | -- | 1 | 5 | 1 | 1 | -- |
| | | PCBs | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |

## TABLE 1-1 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY (Continued) | | | | | | | | | | | | |
| Subsurface Soils | | SVOC | C | 4 | 1 | -- | -- | -- | 5 | -- | -- | -- |
| | | Metals | C | 4 | 1 | -- | -- | -- | 5 | -- | -- | -- |
| | | Lithium | C | 4 | 1 | | -- | 1 | 6 | 1 | 1 | -- |
| Groundwater from existing wells | Temp., pH, Specific Conductance | | EPA 1 | 20 | -- | -- | -- | -- | 20 | -- | -- | -- |
| | | VOC | C | 20 | 6 | 2 | 6 | 2 | 36 | -- | 2 | 2 |
| | | SVOC | C | 20 | 6 | 2 | -- | 2 | 30 | -- | 2 | 2 |
| | | Metals | C | 20 | 6 | 2 | -- | 2 | 30 | 2 | 2 | -- |
| | | Lithium | C | 2 | 1 | 2 | -- | 1 | 6 | 1 | 1 | -- |
| | | Cl | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | $SO_4$ | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | Alkalinity | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | COD | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | TDS | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | $NO_2+NO_3$ | E | 20 | 6 | 2 | -- | 1 | 29 | 2 | -- | -- |
| | | TOC | E | 20 | 6 | 2 | -- | 2 | 30 | 2 | -- | -- |
| Groundwater from boreholes | Temp., pH Specific Conductance | | EPA 1 | 4 | | | | | | | | |
| | | VOC | C | 4 | 1 | -- | 1 | -- | 6 | -- | 1 | 1 |
| | | SVOC | C | 4 | 1 | -- | -- | -- | 5 | -- | 1 | 1 |
| | | Metals | C | 4 | 1 | -- | -- | -- | 5 | 1 | 1 | -- |
| | | Lithium | C | 4 | 1 | 2 | -- | 1 | 8 | 1 | 1 | -- |
| | | Cl | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | $SO_4$ | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | Alkalinity | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | COD | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | TDS | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | $NO_2+NO_3$ | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |
| | | TOC | E | 4 | 1 | -- | -- | -- | 5 | 1 | -- | -- |

**TABLE 1-1 (Continued)**

**SAMPLING AND ANALYSIS SUMMARY**
**SWMUs #15/06, #14/00, #16/16**

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SWMU #14/00 - SANITARY LANDFILL AND LITHIUM BATTERY (Continued)** | | | | | | | | | | | | |
| Subsurface Gas | Oxygen, Methane | | | | | | | | | | | |
| | | VOC | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | Methane | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $O_2$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $H_2S$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | $N_2$ | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| | | Hydrocarbons | E | 25 | -- | -- | -- | 1 | 26 | -- | -- | -- |
| **SWMU #16/16 - CAST HIGH EXPLOSIVES FILL/INCINERATOR BUILDING 146** | | | | | | | | | | | | |
| Surface Water | | VOC | C | 2 | 1 | -- | 1 | -- | 4 | -- | -- | -- |
| | | SVOC | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | Explosives | E | 2 | 1 | 2 | -- | -- | 5 | -- | 1 | 1 |
| | | Metals | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | COD | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | Alkalinity | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | TDS | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| | | $NO_2+NO_3$ | E | 2 | -- | -- | -- | -- | 2 | -- | -- | -- |
| Sediment | | VOC | C | 2 | 1 | -- | 1 | 1 | 5 | -- | 1 | 1 |
| | | SVOC | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| | | Explosives | E | 2 | 1 | -- | -- | 1 | 4 | -- | 1 | 1 |
| | | Metals | C | 2 | 1 | -- | -- | -- | 3 | -- | -- | -- |
| Surface Soils | | Explosives | E | 14 | 2 | -- | -- | 1 | 17 | -- | 1 | 1 |
| | | Metals | C | 14 | 2 | -- | -- | 2 | 18 | 1 | 1 | -- |
| | | TRPH | C | 4 | 2 | -- | -- | 1 | 7 | -- | -- | -- |
| | | SVOC | C | 14 | 2 | -- | -- | 2 | 18 | -- | 1 | 1 |
| | | $NO_2+NO_3$ | E | 14 | 2 | -- | -- | 2 | 18 | 1 | -- | -- |
| | | PCBs | C | 8 | 2 | -- | -- | 1 | 11 | -- | -- | -- |

## TABLE 1-1 (Continued)

## SAMPLING AND ANALYSIS SUMMARY
## SWMUs #15/06, #14/00, #16/16

| Location/Matrix | Field Parameters | Laboratory Parameters | Navy QC Level | Field Samples | Field QC(1) RB | FB | TB | No. of FD | Samples | Laboratory QC LD | MS | MSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWMU #16/16 - CAST HIGH EXPLOSIVES FILL/INCINERATOR BUILDING 146 (Continued) | | | | | | | | | | | | |
| Groundwater from existing wells | Temp., pH, Specific Conductance | | EPA 1 | 5 | -- | -- | -- | -- | 5 | -- | -- | -- |
| | | SVOC | C | 6 | 2 | -- | -- | 1 | 9 | -- | 1 | 1 |
| | | Metals | C | 6 | 2 | -- | -- | 1 | 9 | -- | 1 | 1 |
| | | Explosives | E | 6 | 2 | 2 | -- | 1 | 11 | -- | 1 | 1 |
| | | VOC | C | 6 | 2 | -- | 2 | 1 | 11 | -- | 1 | 1 |
| | | TDS | E | 6 | 2 | -- | -- | 1 | 9 | 1 | -- | -- |
| | | $NO_3+NO_2$ | E | 6 | 2 | -- | -- | 1 | 9 | 1 | 1 | -- |
| | | $SO_4$ | E | 6 | 2 | -- | -- | 1 | 9 | 1 | 1 | -- |
| | | Alkalinity | E | 6 | 2 | -- | -- | 1 | 9 | 1 | -- | -- |

(1) Trip blanks will be provided at a frequency of one per cooler containing VOCs samples (soil and water). The number of field blanks are based on two water sources for three events. Rinsate blanks samples will be collected at a frequency of one per day per sampling train. Field duplicates will be collected at a frequency of 1 per 10 samples collected except for explosives and water quality analytes which will be collected at a frequency of 1 per 20 samples collected.

FB - Field Blank
RB - Rinsate Blank
FD - Field Duplicate
LD - Laboratory Duplicate
MS - Matrix Spike
MSD - Matrix Spike Duplicate
TB - Trip Blank

## 2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The Navy Remedial Project Manager (RPM) will provide direction for the HALLIBURTON NUS Team Project Manager through the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Manager at HALLIBURTON NUS. The various management and QA responsibilities of key project personnel are shown on Figure 3-1 of the Work Plan and are described below.

### CLEAN Program Manager

The CLEAN Program Manager, John Trepanowski, has overall responsibility for ensuring that the project meets the quality objectives and standards. In addition, the CLEAN Program Manager is responsible for technical QC and project oversight, and will provide the Project Manager with access to management at the Department of the Navy.

### CLEAN Quality Assurance Manager

The CLEAN QA Manager, Debra Scheib, is responsible for QA/QC monitoring at the program level, QA/QC monitoring of the subcontractors, QA/QC training, and updates to the CLEAN QC Management Plan. The CLEAN QA Manager will also assist the Program and Project Managers in resolution of issues related to quality that may occur in the field.

### Project Manager

The Project Manager, Jeff Maletzke, is responsible for implementing the project, and has the authority to commit the resources necessary to meet project objectives and requirements. The Project Manager's primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. He will also be responsible for the preparation and quality of interim and final reports, including the cleanup/remediation specifications.

### Field Team Leader

The Field Team Leader (FTL) is responsible for leading and coordinating the daily field activities, including sample collection. The FTL reports directly to the Project Manager and will assist in report preparation. He will also identify problems at the field team level, resolve identified problems with the Project Manager, and provide the communication link between the field team and upper management. The FTL has not been identified at this time.

Quality Assurance Manager

The QA Manager, Greg Ruechel, in conjunction with the CLEAN QA Manager, will oversee implementation of the Quality Assurance Project Plan (QAPP) on the project. He will also be responsible for the evaluation of the field and laboratory QC measures for this project.

6/RP/78QAPPD/TEXT

# 3.0 QUALITY ASSURANCE OBJECTIVES FOR ANALYTICAL DATA

The overall QA objective is to ensure that the data are of known and acceptable quality. The analytical quality will be maintained through the use of United States Environmental Protection Agency (USEPA) or National Institute of Occupational Safety and Health (NIOSH) analysis methods and Navy Level C and E QC data packages with diskette deliverables, as defined in the NEESA Guidelines (20.2 - 047B; 6/88).

## 3.1 DATA QUALITY OBJECTIVE LEVELS

The Navy QC levels proposed for this project are Levels C, E, and EPA Level 1.

### 3.1.1 Navy QC Level C

A site requiring Level C QC will be near a populated area, not on the National Priorities List (NPL), and not likely to undergo litigation. The Level C QC includes review and approval of the laboratory QA Plan and the site work plan. The laboratory must successfully analyze a performance sample, undergo an audit, correct deficiencies found during the audit, and provide monthly progress reports (MPRs). The laboratory that performs Level C QC must have passed the performance sample furnished by the Superfund Contract Laboratory Program (CLP) in the past year. The laboratory does not need to be receiving CLP bid lots of samples. Level C allows the use of non-CLP methods but requires that the methods be accepted USEPA methods.

To assess whether the overall quality assurance objectives have been met, analysis of specific field quality control samples and laboratory quality control samples are required for Level C. These quality control samples include field blanks, field duplicates, laboratory duplicates, matrix spike, matrix spike duplicates. The preparation of each of these types of samples is described in Sections 3.2 and 9.0. The frequency with which they will be collected/analyzed is presented in Table 1-1.

### 3.1.2 Navy QC Level E

A site requiring Level E QC will be located away from a populated area, will not be an NPL site, and will have a low probability of litigation. Level E QC includes review and approval of the laboratory QA plan and the site work plan. The laboratory must successfully analyze a performance sample, undergo an audit, correct deficiencies found during the audit, and provide MPRs on QA. For Level E, the laboratory is not required to have passed a CLP performance sample. Level E allows the use of non-CLP methods, but requires that the methods be accepted EPA methods listed in Tables 7.1

through 7.5 of the NEESA Guidelines (20.2 - 047B; 6/88). All methods used must be EPA or equivalent. Level E QC is also appropriate for analysis of the contents of underground storage tanks where the samples are primarily pure product or waste.

### 3.1.3 EPA Level 1

EPA Level 1 will be used for field parameters such as temperature, pH, and specific conductance. Equipment rinsate blanks, field blanks, and field duplicates are not required for this level.

## 3.2 FIELD SPECIFIC QUALITY CONTROL SAMPLES

To achieve the overall Data Quality Objectives (DQOs), proper sample handling, sample analysis, and data handling procedures will be followed. These procedures are described in the following sections of this QAPP and are in accordance with the requirements and recommendations of each analytical method. This document describes the specific objectives for analytical precision, accuracy, representativeness, completeness, and comparability (PARCC).

### 3.2.1 Field Blanks

Field blanks are samples of source water used for decontamination and steam cleaning. At a minimum, one sample for each source of water for a given event will be collected for analyses. Normally, there will be two field blanks per event: a sample of the potable water used for steam cleaning and a sample of the deionized water used for decontamination. If more than one source of deionized water is used or if potable water is taken from more than one location, then additional field blanks will be collected and analyzed for the same suite of parameters as that of samples.

### 3.2.2 Field Duplicates

Field duplicate results will be used to assess the precision of the sample results. They will be used to monitor overall precision, including the reproducibility of sampling and analytical procedures. Field duplicate samples will be collected at a frequency of 1 per group of 20 or fewer for Navy QC Level E investigative samples and will be collected at a frequency of 1 per 10 for Navy QC Level C investigative samples.

### 3.2.3 Trip Blanks

Trip blanks are used to detect potential contamination by volatile organic compounds (VOCs) during sample shipping and handling. Trip blanks are 40 ml volatile organic

analysis (VOA) vials of ASTM Type II water that are filled in the laboratory, transported to the sampling site, and returned to the laboratory with VOC samples. Each trip blank is to be stored at the laboratory with associated samples and analyzed with those samples. Trip blanks are only analyzed for VOCs. Trip blanks must be sent with both water and soil samples; however, they are always analyzed and reported as water samples.

### 3.2.4 Equipment Rinsates

Equipment rinsates are samples of ASTM Type II water passed through decontaminated sampling equipment immediately prior to sample collection. They are used as a measure of decontamination process effectiveness. Equipment rinsates are collected daily during the sampling event. Matrices for this purpose are considered to be soils, sediments, or waters. One rinsate blank will be collected per sampling train. Equipment rinsates are analyzed for the same analytes as samples collected that day. Equipment rinsates are always analyzed and reported as water samples. Equipment rinsates collected every other day will be analyzed. Others will be marked "hold" on the chain of custody forms and analysis will be as deemed necessary by the Navy RPM, Project Manager, and QA Manager with consideration of elapsed holding time.

## 3.3 PARCC CRITERIA

Critical indicators of project data quality are precision, accuracy, representativeness, completeness, and comparability. Objectives for these indicator parameters were developed for this project based on past experience and on the objectives of this RA. Field procedures, analytical methods, and the project QA Program were selected and developed to meet these objectives.

### 3.3.1 Precision

Precision refers to the reproducibility of measurements of the same characteristics, usually under a set of conditions. For large data sets, precision is expressed as the measure of variability of a group of measurements compared to their average value [i.e. Relative Percent Difference (RPD) of the pair].

The precision of field measurements (e.g. temperature, conductivity, and pH) will be evaluated based on the results of duplicate measurements. The results will be compared to the established acceptance criteria shown in Table 3-1.

The precision of chemical analyses will be assessed through the analysis of field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, and

## TABLE 3-1
## PRECISION AND ACCURACY ACCEPTANCE CRITERIA

| | | Precision | | | | Accuracy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte Group | Matrix | Laboratory Duplicates or Matrix Spike Duplicate (RPD) | | Field Duplicate (RPD) | | Matrix Spike and/or MSD (% Recovery) | | Surrogate Spike (% Recovery) | | Rinsate Blank (max. conc.) | Trip Blank (max. conc.) |
| Volatile Organics | Soil | 1,1-Dichloroethene: | 22 | All compounds: | 110 | 1,1-Dichloroethene: | 59-172 | Toluene-d8: | 84-138 | N/A | N/A |
| | | Trichloroethene: | 24 | | | Trichloroethene: | 62-137 | BFB: | 59-113 | | |
| | | Benzene: | 21 | | | Benzene: | 66-142 | 1,2-DCA-d4: | 70-121 | | |
| | | Toluene: | 21 | | | Toluene: | 59-139 | | | | |
| | | Chlorobenzene: | 21 | | | Chlorobenzene: | 60-133 | | | | |
| Volatile Organics | Water | 1,1-Dichloroethene: | 14 | All compounds: | 80 | 1,1-Dichloroethene: | 61-145 | Toluene-d8: | 88-110 | 5x DL | 5x DL |
| | | Trichloroethene: | 14 | | | Trichloroethene: | 71-120 | BFB: | 86-115 | except lab | except lab |
| | | Benzene: | 11 | | | Benzene: | 76-127 | 1,2-DCA-d4: | 76-114 | solvents | solvents |
| | | Toluene: | 13 | | | Toluene: | 76-125 | | | | |
| | | Chlorobenzene: | 13 | | | Chlorobenzene: | 75-130 | | | | |
| Semi-Volatile Organics | Soil | Phenol: | 35 | All compounds: | 75 | Phenol: | 26-90 | Nitrobenzene-d5: | 23-120 | N/A | N/A |
| | | 2-Chlorophenol: | 50 | | | 2-Chlorophenol: | 25-102 | 2-Fluourobiphenyl: | 30-115 | | |
| | | 1,4-Dichlorobenzene: | 27 | | | 1,4-Dichlorobenzene: | 28-104 | Terphenyl-d14: | 18-137 | | |
| | | N-Nitroso-di-n-prop.: | 38 | | | N-Nitroso-di-n-prop.: | 41-126 | Phenol-d5: | 24-113 | | |
| | | 1,2,4-Trichlorobenzene: | 23 | | | 1,2,4-Trichlorobenzene: | 38-107 | 2-Fluorophenol: | 25-121 | | |
| | | 4-Chloro-3-methylphenol: | 33 | | | 4-Chloro-3-methylphenol: | 26-103 | 2,4,6-Tribromophenol: | 19-122 | | |
| | | Acenaphthene: | 19 | | | Acenaphthene: | 31-137 | 2-Chlorophenol-df | 20-130 | | |
| | | 4-Nitrophenol: | 50 | | | 4-Nitrophenol: | 11-114 | 1,2-Dichlorobenzene-d4 | 20-130 | | |
| | | 2,4-Dinitrotoluene: | 47 | | | 2,4-Dinitrotoluene: | 28-89 | | | | |
| | | Pentachlorophenol: | 47 | | | Pentachlorophenol: | 17-109 | | | | |
| | | Pyrene: | 36 | | | Pyrene: | 35-142 | | | | |
| Semi-Volatile Organics | Water | Phenol: | 42 | All compounds: | 75 | Phenol: | 12-110 | Nitrobenzene-d5: | 35-114 | <DL | N/A |
| | | 2-Chlorophenol: | 40 | | | 2-Chlorophenol: | 27-123 | 2-Fluourobiphenyl: | 43-116 | | |
| | | 1,4-Dichlorobenzene: | 28 | | | 1,4-Dichlorobenzene: | 36-97 | Terphenyl-d4: | 33-141 | | |
| | | N-Nitroso-di-n-prop.: | 38 | | | N-Nitroso-di-n-prop: | 41-116 | Phenol-d5: | 10-110 | | |
| | | 1,2,4-Trichlorobenzene: | 28 | | | 1,2,4-Trichlorobenzene: | 39-98 | 2-Fluorophenol: | 21-110 | | |
| | | 4-Chlor-3-methylphenol: | 42 | | | 4-Chloro-3-methylphenol: | 23-97 | 2,4,6-Tribromophenol: | 10-123 | | |
| | | Acenaphthene: | 31 | | | Acenaphthene: | 46-118 | 2-Chlorophenol-d4 | 33-110 | | |
| | | 4-Nitrophenol: | 50 | | | 4-Nitrophenol: | 10-80 | 1,2-Dichlorobenzene-d4 | 16-110 | | |
| | | 2,4-Dinitrotoluene: | 38 | | | 2,4-Dinitrotoluene: | 24-96 | | | | |
| | | Pentachlorophenol: | 50 | | | Pentachlorophenol: | 9-103 | | | | |
| | | Pyrene: | 31 | | | Pyrene: | 26-127 | | | | |
| Volatile Organics | Gas | Lab Duplicate: All compounds | 30 | All compounds: | 110 | LCS: All compounds | 75-125 | N/A | | N/A | N/A |

## TABLE 3-1 (Continued)
## PRECISION AND ACCURACY ACCEPTANCE CRITERIA

| | | Precision | | | | Accuracy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte Group | Matrix | Laboratory Duplicates or Matrix Spike Duplicate (RPD) | | Field Duplicate (RPD) | | Matrix Spike and/or MSD (% Recovery) | | Surrogate Spike (% Recovery) | Rinsate Blank (max. conc.) | Trip Blank (max. conc.) |
| TAL Metals | Soil | Aluminum: | 20 | Aluminum: | 50 | Aluminum: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Antimony: | 20 | Antimony: | 50 | Antimony: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Arsenic: | 20 | Arsenic: | 50 | Arsenic: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Beryllium: | 20 | Beryllium: | 50 | Beryllium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Barium: | 20 | Barium: | 50 | Barium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Cadmium: | 20 | Cadmium: | 50 | Cadmium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Calcium: | 20 | Calcium: | 50 | Calcium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Chromium: | 20 | Chromium: | 50 | Chromium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Cobalt: | 20 | Cobalt: | 50 | Cobalt: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Copper: | 20 | Copper: | 50 | Copper: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Iron: | 20 | Iron: | 50 | Iron: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Lead: | 20 | Lead: | 50 | Lead: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Magnesium: | 20 | Magnesium: | 50 | Magnesium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Manganese: | 20 | Manganese: | 50 | Manganese: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Mercury: | 20 | Mercury: | 50 | Mercury: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Nickel: | 20 | Nickel: | 50 | Nickel: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Potassium: | 20 | Potassium: | 50 | Potassium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Selenium: | 20 | Selenium: | 50 | Selenium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Silver: | 20 | Silver: | 50 | Silver: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Sodium: | 20 | Sodium: | 50 | Sodium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Thallium: | 20 | Thallium: | 50 | Thallium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Vanadium: | 20 | Vanadium: | 50 | Vanadium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Zinc: | 20 | Zinc: | 50 | Zinc: | 75-125 | N/A | <DL/10% HSC | N/A |
| TAL Metals | Water | Aluminum: | 20 | Aluminum: | 40 | Aluminum: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Antimony: | 20 | Antimony: | 40 | Antimony: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Arsenic: | 20 | Arsenic: | 40 | Arsenic: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Beryllium: | 20 | Beryllium: | 40 | Beryllium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Barium: | 20 | Barium: | 40 | Barium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Cadmium: | 20 | Cadmium: | 40 | Cadmium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Calcium: | 20 | Calcium: | 40 | Calcium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Chromium: | 20 | Chromium: | 40 | Chromium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Cobalt: | 20 | Cobalt: | 40 | Cobalt: | 75-125 | N/A | <DL/10% HSC | N/A |

## TABLE 3-1 (Continued)
## PRECISION AND ACCURACY ACCEPTANCE CRITERIA

| | | Precision | | | | Accuracy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte Group | Matrix | Laboratory Duplicates or Matrix Spike Duplicate (RPD) | | Field Duplicate (RPD) | | Matrix Spike and/or MSD (% Recovery) | | Surrogate Spike (% Recovery) | Rinsate Blank (max. conc.) | Trip Blank (max. conc.) |
| TAL Metals (Continued) | Water | Copper: | 20 | Copper: | 40 | Copper: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Iron: | 20 | Iron: | 40 | Iron: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Lead: | 20 | Lead: | 40 | Lead: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Magnesium: | 20 | Magnesium: | 40 | Magnesium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Manganese: | 20 | Manganese: | 40 | Manganese: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Mercury: | 20 | Mercury: | 40 | Mercury: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Nickel: | 20 | Nickel: | 40 | Nickel: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Potassium: | 20 | Potassium: | 40 | Potassium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Selenium: | 20 | Selenium: | 40 | Selenium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Silver: | 20 | Silver: | 40 | Silver: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Sodium: | 20 | Sodium: | 40 | Sodium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Thallium: | 20 | Thallium: | 40 | Thallium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Vanadium: | 20 | Vanadium: | 40 | Vanadium: | 75-125 | N/A | <DL/10% HSC | N/A |
| | | Zinc: | 20 | Zinc: | 40 | Zinc: | 75-125 | N/A | <DL/10% HSC | N/A |
| Lithium | Soil | | 20 | | 50 | | 75-125 | N/A | <DL/10% HSC | N/A |
| Lithium | Water | | 20 | | 40 | | 75-125 | N/A | <DL/10% HSC | N/A |
| PCBs/Pesticides | Soil | gamma-BHC (Lindane): | 50 | All compounds: | 75 | gamma-BHC (Lindane): | 46-127 | Tetrachloro-m-xylene: 60-150 | <DL | N/A |
| | | Heptachlor: | 31 | | | Heptachlor: | 35-130 | Decachlorobiphenyl: 60-150 | <DL | N/A |
| | | Aldrin: | 43 | | | Aldrin: | 34-132 | | <DL | N/A |
| | | Dieldrin: | 38 | | | Dieldrin: | 31-134 | | <DL | N/A |
| | | Endrin: | 45 | | | Endrin: | 42-139 | | <DL | N/A |
| | | 4,4' - DDT: | 50 | | | 4,4' - DDT: | 23-134 | | <DL | N/A |
| Pesticides | Water | gamma-BHC (Lindane) | 15 | All compounds: | 45 | gamma-BHC (Lindane): | 56-123 | Tetrachloro-m-xylene: 60-150 | <DL | N/A |
| | | Heptachlor: | 20 | | | Heptachlor: | 40-131 | Decachlorobiphenyl: 60-150 | <DL | N/A |
| | | Aldrin: | 22 | | | Aldrin: | 40-120 | | <DL | N/A |
| | | Dieldrin: | 18 | | | Dieldrin: | 52-126 | | <DL | N/A |
| | | Endrin: | 21 | | | Endrin: | 56-121 | | <DL | N/A |
| | | 4,4' - DDT: | 27 | | | 4,4' - DDT: | 38-127 | | <DL | N/A |
| Explosives | Soil | All compounds: | 25 | All compounds: | 50 | All compounds: | 75-125 | N/A | <DL | N/A |
| Explosives | Water | All compounds: | 25 | All compounds: | 50 | All compounds: | 75-125 | N/A | <DL | N/A |

**TABLE 3-1 (Continued)**
**PRECISION AND ACCURACY ACCEPTANCE CRITERIA**

| | | Precision | | Accuracy | | | |
|---|---|---|---|---|---|---|---|
| Analyte Group | Matrix | Laboratory Duplicates or Matrix Spike Duplicate (RPD) | Field Duplicate (RPD) | Matrix Spike and/or MSD (% Recovery) | Surrogate Spike (% Recovery) | Rinsate Blank (max. conc.) | Trip Blank (max. conc.) |
| TRPH | Soil | 25 | 50 | 75-125 | N/A | <DL | N/A |
| TRPH | Water | 25 | 50 | 75-125 | N/A | <DL | N/A |
| Nitrite+Nitrate | Soil | 20 | 40 | 80-120 | N/A | <DL | N/A |
| Nitrite-Nitrate | Water | 20 | 40 | 80-120 | N/A | <DL | N/A |
| COD | Water | 20 | 40 | 80-120 | N/A | <DL | N/A |
| Chloride | Water | 20 | 40 | 80-120 | N/A | <DL | N/A |
| Sulfate | Water | 20 | 40 | 80-120 | N/A | <DL | N/A |
| Alkalinity | Water | 20 | 40 | N/A | N/A | <DL | N/A |
| Total Dissolved Solids (TDS) | Water | 20 | 40 | N/A | N/A | <DL | N/A |
| pH | Water | 10 | 10 | N/A | N/A | N/A | N/A |
| Temperature | Water | N/A | 10 | N/A | N/A | N/A | N/A |
| Conductivity | Water | N/A | 10 | N/A | N/A | N/A | N/A |

Notes: 1,2-DCA-d4 = 1,2-Dichloroethane-d4
BFB = 4-Bromofluorobenzene
HSC = Highest Sample Concentration
NA = Not Applicable
RPD = Relative Percent Difference
TRPH = Total Recoverable Petroleum Hydrocarbons
RPDs and % Recoveries for Volatile Organics, Semi-Volatile Organics, and PCB/Pesticides for soil and water are determined from USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Document Number OLM01.0, March 1990, with current revisions.
RPDs and % Recoveries for TAL Metals and Cyanide for soil and water are determined from U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Document Number ILM01.0, March 1988.

laboratory duplicates. MS/MSD samples and laboratory duplicates will be analyzed at a frequency of 1 per group of 20 or fewer investigative samples per sample matrix. Each QC sample type will provide unique information regarding the precision of the program:

- Field duplicate samples: sampling and laboratory precision.
- MS/MSD samples, laboratory duplicates: analytical precision.

General precision acceptance criteria for duplicate and MS/MSD samples are presented in Table 3-1. When analytes are present in samples either near the method detection limit or substantially above the detection limit, these objectives may not be met. If precision objectives are not met, other QC data will be evaluated to determine the usability of the data.

### 3.3.2 Accuracy

Accuracy refers to the degree of agreement of a measurement to the true value. The accuracy of a measurement system is impacted by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques. Sampling accuracy will be evaluated based on the results of the analysis of field blanks, VOCs trip blanks, and equipment rinsate samples. Analytical accuracy will be evaluated on the basis of MS samples, surrogate compounds, laboratory control standards (LCSs), and method blank samples. MS samples, LCSs, and method blank samples will be analyzed at a frequency of 1 per group of 20 or fewer investigative samples per sample matrix. Surrogate compounds are added to every sample and standard that require them.

The results of blank samples, expressed in the units of measurement (e.g. Mg/l), will provide information on positive bias. Blank samples should not contain analytes of interest above background levels, preferably not above method detection limits. The results of spiked samples and reference standards will be expressed as percent recovery (%R) and will provide information on positive and negative bias. Objectives for MS samples and surrogate compounds, expressed in %R, are presented in Table 3-1. Objectives for LCSs are those provided by the supplier for LCSs purchased commercially or procured from the USEPA.

### 3.3.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness will be satisfied by ensuring that the proper sampling techniques are used, proper analytical procedures are followed, and sample holding times are not exceeded by the laboratory.

### 3.3.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. It is expected that the laboratories will provide data meeting QC acceptance criteria for 90 percent or more for all samples tested using the analytical methods listed in Table 8-1.

### 3.3.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. The use of standard USEPA analytical methodologies, CLP methods or non-CLP methods, to obtain the planned analytical data, as documented in the QAPP, are expected to provide comparable data. These new (Phase II RA) analytical data, however, may not be directly comparable to previously collected data at the SWMUs because of differences in procedures and QA objectives.

The sensitivity of analysis is measured by the use of detection limits. The detection limits to be used for this project are given in Tables 3-2 through 3-8.

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## TABLE 3-2

## TARGET COMPOUND LIST (VOCs) AND REQUIRED QUANTITATION LIMITS

| Compound | Quantitation Limits* Water ug/L | Low Soil ug/Kg | Med. Soil ug/kg |
|---|---|---|---|
| 1. Chloromethane | 10 | 10 | 1200 |
| 2. Bromomethane | 10 | 10 | 1200 |
| 3. Vinyl Chloride | 10 | 10 | 1200 |
| 4. Chloroethane | 10 | 10 | 1200 |
| 5. Methylene Chloride | 10 | 10 | 1200 |
| 6. Acetone | 10 | 10 | 1200 |
| 7. Carbon Disulfide | 10 | 10 | 1200 |
| 8. 1,1-Dichloroethene | 10 | 10 | 1200 |
| 9. 1,1-Dichloroethane | 10 | 10 | 1200 |
| 10. 1,2-Dichloroethene (total) | 10 | 10 | 1200 |
| 11. Chloroform | 10 | 10 | 1200 |
| 12. 1,2-Dichloroethane | 10 | 10 | 1200 |
| 13. 2-Butanone | 10 | 10 | 1200 |
| 14. 1,1,1-Trichloroethane | 10 | 10 | 1200 |
| 15. Carbon Tetrachloride | 10 | 10 | 1200 |
| 16. Bromodichloromethane | 10 | 10 | 1200 |
| 17. 1,2-Dichloropropane | 10 | 10 | 1200 |
| 18. cis-1,3-Dichloropropene | 10 | 10 | 1200 |
| 19. Trichloroethene | 10 | 10 | 1200 |
| 20. Dibromochloromethane | 10 | 10 | 1200 |
| 21. 1,1,2-Trichloroethane | 10 | 10 | 1200 |
| 22. Benzene | 10 | 10 | 1200 |
| 23. trans-1,3-Dichloropropene | 10 | 10 | 1200 |
| 24. Bromoform | 10 | 10 | 1200 |
| 25. 4-Methyl-2-pentanone | 10 | 10 | 1200 |
| 26. 2-Hexanone | 10 | 10 | 1200 |
| 27. Tetrachloroethene | 10 | 10 | 1200 |
| 28. Toluene | 10 | 10 | 1200 |
| 29. 1,1,2,2-Tetrachloroethane | 10 | 10 | 1200 |
| 30. Chlorobenzene | 10 | 10 | 1200 |
| 31. Ethyl benzene | 10 | 10 | 1200 |
| 32. Styrene | 10 | 10 | 1200 |
| 33. Xylenes (total) | 10 | 10 | 1200 |

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

**TABLE 3-3**

**TARGET COMPOUND LIST (SVOCs) AND REQUIRED QUANTITATION LIMITS**

| Compound | Quantitation Limits* Water ug/L | Low Soil ug/Kg | Med. Soil ug/kg |
|---|---|---|---|
| 34. Phenol | 10 | 330 | 10000 |
| 35. bis(2-Chloroethyl) ether | 10 | 330 | 10000 |
| 36. 2-Chlorophenol | 10 | 330 | 10000 |
| 37. 1,3-Dichlorobenzene | 10 | 330 | 10000 |
| 38. 1,4-Dichlorobenzene | 10 | 330 | 10000 |
| 39. 1,2-Dichlorobenzene | 10 | 330 | 10000 |
| 40. 2-Methylphenol | 10 | 330 | 10000 |
| 41. 2,2'-oxybis-(1-Chloropropane)** | 10 | 330 | 10000 |
| 42. 4-Methylphenol | 10 | 330 | 10000 |
| 43. N-Nitroso-di-n-dipropylamine | 10 | 330 | 10000 |
| 44. Hexachloroethane | 10 | 330 | 10000 |
| 45. Nitrobenzene | 10 | 330 | 10000 |
| 46. Isophorone | 10 | 330 | 10000 |
| 47. 2-Nitrophenol | 10 | 330 | 10000 |
| 48. 2,4-Dimethylphenol | 10 | 330 | 10000 |
| 49. bis(2-Chloroethoxy) methane | 10 | 330 | 10000 |
| 50. 2,4-Dichlorophenol | 10 | 330 | 10000 |
| 51. 1,2,4-Trichlorobenzene | 10 | 330 | 10000 |
| 52. Naphthalene | 10 | 330 | 10000 |
| 53. 4-Chloroaniline | 10 | 330 | 10000 |
| 54. Hexachlorobutadiene | 10 | 330 | 10000 |
| 55. 4-Chloro-3-methylphenol | 10 | 330 | 10000 |
| 56. 2-Methylnaphthalene | 10 | 330 | 10000 |
| 57. Hexachlorocyclopentadiene | 10 | 330 | 10000 |
| 58. 2,4,6-Trichlorophenol | 10 | 330 | 10000 |

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

** Previously known by the name of bis(2-chloroisopropyl) ether.

**TABLE 3-3 (Continued)**

**TARGET COMPOUND LIST (SVOCs) AND REQUIRED QUANTITATION LIMITS**

| Compound | Quantitation Limits* Water ug/L | Low Soil ug/Kg | Med. Soil ug/kg |
|---|---|---|---|
| 59. 2,4,5-Trichlorophenol | 50 | 1700 | 50000 |
| 60. 2-Chloronaphthalene | 10 | 330 | 10000 |
| 61. 2-Nitroaniline | 50 | 1700 | 50000 |
| 62. Dimethylphthalate | 10 | 330 | 10000 |
| 63. Acenaphthalene | 10 | 330 | 10000 |
| 64. 2,6-Dinitrotoluene | 10 | 330 | 10000 |
| 65. 3-Nitroaniline | 50 | 1700 | 50000 |
| 66. Acenaphthene | 10 | 330 | 10000 |
| 67. 2,4-Dinitrophenol | 50 | 1700 | 50000 |
| 68. 4-Nitrophenol | 50 | 1700 | 50000 |
| 69. Dibenzofuran | 10 | 330 | 10000 |
| 70. 2,4-Dinitrotoluene | 10 | 330 | 10000 |
| 71. Diethylphthalate | 10 | 330 | 10000 |
| 72. 4-Chlorophenyl-phenyl ether | 10 | 330 | 10000 |
| 73. Fluorene | 10 | 330 | 10000 |
| 74. 4-Nitroaniline | 25 | 1700 | 50000 |
| 75. 4,6-Dinitro-2-methylphenol | 25 | 1700 | 50000 |
| 76. N-Nitrosodiphenylamine | 10 | 330 | 10000 |
| 77. 4-Bromophenyl-phenyl ether | 10 | 330 | 10000 |
| 78. Hexachlorobenzene | 10 | 330 | 10000 |
| 79. Pentachlorophenol | 25 | 1700 | 50000 |
| 80. Phenanthrene | 10 | 330 | 10000 |
| 81. Anthracene | 10 | 330 | 10000 |
| 82. Carbazole | 10 | 330 | 10000 |
| 83. Di-n-butylphthalate | 10 | 330 | 10000 |
| 84. Fluoranthene | 10 | 330 | 10000 |
| 85. Pyrene | 10 | 330 | 10000 |
| 86. Butylbenzylphthalate | 10 | 330 | 10000 |
| 87. 3,3-Dichlorobenzidine | 10 | 330 | 10000 |

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

**TABLE 3-3 (Continued)**

**TARGET COMPOUND LIST (SVOCs) AND REQUIRED QUANTITATION LIMITS**

| Compound | Quantitation Limits* Water ug/L | Low Soil ug/Kg | Med. Soil ug/kg |
|---|---|---|---|
| 88. Benzo(a)anthracene | 10 | 330 | 10000 |
| 89. Chrysene | 10 | 330 | 10000 |
| 90. bis(2-Ethylhexyl)phthalate | 10 | 330 | 10000 |
| 91. Di-n-Octylphthalate | 10 | 330 | 10000 |
| 92. Benzo(b)fluoranthene | 10 | 330 | 10000 |
| 93. Benzo(k)fluoranthene | 10 | 330 | 10000 |
| 94. Benzo(a)pyrene | 10 | 330 | 10000 |
| 95. Indeno(1,2,3-cd)pyrene | 10 | 330 | 10000 |
| 96. Dibenzo(a,h)anthracene | 10 | 330 | 10000 |
| 97. Benzo(g,h,i)perylene | 10 | 330 | 10000 |

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

## TABLE 3-4

## TARGET COMPOUND LIST (PCBs/PESTICIDES) AND REQUIRED QUANTITATION LIMITS

| | Aroclors | Quantitation Limits* Water ug/L | Soil ug/Kg |
|---|---|---|---|
| 98. | alpha-BHC | 0.05 | 1.7 |
| 99. | beta-BHC | 0.05 | 1.7 |
| 100. | delta-BHC | 0.05 | 1.7 |
| 101. | gamma-BHC (Lindane) | 0.05 | 1.7 |
| 102. | Heptachlor | 0.05 | 1.7 |
| 103. | Aldrin | 0.05 | 1.7 |
| 104. | Heptachlor epoxide | 0.05 | 1.7 |
| 105. | Endosulfan I | 0.05 | 1.7 |
| 106. | Dieldrin | 0.10 | 3.3 |
| 107. | 4,4'-DDE | 0.10 | 3.3 |
| 108. | Endrin | 0.10 | 3.3 |
| 109. | Endosulfan II | 0.10 | 3.3 |
| 110. | 4,4'-DDD | 0.10 | 3.3 |
| 111. | Endosulfan sulfate | 0.10 | 3.3 |
| 112. | 4,4'-DDT | 0.10 | 3.3 |
| 113. | Methoxychlor | 0.50 | 17.0 |
| 114. | Endrin ketone | 0.10 | 3.3 |
| 115. | Endrin aldehyde | 0.10 | 3.3 |
| 116. | alpha-Chlordane | 0.05 | 1.7 |
| 117. | gamma-Chlordane | 0.05 | 1.7 |
| 118. | Toxaphene | 5.0 | 170.0 |
| 119. | Aroclor-1016 | 1.0 | 33.0 |
| 120. | Aroclor-1221 | 2.0 | 33.0 |
| 121. | Aroclor-1232 | 1.0 | 67.0 |
| 122. | Aroclor-1242 | 1.0 | 33.0 |
| 123. | Aroclor-1248 | 1.0 | 33.0 |
| 124. | Aroclor-1254 | 1.0 | 33.0 |
| 125. | Aroclor-1260 | 1.0 | 33.0 |

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Aroclors.

## TABLE 3-5

## TARGET ANALYTE LIST METALS AND LITHIUM

| Analyte | Quantitation Limits (1,2,3) Water (ug/L) | Soil mg/kg |
|---|---|---|
| Aluminum | 200 | 20 |
| Antimony | 60 | 6 |
| Arsenic | 10 | 1 |
| Barium | 200 | 20 |
| Beryllium | 5 | 0.5 |
| Cadmium | 5 | 0.5 |
| Calcium | 5000 | 500 |
| Chromium | 10 | 1 |
| Cobalt | 50 | 5 |
| Copper | 25 | 2.5 |
| Iron | 100 | 10 |
| Lead | 3 | 0.3 |
| Magnesium | 5000 | 500 |
| Manganese | 15 | 1.5 |
| Mercury | 0.2 | 0.02 |
| Nickel | 40 | 4 |
| Potassium | 5000 | 500 |
| Selenium | 5 | 0.5 |
| Silver | 10 | 1 |
| Sodium | 5000 | 500 |
| Thallium | 10 | 1 |
| Vanadium | 50 | 5 |
| Zinc | 20 | 2 |
| Lithium | To be determined | To be determined |

(1) Subject to the restrictions specified in the first page of Part G, Section IV of Exhibit D for ILM01.0 (Alternate Methods - Catastrophic Failure). Any analytical method specified in SOW Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Required Detection Limit requirements. Higher detection limits may only be used in the following circumstances:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the values may be reported even though the instrument or method detection limit may not equal the Required Detection Limit. This is illustrated in the example below:

For lead: Method in use = ICP — Instrument Detection Limit (IDL) = 40
Sample concentration = 200 — Required Detection Limit (RDL) = 3

The value of 200 may be reported even though the instrument detection limit is greater than the required detection limit. The instrument or method detection limit must be documented as described in Exhibit E.

(2) The instrument detection limits obtained in pure water that must be met using the procedure in Exhibit E of OLM01.0. The detection limits for samples may be considerably higher depending on the sample matrix.

(3) Detection limits for soil are based on wet weight. The detection limits are calculated by the laboratory for soil. Sample results will be reported on a dry weight basis.

**TABLE 3-6**

**EXPLOSIVES COMPOUND LIST AND TRPH QUANTITATION LIMITS**

| Explosives | Abbrev | Water (ug/L) | Soil (ug/kg) |
|---|---|---|---|
| Octahydro-1,3,5,7-tetranitro-1,3, 5,7-tetrazocine | HMX | 13.0 | 2.2 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine | RDX | 14.0 | 1.0 |
| 1,3,5-Trinitrobenzene | TNB | 7.3 | 0.25 |
| 1,3-Dinitrobenzene | DNB | 4.0 | 0.25 |
| Methyl-2,4,6-trinitrophenylnitramine | Tetryl | 44.0 | 0.65 |
| Nitrobenzene | NB | NA | 0.26 |
| 2,4,6-Trinitrotoluene | TNT | 6.9 | 0.25 |
| 2,4-Dinitrotoluene | 24DNT | 5.7 | 0.25 |
| 2,6-Dinitrotoluene | 26DNT | 9.4 | 0.26 |
| o-Nitrotoluene | 2NT | 12.0 | 0.25 |
| m-Nitrotoluene | 3NT | 7.9 | 0.25 |
| p-Nitrotoluene | 4NT | 8.5 | 0.25 |

| Petroleum Hydrocarbons | Water mg/L | Soil mg/kg |
|---|---|---|
| Total Recoverable Petroleum Hydrocarbon (TRPH) | .5 | 5 |

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**TABLE 3-7**

**WATER QUALITY ANALYTE LIST**

| Analyte | Detection Limit Aqueous mg/L | Detection Limit Soil mg/kg |
|---|---|---|
| Chemical Oxygen Demand (COD) | 5 | - |
| Total Dissolved Solids (TDS) | 10 | - |
| Alkalinity | 5 | - |
| Chloride | .1 | - |
| Sulfate | 2 | - |
| Nitrite + Nitrate Nitrogen | .5 | (a) |
| pH | .01 units | -- |

(a) Detection limits for soil are based on wet weight. The detection limits are calculated by the laboratory for soils. Sample results will be reported on a dry weight basis.

**TABLE 3-8**

**SANITARY LANDFILL GAS ANALYTES**

| Volatile Compounds | Detection Limit ppb |
|---|---|
| Benzene | 1 |
| Bromodichloromethane | 1 |
| Carbon Tetrachloride | 1 |
| Chlorobenzene | 1 |
| Chloroethane | 1 |
| 2-Chloroethylvinyl Ether | 1 |
| Chloroform | 1 |
| Chloromethane | 1 |
| 1,1-Dichloroethane | 1 |
| 1,2-Dichloroethane | 1 |
| 1,1-Dichloroethene | 1 |
| trans-1,2-Dichloroethene | 1 |
| 1,2-Dichloropropane | 1 |
| cis-1,3-Dichloropropene | 1 |
| Ethyl Benzene | 1 |
| Methylene Chloride | 1 |
| 1,1,2,2-Tetrachloroethane | 1 |
| Tetrachloroethene | 1 |
| Toluene | 1 |
| 1,1,1-Trichloroethane | 1 |
| 1,1,2-Trichloroethane | 1 |
| Trichloroethene | 1 |
| Trichlorofluoromethane | 1 |
| Vinyl Chloride | 1 |
| 1,2-Dichlorobenzene | 1 |
| 1,3-Dichlorobenzene | 1 |
| 1,4-Dichlorobenzene | 1 |

| Major Components | Detection Limit % |
|---|---|
| Methane | 0.1 |
| Carbon Dioxide | 0.1 |
| Nitrogen | 0.1 |
| Oxygen | 0.1 |
| Hydrogen Sulfide | 0.1 |

**TABLE 3-8 (Continued)**

**SANITARY LANDFILL GAS ANALYTES**

| Hydrocarbons | Detection Limit % |
|---|---|
| Methane | 0.1 |
| Ethane | 0.1 |
| Propane | 0.1 |
| Butane | 0.1 |
| Pentane | 0.1 |
| Hexane | 0.1 |
| Total Non-Methane Hydrocarbons | 0.1 |

# 4.0 SAMPLING PROCEDURES

Media-specific sampling procedures are briefly described below. Sampling procedures are detailed in Section 5.0 of the Work Plan and integrate HALLIBURTON NUS Standard Operating Procedures (SOPs) as contained in Appendix A of the Work Plan. Sample containers will be certified clean by the laboratory or vendor responsible for supplying them. Table 4-1 contains a list of the type and quantities of sample containers required for each analysis, the sample preservation techniques, and holding times.

## 4.1 SURFACE SOIL SAMPLING

Surface (0 to 2 feet) soil samples will be collected to verify releases to soil attributable to potential primary sources. Sample locations are described in Tables 5-1 through 5-3 and shown on Figures 5-1 through 5-3 of the Work Plan. Discrete grab samples will be collected with a stainless steel hand trowel, examined for visual signs of contamination, and placed directly into appropriate sample jars. Sampling procedures, equipment, and decontamination are detailed in Section 5.3 of the Work Plan.

## 4.2 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected to evaluate water bodies and drainageways adjacent to, and within, the SWMUs. Current conditions as well as potential releases to surface water will be verified. Sample locations are described in Tables 5-1 through 5-3 and shown on Figures 5-1 through 5-3 of the Work Plan. Surface water grab samples will be collected by immersing the sample container in the body of water. Sediment grab samples will be collected with a sampling tube. Sampling procedures, equipment, decontamination, and documentation are detailed in Section 5.4 of the Work Plan.

## 4.3 SUBSURFACE SOIL AND BOREHOLE GROUNDWATER SAMPLING

Subsurface soil sampling will be conducted to assess potential contaminant releases associated with underground storage tanks at the Roads and Grounds Area and within Lithium Battery disposal/burial at the Sanitary Landfill. Soil borings will be completed to depths coincident with the water table, or with anticipated vertical position of underground storage tank bottoms. If a shallow water table is encountered, groundwater will be sampled from within the borehole.

**TABLE 4-1**

**SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES**

| Matrix | Parameter | Container | Preservation | Holding Time |
|---|---|---|---|---|
| Soil/ Sediment | VOC | Two 60-ml wide-mouth glass jars | 4° C | 14 days |
| | SVOC | One 8-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Metals/ Lithium | One 8-oz. wide-mouth glass jar | 4° C | Mercury 28 days<br>All others 6 months |
| | PCBs/ Pesticides | One 8-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Explosives | One 4-oz. wide-mouth glass jar | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | TRPH | One 8-oz. wide-mouth glass jar | 4° C | 28 days |
| | $NO_2+NO_3$ | One 4-oz. wide-mouth glass jar | 4° C | 28 days |
| Groundwater/ Surface Water | VOC | Two 40-ml VOA glass vial | 1:1 HCl, pH <2, 4° C | 14 days |
| | SVOC | Two 1-liter amber glass | 4° C | Extract in 7 days<br>Analyze in 40 days |
| | Metals/ Lithium | One 1-liter HDPE | 1:1 $HNO_3$, pH <2, 4° C | Mercury 28 days<br>All others 6 months |

**TABLE 4-1 (Continued)**

**SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES**

| Matrix | Parameter | Container | Preservation | Holding Time |
|---|---|---|---|---|
| Groundwater/ Surface Water (Continued) | Pesticides | Two 1-liter amber glass | 4° C | Extract in 7 days Analyze in 40 days |
| | Explosives | Two 1-liter amber glass | 4° C | Extract in 7 days Analyze in 40 days |
| | Chloride<br>Sulfate<br>Alkalinity<br>TDS<br>pH | One 1-liter HDPE | 4° C | 28 days<br>28 days<br>14 days<br>7 days<br>Analyze immediately |
| | COD<br>$NO_2+NO_3$ | One 1-liter HDPE | 1:1 $H_2SO_4$, pH <2, 4° C | 28 days |
| | TOC | One 1-liter amber glass | 1:1 $H_2SO_4$ pH<2, 4° C | 28 days |
| Subsurface Gas | VOCs | Summa Canister | -- | 30 days |
| | Major Components and Hydro-carbons | Tedlar Bags | -- | 72 hours |
| | Hydrogen Sulfide | Tedlar Bags | -- | 24 hours |

Soil borings will be completed at the Roads and Grounds Area and the Sanitary Landfill as shown on Figures 5-1 and 5-2 of the Work Plan. The sample locations are also described in Tables 5-1 and 5-2 of the Work Plan.

Borings will be advanced using hollow stem auger techniques through unconsolidated soils. Subsurface soil will be collected utilizing split-spoon samplers.

Groundwater sample acquisition will be consistent with procedures for monitoring wells. Groundwater samples will be collected using a stainless steel bailer. Sampling procedures, equipment, and decontamination are detailed in Section 5.5 of the Work Plan.

## 4.4 GROUNDWATER SAMPLING

One round of groundwater sampling will be conducted from existing monitoring wells at the Sanitary Landfill and at Building 146. The 23 monitoring wells to be sampled are shown on Figures 5-2 and 5-3 of the Work Plan.

Groundwater samples will be collected from the monitoring wells following purging. Samples will be collected within 24 hours of well purging, with the exception of those wells where recovery from the purging process exceeds 24 hours. Groundwater samples will be collected with a pump except for VOC samples, which will be collected with a bailer. Sampling procedures, equipment, and decontamination are detailed in Section 5.6 of the Work Plan.

## 4.5 LANDFILL GAS SAMPLING

Landfill gas sampling will be conducted to evaluate lateral gas migration within the landfill and to evaluate the potential for constituents in the landfill gas to dissolve in the groundwater and to produce hazardous air emissions.

Landfill gas sampling will be accomplished through the advancement of up to 25 barhole probes at locations depicted in Figure 5-2 of the Work Plan. Samples will be collected at the perimeter of the waste and analyzed in the field for methane and oxygen.

A plunger bar approximately 0.5 inches in diameter is used to make a hole to a depth of approximately 3 feet below the ground surface. Upon removal of the plunger bar, the sampling probe is immediately inserted into the hole and sealed to minimize air infiltration into the barhole. A combustible gas meter that measures concentration as percent by volume methane equivalents will be used. Methane concentration data will

be recorded when a stable value is obtained. An oxygen meter will also be used to measure concentrations as percent by volume.

In the event that measurable concentrations of methane are detected, samples will be extracted from the barhole for laboratory analysis. Samples which require laboratory analysis will be collected in evacuated SUMMA, canisters. Sampling procedures, equipment, and decontamination are detailed in Section 5.8 of the Work Plan.

## 4.6 SAMPLE IDENTIFICATION NUMBERS AND DOCUMENTATION

### 4.6.1 Sample Logbook

A bound Sample Logbook with sequentially numbered pages will provide the means for recording samples sent to laboratories.

The cover of each notebook will contain:

Naval Surface Warfare Center - Crane
Start Date
End Date
Book Number

The Sample Logbook will contain the following information for each sample collected for chemical analysis:

- Field sample identification number.
- Type of sample (field, QC, QA).
- Depth of sample.
- Date and time sample collected.
- Initials of sampler.
- Number and type of sample containers filled.
- Field screening readings, if any.
- Analyte(s).
- Laboratory destination.
- Date shipped.
- Airbill number.
- Field screening readings.

### 4.6.2 Field Sample Identification Number

The field sample identification number will consist of the project identifier, the sample matrix, the year, location number, and depth. The scheme used is listed below:

CR93-AABB-CC-DD

Where: CR = project identifier for Naval Surface Warfare Center, Crane Division
93 = 1993 Field Investigation

AA = SWMU:
15 = SWMU #15/06, Roads and Grounds Area
14 = SWMU #14/00, Sanitary Landfill and Lithium Battery
16 = SWMU #16/16, Cast High Explosive Fill/Incinerator Building 146
BB = sample matrix:
GW = Groundwater Sample
SD = Sediment Sample
SS = Soil Sample
SW = Surface Water Sample
GS = Gas Sample
CC = Sample location number (numbered sequentially within each SWMU)

In the case of existing monitoring wells, existing well numbers/nomenclature will be used.

DD = Sample depth in feet:
01 = less than 2 feet below surface
02 = 2 to 4 feet
03 = 4 to 6 feet
04 = 6 to 8 feet
etc.

Field duplicate samples will be identified by noting a fictitious sample location number. Rinsate blanks will be called with the alpha code "RB".

Examples of field sample identification numbers are as follows:

CR93-14SW-01 NAVSURFWARCENDIV, 1993 Field Investigation, Surface Water Sample No. 1 from SWMU #14/00 (Sanitary Landfill and Lithium Battery).

| | |
|---|---|
| CR93-15SS-01-01 | NAVSURFWARCENDIV, 1993 Field Investigation, Soil Sample No. 1 collected from 0-6 inches below the surface at SWMU #15/06 (Roads and Grounds Area). |
| CR93-16RB-01 | NAVSURFWARCENDIV, 1993 Field Investigation, Rinsate Blank Sample No. 1 collected at SWMU #16/16 (Cast High Explosive Fill/Incinerator Bldg. 146). |

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# 5.0 SAMPLE CUSTODY, PACKAGING, AND SHIPPING

## 5.1 SAMPLE CUSTODY

The USEPA chain of custody protocols, as described in "NEIC Policies and Procedures," USEPA-330/9-78-001-R, revised June 1985, will be followed. Custody is in three parts: sample collection, laboratory analysis, and final evidence files. Field evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. Custody procedures are outlined in HALLIBURTON NUS SOP SA 6.1 (Work Plan Appendix A).

## 5.2 PACKAGING AND SHIPPING

For purposes of shipping, samples are classified as low, medium, or high level. Each level requires specific packaging, labelling, and shipping as determined by the U.S. Department of Transportation (DOT), the International Air Transport Association (IATA), and each commercial carrier. Requirements listed in this section were obtained from Federal Express and the IATA Dangerous Good Regulations, effective January 1, 1992.

Soil will be classified as low level if field screening results do not exceed 10 ppm.

### 5.2.1 General Requirements

Samples, regardless of level, will be prepared consistent with HALLIBURTON NUS SOP SA 6.2 (Work Plan Appendix A) as follows:

- Attach completed adhesive sample label to the sample container.
- Place container in appropriate size Ziploc∩ bag and seal.

### 5.2.2 Low Level Packaging

Low level samples will be prepared according to the following instructions:

1. Attach completed adhesive sample label to the sample container.

2. Place container in appropriate size Ziploc∩ bag and seal.

3. Wrap bagged container in bubble wrap or foam sleeve to minimize breakage.

4. Select an appropriately sized metal or plastic shipping container and tape the drain plugs on the inside and outside with fiber reinforced tape (duct tape).

5. Line the shipping container with a large polyethylene garbage bag.

6. Place the samples in the large polyethylene garbage bag.

7. Put absorbent packaging material under and around the samples to minimize the possibility of breakage.

8. Place a completed Chain of Custody Record (white and yellow copies) listing the contents of the shipping container and a completed shipping container return address/label in a Ziploc∩ bag and tape to the underside of the shipping container lid.

9. Place bagged ice on top and around the samples and seal the large polyethylene garbage bag, close to the shipping container.

10. Place the signed and dated Custody Seal on the shipping container at opposite corners of top of the shipping container, so if the shipping container was opened, the seals would break. Cover the seals with clear tape. Tape the shipping container shut with fiber reinforced tape (duct tape or strapping tape). Tape should partially overlap Custody Seals.

11. A label marked "Environmental Samples" will be placed on top of the shipping container and covered with clear tape. The appropriate sides of the container will be marked "This End Up" and arrows should be drawn accordingly. "Fragile" labels will be placed on the shipping container lid if glass bottles/jars are contained in the shipping container.

12. Complete the courier air bill.

### 5.2.3 Medium Level Packaging

Medium level samples will be packed according to the instructions above with the following exceptions.

Do not wrap the container in bubble wrap or foam sleeve as described in Step 4 above. Instead, place the container in a metal transportation can. Fill the transportation can with vermiculite and tape the lid shut. Continue packaging as in Steps 4 through 12, omitting Step 7.

### 5.2.4 Shipment Coordination

The FTL will coordinate with the Federal Express representative for shipment of medium/high hazard samples. If the courier must inspect the containers, inside packaging, and labelling, the opening will be recorded and shipping containers resealed with properly dated custody seals.

The FTL will notify the laboratories of all sample shipments on the day of shipment. At that time the following information will be provided:

- FTL name and site office telephone number.
- Site name.
- Exact number(s), matrix(ces), and level(s) of samples.
- Carrier name and airbill number(s) for the shipment.
- Method of shipment (i.e. overnight, 2-day).
- Date of shipment.
- Suspected hazards associated with the samples or site.
- Any irregularities or anticipated problems with the samples, including special handling instruction or deviations from established sampling procedures or numbers of samples.
- Status of the sampling project (i.e. final shipment, update of future shipping schedule).

Sample shipments made after 5:00 p.m. EST will be called in at the start of business the next day (8:00 a.m. EST). Laboratories will be notified by 3:00 p.m. EST Friday concerning information about sample shipments being sent Friday intended for Saturday delivery/pickup.

## 5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES

Relevant records, reports, logs, field notebooks, pictures, and the data review will be maintained in a secure, limited access area and under custody of the Project Manager. Raw data will be retained by the Navy at the end of the project and under custody of the Project Manager until that time.

# 6.0 CALIBRATION PROCEDURES

## 6.1 FIELD EQUIPMENT

Equipment to be used during the field sampling will be examined to determine that it is in an operable condition and will be calibrated at the beginning and end of each day. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance and operating requirements are being observed.

## 6.2 LABORATORY EQUIPMENT

Instruments used in the laboratory will be calibrated according to the specific method used and the contracted laboratory's QA Plans (Attachment A).

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# 7.0 PREVENTIVE MAINTENANCE

## 7.1 FIELD EQUIPMENT

Field equipment will be maintained and calibrated according to manufacturer's specifications and in such a way that the QC requirements are met.

## 7.2 LABORATORY EQUIPMENT

Laboratory equipment will be maintained according to manufacturer's specifications and in such a way that the QC requirements of the methods will be met for all analyses performed. Preventive maintenance of laboratory instruments will be performed as described in the Halliburton NUS SOPs for Analytical Laboratory Services Group (Attachment A).

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# 8.0 ANALYTICAL PROCEDURES

Analyses will be accomplished using only Navy approved laboratories.

Analysis of samples collected will be performed according to the methods shown in Table 8-1. Samples for volatiles, semivolatiles, PCBs and metals and lithium will be analyzed according to analytical procedures in the USEPA Statement of Work (SOW) OL MO1.1 for organic analysis and SOW IL MO1.0 for inorganic analysis, or their most recent updates.

Samples analyzed for explosives, TRPH, and indicator parameters, will follow the appropriate method as present in Table 8-1.

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**TABLE 8-1**

**ANALYTICAL METHODS**

| Parameters | Method | | |
|---|---|---|---|
| | Gas | Aqueous | Soil/Sediment |
| TCL Volatiles | | (a) | (a) |
| TCL Semivolatiles | | (a) | (a) |
| TAL Metals | | (a) | (a) |
| Lithium | | To be determined | To be determined |
| PCBs/Pesticides | | (a) | (a) |
| Explosives | | SW-846 8330 | SW-846 8330 |
| Total Recoverable Petroleum Hydrocarbon (TRPH) | | USEPA 418.1 | USEPA 418.1 |
| Nitrite + Nitrate Nitrogen | | USEPA 353.3 | USEPA 353.3 |
| Phosphorus | | USEPA 365.4 | USEPA 365.4 |
| Chloride | | USEPA 325.2 | -- |
| Sulfate | | USEPA 375.4 | -- |
| Alkalinity | | USEPA 310.1 | -- |
| Total Dissolved Solids (TDS) | | USEPA 160.2 | -- |
| pH | | SW-846 9040 | -- |
| VOCs | EPA TO-14 | | |
| Major Components and Hydrocarbons | ASTM 1945 | | |
| Hydrogen Sulfide | EPA 15 | | |

(a) USEPA Contract Laboratory Program Statements of Work. OLMO1.0-OLMO1.8 for organic analyses and ILMO2.0 for TAL metals.

USEPA "Method for Chemical Analysis of Water and Waste," USEPA 41791020, March 1983.

SW-846 Test Methods for Evaluating Solid Wastes Physical/Chemical Methods, 3rd Edition.

# 9.0 INTERNAL QUALITY CONTROL CHECKS

## 9.1 FIELD QUALITY CONTROL SAMPLES

The assessment of field sampling precision and accuracy will be made through the collection of field duplicates, field blanks, equipment rinsates, and trip blanks as discussed in Section 3.2 of this QAPP.

## 9.2 LABORATORY QUALITY CONTROL SAMPLES

Internal QC procedures for laboratory analyses are specified in the appropriate CLP SOW for volatiles, semivolatiles, PCBs/pesticides, and metals, and in the laboratory SOPs and analytical methods for explosives, TRPH, lithium, total organic carbon, and indicator parameters.

A brief discussion of the laboratory QC samples is provided in the following paragraphs:

### 9.2.1 Method Blanks

The method blank is an analytical control consisting of deionized water, reagents, and internal standards and surrogates (if appropriate for the analysis), which is carried through the entire analytical procedure. An aqueous method blank is treated the same as a sample with a water matrix; a solid method blank is treated the same as a soil sample. The method blank is used to define the level of laboratory background contamination.

### 9.2.2 Laboratory Duplicates

Laboratory duplicates are a second aliquot of a sample that is treated the same as the original sample in order to determine the analytical precision of the method.

### 9.2.3 Matrix Spike

An aliquot of a sample that is fortified (spiked) with known quantities of specific analytes and subjected to the entire analytical procedure. The percent recoveries are calculated for each of the added analytes in order to evaluate the effect of the sample matrix on accuracy of the method.

### 9.2.4 Matrix Spike Duplicate

A second aliquot of the same sample as the matrix spike (Section 9.3.3 above) that is spiked the same as the matrix spike. The RPD is calculated for the results of the analytes added to the MS/MSD samples to evaluate the effect of the sample matrix on analytical precision.

### 9.2.5 Surrogate Compounds

Surrogates are compounds that are added to every blank, sample, MS/MSD, and standard that are not expected to be detected in environmental media. Surrogates are brominated, fluorinated, deuterated, or isotopically labelled compounds used to evaluate analytical efficiency by measuring %R.

### 9.2.6 Laboratory Control Sample

An aqueous or solid sample of known composition. The LCS is subjected to the same sample preparation, reagents, and analytical methods as the field samples submitted for analysis. The results of the LCS are calculated as a %R and used to evaluate analytical accuracy.

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# 10.0 DATA REDUCTION, VALIDATION, AND REPORTING

## 10.1 FIELD MEASUREMENTS

Data from field measurements and sample collection activities will be appropriately recorded on field forms (Appendix A of the Work Plan). If the data are to be used on the project reports, they will be reduced or summarized and presented in the RA report.

## 10.2 LABORATORY SERVICES

All laboratory analysis will be performed by Halliburton NUS Laboratory with the exception of explosives and subsurface gas samples; these samples will be analyzed by TCT - St. Louis.

Data reduction will be performed by the laboratory in accordance with the requirements of the laboratory-specific SOPs. Subsequent to receipt of data from the laboratory, data validation will be performed by Halliburton NUS Team personnel in accordance with CLEAN Guidelines. Data evaluation of validated analytical data may include data reduction and tabulation, statistical analysis, environmental fate and transport modeling, and mapping. The results will be incorporated into the RA report.

Diskette deliverables received from the laboratory will be utilized for Navy Level C reporting. The diskettes will be uploaded to Oracle relational database software. Oracle may be used to provide statistical analysis of the data and for generation of report tables. Report tables generated from Oracle are backchecked against hardcopy reports received from the laboratory to verify correctness of uploaded data. Results for the TCLP metals analyses will be reported for both the measured analyte value corrected for analytical bias (using matrix spike recovery) and the uncorrected value. Organic analytical results will be reported using CLP SOW format and forms.

6/RP/78QAPPD/TEXT

## 11.0 DATA ASSESSMENT PROCEDURES

Analytical data will be evaluated for precision, accuracy, and completeness. The acceptability of the analytical precision and accuracy will be determined by comparing them to the control limits recommended in the methods. Data determined to be insufficiently precise or accurate will be subject to the corrective action prescribed by the appropriate analytical method. The QC samples used in the determination of precision and accuracy have been described in Section 3.0. Specific equations used to calculate precision, accuracy, and completeness are presented below.

Precision will be expressed in terms of Relative Percent Difference (RPD).

$$RPD = \frac{\text{Concentration 1 - Concentration 2}}{\text{(Concentration 1 + Concentration 2)/2}} \times 100$$

Accuracy as determined from the analysis of an external reference standard will be expressed as Percent Recovery (%R).

$$\%R = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Accuracy as determined from the analysis of a spiked sample will also be expressed as %R.

$$\%R = \frac{\text{Measured Spike Value - Unspiked Value}}{\text{Known Spike Value}} \times 100$$

Completeness will describe the number of usable analytical results as a percentage of the total number of samples submitted for analysis.

$$\%\ \text{Complete} = \frac{\text{Valid Data}}{\text{Total Data Planned}} \times 100$$

6/RP/78QAPPD/TEXT

# 12.0 CORRECTIVE ACTION

Corrective actions may be required for problems that occur during sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review. A formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Project Manager who in turn, will notify the QA Managers as appropriate. Implementation of corrective action will be confirmed in writing through the same channels. Any nonconformance with the established QC procedures in the QAPP or Work Plan will be identified and corrected in accordance with the QAPP. The Project Manager or his designee will prepare a nonconformance report for each nonconformance/corrective action situation. No staff member may initiate corrective action without prior communication of findings through the proper channels.

## 12.1 FIELD ACTIVITIES

Project field personnel will be responsible for reporting all suspected nonconformances or deficiencies to the Project Manager or designee. The Project Manager will be responsible for assessing the suspected problems in consultation with the QA Managers, as appropriate. The final decision is to be based on the potential for the situation to impact the quality of the data. If the situation warrants corrective action measures, the Project Manager will prepare a nonconformance report.

The FTL at times is required to adjust the site activities to accommodate site-specific needs. The changes will be documented in the field log notebook and signed by the initiators and the FTL. The Project Manager must approve the changes in writing or verbally prior to field implementation. A Field Modification Record form (Attachment C) will also be prepared and distributed as appropriate.

## 12.2 LABORATORY ACTIVITIES

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent upon the analysis and the event. Specific analytical corrective actions are described in the methods and should be followed by the laboratory personnel.

Laboratory personnel are alerted that corrective action may be necessary if:

- QC data are outside the warning or acceptance window for precision or accuracy.
- Blanks contain target analytes above acceptable levels.
- Undesirable trends are detected in spike recoveries or RPD between duplicates.
- There are unusual changes in detection limits.
- Inquiries concerning data quality are received.
- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor and the QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA Department and the Site QA Manager.

6/RP/78QAPPD/TEXT

# 13.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the Work Plan and QAPP. The audits of field and laboratory activities include internal and external audits.

## 13.1 FIELD AUDITS

Internal audits of field activities (sampling and measurements) will be conducted by the Project Manager. The audits will include examination of field sampling records, sample collection, handling and packaging in compliance with the established procedures, and chain of custody. These audits will occur at the onset of the project to verify that all established procedures are followed. Follow-up audits will be conducted to correct deficiencies and to verify that QA procedures are maintained throughout the inspection. The audits will involve review of field measurement records and sample documentation.

External audits may be conducted by the Navy or USEPA.

## 13.2 LABORATORY AUDITS

The performance and system audits of the laboratory will be conducted by NEESA personnel. Additional audits may be conducted by the QA Manager and/or Project Manager based upon the review of monthly progress reports. The system audits, which will be performed on an annual basis, will include examination of laboratory documentation on sample receiving, sample log-in, sample storage, chain of custody procedure, sample preparation and analysis, instrument operating records, etc. The performance audits will be conducted annually and may be conducted on a quarterly basis. The analytical results of performance samples will be evaluated to ensure the laboratory maintains a good performance.

External performance and system audits of the laboratory selected for the project for approval/disapproval may be conducted by the USEPA.

## 14.0 QUALITY ASSURANCE REPORTS

A summary QA report will be prepared for the analytical results by the QA Manager and submitted to the Project Manager. This QA report will include an assessment of data quality based upon the quality control data, as well as an account of any significant QA problems encountered and corrective actions taken. This report will be in writing and provided as a final report to the Project Manager.

The summary QA report contents will include:

- Any deviations from the QAPP.
- Summary of the QA/QC program.
- Data quality assessment in terms of precision, accuracy, and completeness.
- Conformance of data quality to QAPP requirements.
- An indication of whether the QA objectives were met.
- A discussion of the limitations on use of the data collected, as applicable.
- Significance of any QA/QC problems encountered, recommended solutions, and results of corrective action.

6/RP/78QAPPD/TEXT

# ATTACHMENT A

# LABORATORY STANDARD OPERATING PROCEDURES

# HALLIBURTON NUS ENVIRONMENTAL CORPORATION
# LABORATORY QUALITY ASSURANCE PLAN

## IN SUPPORT OF THE US DEPARTMENT OF THE NAVY'S

## COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY PROGRAM (CLEAN)

## REQUIREMENTS FOR QUALITY CONTROL OF ANALYTICAL DATA

**PREPARED BY**

**HALLIBURTON NUS ENVIRONMENTAL CORPORATION**
**LABORATORY SERVICES GROUP**

**TITLE PAGE**

# HALLIBURTON NUS ENVIRONMENTAL CORPORATION LABORATORY QUALITY ASSURANCE PLAN

**IN SUPPORT OF THE US DEPARTMENT OF THE NAVY'S**

**COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY PROGRAM (CLEAN)**

**REQUIREMENTS FOR QUALITY CONTROL OF ANALYTICAL DATA**

**PITTSBURGH, PENNSYLVANIA**
**HOUSTON, TEXAS**

**HALLIBURTON NUS ENVIRONMENTAL CORPORATION**
**LABORATORY SERVICES GROUP**

Reviewed and Approved By:

Patricia L. Lynch — 3/4/92
LSG Project Manager - Pittsburgh — Date

Diane Meyer /RV — 3/4/92
LSG Project Manager - Houston — Date

Lisa A. Manning (SH) — 3/4/92
LSG Quality Assurance Coordinator — Date

# INTRODUCTION

This quality assurance project plan (QAPP) covers the analytical requirements of the Comprehensive Long Term Environmental Action Navy Program (CLEAN). CLEAN provides support to the U.S. Department of the Navy for the Installation Restoration Program (IRP). The IRP identifies and evaluates past hazardous material disposal sites in order to control the migration of hazardous contaminants. This QAPP is based on the requirements defined in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program," NEESA 20.2-047B, dated June 1988.

This laboratory quality assurance plan (LQAP), in conjunction with the portions of the HALLIBURTON NUS Environmental Corporation Laboratory Services Group's (LSG's) General Quality Assurance Plan (GQAP) referenced throughout the LQAP, define how work under CLEAN is to be performed. The GQAP is provided to all recipients of this LQAP as a separate document.

This program LQAP will be supplemented with a project-specific plan for each individual CLEAN project in which LSG participates. The project-specific plan will identify the specific analytes of interest, methods of analysis, and control limits for the project. Any deviations from this general plan, which are based on Baker's approved work plan, will also be specified.

## CONTENTS

The contents of this quality assurance project plan address the requirements as specified in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program," CLEAN, NEESA 20.2-047B. Sections 5.0 through 17.0 are supplemented by appendices, quality assurance procedures from the HALLIBURTON NUS Environmental Corporation Laboratory Services Group's (LSG's) General Quality Assurance Plan (GQAP). The GQAP is provided to all recipients of this QAPP. Users of this QAPP should refer to the GQAP for the current version of the quality assurance procedures referenced as appendices to this CLEAN plan. The CLEAN quality assurance project plan will not be reissued each time a procedure in the GQAP is revised.

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APPENDICES

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| B | Professional Resumes |
| C | LSG Procedure, QA-17, Training Program |
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| L | LSG Procedure QA-11, Systems Audits |
| M | LSG Procedure QA-16, Quality Assurance Reports to Management |

# 4.0 ORGANIZATION AND PERSONNEL

## 4.1 LABORATORY SERVICES GROUP (LSG) ORGANIZATION

The HALLIBURTON NUS Laboratory Services Group operates two laboratory facilities: one located in Pittsburgh, Pennsylvania and the other in Houston, Texas. These laboratories are centrally managed and operate under the same quality assurance (QA) program. An organization chart for the HALLIBURTON NUS Laboratory Services Group (LSG) is enclosed as Appendix A.

The laboratory Quality Assurance Coordinator (QAC) reports directly to the Group General Manager and has sufficient organizational freedom to accomplish QA functions in a manner that is independent of cost and schedule constraints.

## 4.2 QUALIFICATIONS

LSG employs a select staff of highly trained and qualified technical and management personnel. The staff consists of approximately 160 chemists, biologists, and laboratory technicians, and 50 administrative support personnel, and LSG is constantly upgrading its staff to meet current needs. Because of the importance and scope of this project, LSG has defined a project organization led by experienced and responsive management personnel. This organization will provide Baker Environmental (Baker) with a strong centralized management structure composed of dedicated personnel. A summary of the experience and qualifications of key personnel is provided in the Experience and Qualifications Matrices (Figures 4-1 and 4-2). Resumes of key personnel showing project responsibilities are found in Appendix B.

## 4.3 PROJECT ORGANIZATION AND RESPONSIBILITIES

The laboratory project organization for CLEAN is shown in Figure 4-3 and defined below. Because of the complexity and the projected volume of work for this program, LSG has designated a Laboratory Project Manager at each facility.

### 4.3.1 Project Managers - P. Lynch, D. Meyer

- Act as the primary contact with the client.

- Determine scope and schedule for the job; identify the resources necessary to complete the job.

- Oversee project-managed jobs and control project-related resource prioritization.

- Compile and review final reports. Authorize their delivery to the client.

- Ensure that project requirements are met. This includes review of sample check-in, tracking samples through the laboratory to ensure that schedules or turnaround times are met, and final review of reports and invoices.

- Participate in internal and external audits of project performance.

- Prepare project-specific work plans and conduct project training.

### 4.3.2 Laboratory Operations Managers - J. Simanic, S. Mayo

The Laboratory Operations Managers are responsible for supervising and coordinating the performance of analyses according to appropriate procedures, monitoring the productivity of the laboratory, monitoring staffing requirements and staff capabilities, and following HALLIBURTON NUS Corporate administrative procedures in operation of the laboratory. The specific responsibilities of the Laboratory Operations Managers include but are not limited to the following:

- Review and approve data during sample check-out.

- Interface with Laboratory Group Leaders and the Project Manager to coordinate performance of analyses.

- Direct implementation of corrective actions required as a result of data review, internal audits, or external audits.

### 4.3.4 Quality Assurance Coordinator - L. Manning, and Representatives - K. Anders, G. Malzone, J. Otte

The Quality Assurance Coordinator reports directly to the General Manager of LSG. He/she is assisted by Quality Assurance Representatives at each fixed-base facility. The responsibilities of the Quality Assurance Department are as follows:

- Prepare the CLEAN laboratory quality assurance plan in compliance with CLEAN guidance documents.

- Conduct internal performance and systems audits to monitor compliance with the LSG General Quality Assurance Plan and this quality assurance plan. Conduct internal systems audits of safety procedures or other areas where potential liability exists, such as waste disposal.

- Assist in the conduct of CLEAN-related audits.

- Coordinate laboratory performance evaluation studies.

- Track correction of detected nonconformances to the LSG General Quality Assurance Plan, the CLEAN laboratory quality assurance plan, or to safety or waste disposal procedures.

- Statistically analyze QC results and update control limits for each laboratory. Perform trend analyses to determine ongoing validity of analytical systems.

- Assess data and final reports for compliance with defined objectives and for suitability and completeness.

4.3.5 **Laboratory Group Leaders - L. Beyer, R. Capp, T. Colbert, B. Howbert, C. Kieda, D. Kohl, R. Komm, C. Kovach, J. Lehman, M. Hearne, S. Chen, R. MacGregor**

Laboratory Group Leaders are responsible for data production activities within their assigned groups. In larger analytical disciplines, Assistant Group Leaders may assist the Group Leader in the supervision of analysts. (He/she is responsible to the Group Leader for accomplishing a subset of the responsibilities listed below that have been assigned to them.) Laboratory Group leaders are responsible for the following:

- Receive and distribute assignments, scheduling analyses in a timely manner to meet holding times and project schedules.

- Maintain assigned laboratory areas in a safe and clean condition.

- Review and approve data, evaluating it for completeness, accuracy, and compliance with stated QA/QC objectives.

- Perform technical reviews of analytical procedures and ensure compliance with required quality control standards.

- Monitor the throughput of the laboratory section.

- Assist in the selection of employees, identify manpower needs, and provide training and supervision of staff.

- Identify capital equipment and capital appropriation needs for the respective laboratory section and communicate these needs to the Laboratory Operations Manager.

- Assist in client contacts, problem resolution, and work plan development as requested by the LSG Project Manager.

4.3.6 **Sample Custodians/Sample Log-in Personnel - M. Bartolovic, T. Carnegie, A. Cardenas, N. Lopez, R. Salopek, R. Turnell, T. Waters, G. Schwab**

- Receive samples.

- Perform sample check-in.

4.3.7 **Data Management Group Leaders - S. Green, E. Scoullos**

Prepare project deliverables following data reduction and independent review by the laboratory groups.

# FIGURE 4-1
# EXPERIENCE QUALIFICATIONS MATRIX - PITTSBURGH LABORATORY

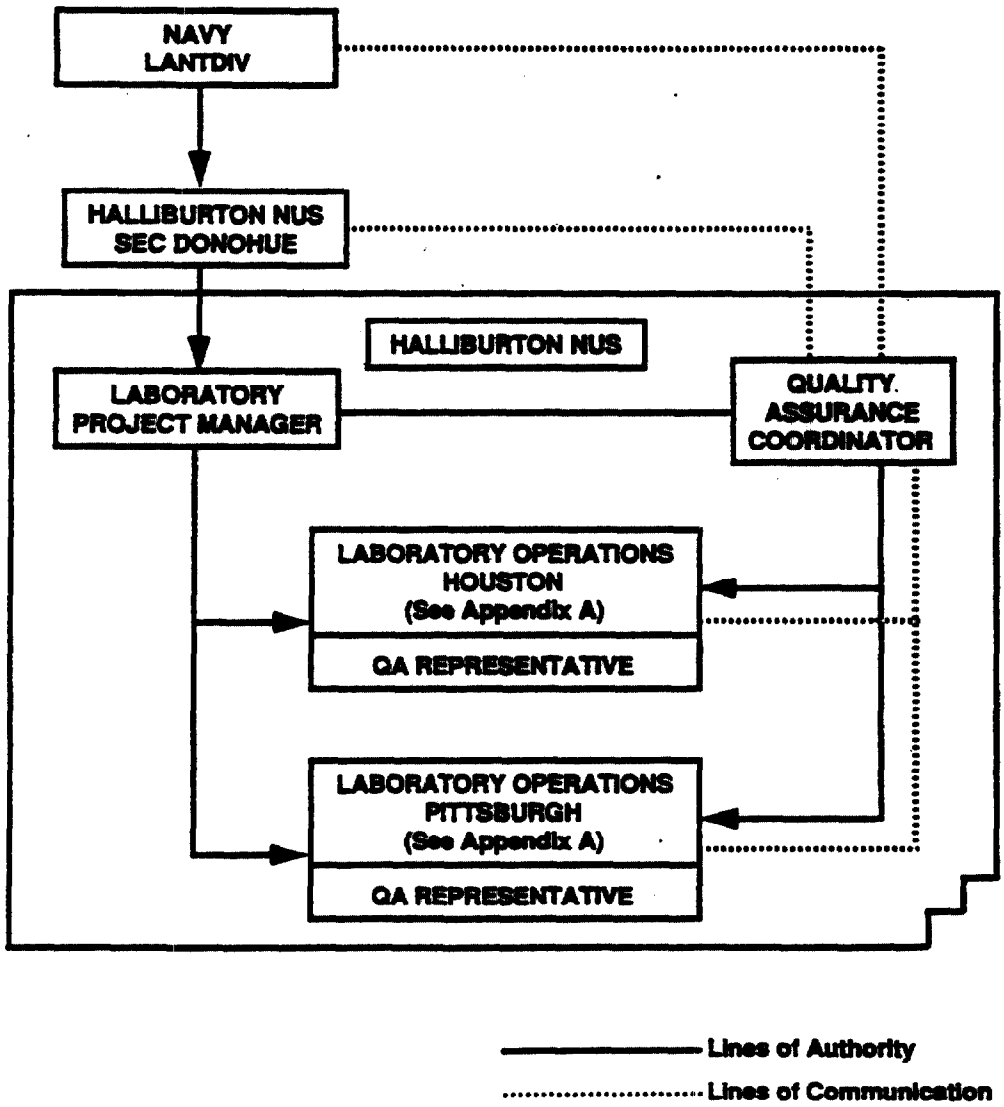
| | Project Management | Supervision | QA/QC Documentation | Instrument Maint. & Repair | GC or LC | GC/MS | Organic Extraction/Concentration | Purge and Trap | Mass Spectral Interpretation | Metals Sample Prep | ICP | Flameless AA | Flame AA | Cold Vapor AA | Inorganic (Wet) Chemistry | Industrial Hygiene | Radiochemistry | Radiation Safety | Bioassay | RCRA | Geotech |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capp, R. | | | | | X | X | | X | | | | | | | | | | | | | |
| Colbert, T. | | X | | | X | | | | | | | | | X | X | | | | | | |
| Elkin, D. | | X | | | | | | | | | | | | | X | | | | | | |
| Frank, P. | X | | | | | X | | X | X | | | | | | X | | | | | | |
| Kieda, C. | | X | | X | X | X | | X | X | | | | | | X | | | | | | |
| Kohl, D. | | X | | | | | | | | | | | | | X | | X | X | | | |
| Kovach, C. | | X | | | X | X | | X | X | X | X | X | X | X | | | | | | | |
| Kuhn, J. | | | | X | | | | | | | | | | | | | | | | | |
| Lehman, J. | | X | | | | | | | | | | | | | | | | | | X | X |
| Lynch, P. | X | X | X | | | | | | | X | | X | X | X | X | | | | | | |
| Malzone, G. | | X | X | | | | | | | | | | | | X | | | | | | |
| Manning, L. | | X | X | | | | | | | X | | X | X | X | X | | | X | | | |
| Mikus, J. | | | | | | X | | X | | | | | | | | | | | | | |
| Miller, J. | | X | | | | | | | | | | | | | X | | | | | | |
| Motley, E. | | | | | | | | | | X | | X | X | X | X | | | X | | | |
| Papenmeier, P. | | X | | X | | X | | X | X | | | | | | | | | | | | |
| Rieseck, M. | | X | | | X | | | X | | | | | | | X | | | | | | |
| Samchuck, J. | | X | | | X | X | X | X | X | | | | | | | | | | | | |
| Saracena, P. | | X | | | | | X | | | | | | | | | | | | | | |
| Scoullos, E. | | X | | | | X | | X | X | | | | | | | | | | | | |
| Simanic, J. | X | X | | | | | | | | X | | X | X | X | X | | | | | | |
| Whartenby, R. | | | | | | | | | | X | | | | | | | | | | X | |

# FIGURE 4-2
# EXPERIENCE QUALIFICATIONS MATRIX - HOUSTON LABORATORY

| | Project Management | Supervision | QA/QC Documentation | Instrument Maint. & Repair | GC or LC | GC/MS | Organic Extraction/Concentration | Purge and Trap | Mass Spectral Interpretation | Metals Sample Prep | ICP | Flameless AA | Flame AA | Cold Vapor AA | Inorganic (Wet) Chemistry | Industrial Hygiene | Radiochemistry | Radiation Safety | Bioassay | RCRA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anders, K. | | | X | | | | | | | | | | | | | | | | | |
| Beyer, L. | X | X | | | | | | | | X | X | X | X | X | X | | | | | |
| Chen, S. | | X | | | | X | | X | X | | | | | | | | | | | |
| Clepper, J. | | X | X | X | | | | | | | | | | | | | | | | |
| Finlay, G. | | X | | | | | | | | X | X | | X | | X | | | | | |
| Green, S. | X | X | | X | X | X | X | X | X | X | | X | X | X | X | | | | | |
| Howbert, B. | | X | | | | | | | | X | X | X | X | X | X | | | | | |
| Hearne, M. | | X | | X | | X | | X | X | | | | | | X | | | | | |
| Komm, R. | | X | | | X | | | X | | | | | | | | | | | | |
| Lin, S. | X | X | | X | X | X | X | X | X | | | | | | | | | | | |
| MacGregor, R. | X | X | X | | | | | | | | | | | | X | | | | X | |
| Mayo, S. | X | X | | | | | | | | X | | X | X | X | X | | | | | |
| Meyer, D. | X | X | | | X | X | | X | X | X | | X | X | X | X | | | | | |
| Perrigo, J. | | X | | X | X | X | X | X | X | | | | | | X | | | | | |
| Rose, D. | | X | | | | | | | | X | X | X | X | X | X | | | | | |
| Sommers, E. | | X | | | X | | | | | X | X | X | X | X | X | | | | | |
| Taylor, R. | | X | | X | | X | X | X | X | X | X | X | X | X | X | | | | | |

**FIGURE 4-3**

**PROJECT ORGANIZATION CHART**



# 5.0 PERSONNEL TRAINING

LSG's training procedures are described in LSG Procedure QA-17 (see Appendix C). These training procedures consist of the following:

- Quality assurance training
- Analytical method training
- Project training
- Safety and hazard communication training

The LSG project managers will conduct project-specific training for all CLEAN projects. This training will be provided to all group leaders and assistant group leaders. The group leaders will ensure that all staff working on CLEAN projects receive project-specific training.

# 6.0 SAMPLING HANDLING AND CHAIN-OF-CUSTODY

## 6.1 INTRODUCTION

To ensure the integrity of the sample from collection through analysis, it is necessary to follow proper sample bottle preparation and sample preservation procedures, and to generate an accurate, written record that traces the possession and handling of the sample. This documentation of the history of the sample is referred to as chain-of-custody.

For the purpose of this discussion, "custody" is defined as follows:

- The sample is in the physical possession of an authorized person, or
- the sample is in the view of an authorized person after being in his/her possession, or
- the sample is secured by an authorized person so it cannot be tampered with (or tampering will be evident if it does occur) after being in his/her possession, or
- the sample is in a secured area, restricted to authorized personnel.

## 6.2 SAMPLE BOTTLE CLEANING AND PREPARATION

HALLIBURTON NUS will supply bottles for collection of environmental samples that have been pre-cleaned as follows. (HALLIBURTON NUS may purchase the cleaned bottles, or clean them at the laboratory.)

### 6.2.1 Cleaning Procedure for Glass Bottles

- Wash glass bottles, Teflon liners, and caps in hot tap water with laboratory-grade nonphosphate detergent.

- Rinse three times with tap water.

- Rinse with 1:1 nitric acid (metals grade), American Society for Testing Materials (ASTM) Type I water.

- Rinse three times with ASTM Type I water.

- Rinse with pesticide-grade methylene chloride using 20 mL for 1/2-gallon container and 5 mL for 4- and 8-ounce containers.

- Oven dry at 125°C. Allow to cool to room temperature in an enclosed, contaminant-free environment.
- Place liners in lids and cap containers.
- Store in contaminant-free area.

### 6.2.2 Cleaning Procedure for Bottles Used for Volatile Organics (40-mL Glass)

- Wash glass vials, Teflon-backed septa, Teflon liners, and caps in hot tap water using laboratory-grade nonphosphate detergent.
- Rinse three times with tap water.
- Rinse three times with ASTM Type I water.
- Oven dry vials, septa, and liners at 125°C.
- Allow vials, septa, and liners to cool to room temperature in an enclosed, contaminant-free environment.
- Seal 40-mL vials with septa (Teflon side down) and cap.
- Store in contaminant-free area.

### 6.2.3 Cleaning Procedure for Polyethylene Bottles

- Wash polyethylene bottles and caps in hot tap water with laboratory-grade nonphosphate detergent.
- Rinse with 1:1 nitric acid (metals grade) and ASTM Type I water.
- Rinse three times with ASTM Type I water.
- Invert and air dry in contaminant-free environment.

### 6.2.4 All Bottles

- Cap and label bottles and store them in a contaminant-free area.

### 6.2.5 Sample Bottle Preparation

LSG provides cleaned sample bottles and the proper preservatives to the field sampling teams. For water samples, the preservatives and the types of sample containers provided are based on the requirements specified in 40CFR136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants." The types of sample containers for soil or waste samples are determined by the analyses to be performed on the sample (e.g., glass containers if sample requires organics analyses, separate glass container for volatiles). Table 6-1 lists the types of sample containers and the preservatives that are used for water samples. For soil or waste samples, chemical preservation techniques that apply to water matrix samples are not appropriate. For these matrices, no chemical preservatives are added.

Each time a preservative from a new lot of stock reagent is prepared for use, a preservative reagent blank is submitted to the laboratory for analysis to check for possible contamination. The preservative must be demonstrated to be free of contamination.

A Sample Bottle Preparation Log is maintained in which the preparation of each set of bottles is documented. Documentation includes:

- Type and number of bottles.
- Date of preparation.
- Preservative added (reagent and lot number).
- Special cleaning procedures.
- Initials of the shipping clerk.

Labels are then placed on all prepared bottles indicating the preservative used and the date of preparation.

## 6.3 SAMPLE BOTTLE SHIPMENT

The shipping clerk places the sample bottles, along with sample custody tags, in ice chests containing several freeze packs. The clerk then completes the appropriate sections of the chain-of-custody record indicating the number and type of bottles contained in the ice chest. The ice chests are then sealed with custody tape to guard against tampering. The seals are applied such that they will be broken when the container is opened.

**TABLE 6-1**

**METHODS OF PRESERVATION AND SAMPLE CONTAINERS FOR WATER SAMPLES**

| PARAMETER | PRESERVATION | CONTAINER |
|---|---|---|
| Alkalinity | Cool, 4°C | P, G |
| Biochemical oxygen demand (BOD) | Cool, 4°C | P, G |
| Chemical oxygen demand (COD) | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| pH | None | P, G |
| Total suspended solids (TSS) | Cool, 4°C | P, G |
| Total dissolved solids (TDS) | Cool, 4°C | P, G |
| Ammonia | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Total organic carbon (TOC) | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Bromide | None | P, G |
| Chromium, hexavalent | Cool, 4°C | P, G |
| Color | Cool, 4°C | P, G |
| Chloride | None | P, G |
| Fecal coliform bacteria | Cool, 4°C/0.008% $Na_2S_2O_3$ | P, G |
| Fluoride | None | P |
| Nitrate-Nitrite | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Nitrate | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Nitrite | Cool, 4°C | P, G |
| Nitrogen, organic and Kjeldahl | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Oil and grease | Cool, 4°C/$H_2SO_4$ to pH <2 | G |
| Total petroleum hydrocarbons | Cool, 4°C/HCl to pH <2 | G |
| Phosphorus, total | Cool, 4°C/$H_2SO_4$ to pH <2 | P, G |
| Sulfate | Cool, 4°C | P, G |

**TABLE 6-1**
**METHODS OF PRESERVATION AND SAMPLE CONTAINERS**
**FOR WATER SAMPLES**
**PAGE TWO**

| PARAMETER | PRESERVATION | CONTAINER |
|---|---|---|
| Sulfide | Cool, 4°C/Zinc acetate plus NaOH to pH >9 | P, G |
| Surfactants | Cool, 4°C | P, G |
| Turbidity | Cool, 4°C | P, G |
| Aluminum | $HNO_3$ to pH <2 | P, G |
| Barium | $HNO_3$ to pH <2 | P, G |
| Boron | $HNO_3$ to pH <2 | P, G |
| Cobalt | $HNO_3$ to pH <2 | P, G |
| Iron | $HNO_3$ to pH <2 | P, G |
| Magnesium | $HNO_3$ to pH <2 | P, G |
| Manganese | $HNO_3$ to pH <2 | P, G |
| Molybdenum | $HNO_3$ to pH <2 | P, G |
| Tin | $HNO_3$ to pH <2 | P, G |
| Titanium | $HNO_3$ to pH <2 | P, G |
| Gross alpha | $HNO_3$ to pH <2 | P, G |
| Gross beta | $HNO_3$ to pH <2 | P, G |
| Radium-226 | $HNO_3$ to pH <2 | P, G |
| Radium-228 | $HNO_3$ to pH <2 | P, G |
| Antimony | $HNO_3$ to pH <2 | P, G |
| Arsenic | $HNO_3$ to pH <2 | P, G |
| Beryllium | $HNO_3$ to pH <2 | P, G |
| Cadmium | $HNO_3$ to pH <2 | P, G |

**TABLE 6-1**
**METHODS OF PRESERVATION AND SAMPLE CONTAINERS**
**FOR WATER SAMPLES**
**PAGE THREE**

| PARAMETER | PRESERVATION | CONTAINER |
|---|---|---|
| Chromium | $HNO_3$ to pH <2 | P, G |
| Copper | $HNO_3$ to pH <2 | P, G |
| Lead | $HNO_3$ to pH <2 | P, G |
| Mercury | $HNO_3$ to pH <2 | P, G |
| Nickel | $HNO_3$ to pH <2 | P, G |
| Selenium | $HNO_3$ to pH <2 | P, G |
| Silver | $HNO_3$ to pH <2 | P, G |
| Thallium | $HNO_3$ to pH <2 | P, G |
| Zinc | $HNO_3$ to pH <2 | P, G |
| Cyanide, total and amenable to chlorination | Cool, 4°C/NaOH to pH >12, 0.6 g Ascorbic acid(1) | P, G |
| Phenols, total | Cool, 4°C/$H_2SO_4$ to pH <2 | G |
| Volatile organics | Cool, 4°C/0.008% $Na_2S_2O_3$(1), HCl to pH <2 | G, Teflon-lined septum |
| Acid extractables | Cool, 4°C/0.008% $Na_2S_2O_3$(1) | G, Teflon-lined cap |
| Base-neutral extractables | Cool, 4°C/0.008% $Na_2S_2O_3$(1) | G, Teflon-lined cap |
| Pesticides | Cool, 4°C/pH 5-9(2) | G, Teflon-lined cap |
| Polychlorinated biphenyls (PCBs) | Cool, 4°C | G, Teflon-lined cap |

P = Polyethylene
G = Glass

(1) = Added only in the presence of residual chlorine.

(2) = The pH adjustment may be performed upon receipt of samples at the laboratory, and may be omitted if the samples are extracted within 72 hours of collection.

Before the sample containers are given to the sampling team, the shipping clerk initiates field chain-of-custody by signing the chain-of-custody form indicating that the laboratory has relinquished custody of the containers. A member of the sampling team signs the form indicating that he/she has accepted custody of the sample containers.

During sample collection, chain-of-custody records are completed and enclosed in the shipping containers. The containers are sealed with custody seals to guard against tampering and are shipped or returned to the laboratory.

## 6.4 SAMPLE RECEIPT

Sample receipt, sample log-in, and review of sample log-in are described in LSG Procedure QA-7, sections 3.1 through 3.8 (see Appendix D), with the following additions/changes for CLEAN work:

- During sample receipt, the Sample Custodian measures and records the temperature inside the cooler.
- The LSG Project Manager functions as the Account Executive for CLEAN work.

## 6.5 SAMPLE TRACKING/CHAIN-OF-CUSTODY

To maintain chain-of-custody within the laboratory, samples, sample extractions, and sample digestions are stored in locked areas when not in use. Keys to the locked storage areas are controlled by the Sample Custodian or designated laboratory personnel. LSG Procedure QA-7, section 3.12 describes the procedure for direct and indirect lab tracking.

## 6.6 SAMPLE STORAGE

Storage conditions and retention times are defined in LSG Procedure QA-7, section 3.7 for each type of sample. (See Appendix D.) CLEAN samples are retained for sixty days following report delivery.

## 6.7 SAMPLE DISPOSAL

Section 7.3 of the LSG Laboratory Waste Disposal Procedure (Appendix E) describes the procedures that are followed for sample disposal.

## 6.8 LABORATORY GLASSWARE CLEANING

Section 3.3.2 of LSG Procedure QA-19 (Appendix E) describes the procedures that are followed to ensure cleanliness of laboratory glassware.

# 7.0 PROCUREMENT AND MATERIALS CONTROL

## 7.1 PROCUREMENT OF MATERIALS

Section 3.1 of LSG Procedure QA-19 (Appendix E), describes the procedures that are followed for procurement of materials, including receipt inspection.

## 7.2 INVENTORY PROCEDURES

Each container of reagent received is logged into the computerized Chemical Inventory System, assigned a unique number, and placed in the appropriate storage area. When a container of reagent has been emptied, it is deleted from the Chemical Inventory System.

## 7.3 STORAGE OF FLAMMABLE AND NONFLAMMABLE SOLVENTS

### 7.3.1 Flammable Solvents

A room having the following characteristics is designated for the storage of flammable solvents:

- Diked curbs
- Four-hour rated fire walls
- Automated sprinkler system
- Halogen extinguisher system that operates independent of the laboratory system

Any flammable solvents not stored in the flammable storage room are kept in flammable storage cabinets that conform to OSHA and NFPA regulations.

### 7.3.2 Nonflammable Solvents

Nonflammable solvents are also stored in the flammable storage cabinets located in various laboratories and in the room designated for chemical storage.

## 7.4 CHEMICAL STORAGE

A room having the following characteristics is designated for the storage of chemical reagents:

- Four-hour rated fire walls made of concrete block
- Fire-proof steel doors
- A ventilation system that conforms to OSHA regulations

Limited quantities of reagents used on a regular basis are kept in the laboratories that use them, in desiccators or under a hood.

## 7.5 LSG LABORATORY WASTE DISPOSAL POLICY

Section 7.2 of the LSG Laboratory Waste Disposal Procedure (Appendix F) describes the procedures that are followed for laboratory waste disposal.

# 8.0 EQUIPMENT AND FACILITIES

## 8.1 Equipment - Quantity, Type, and Age

HALLIBURTON NUS has the equipment necessary to simultaneously complete a number of analytical projects within required holding times, including large-volume contracts. In meeting its commitment to provide complete service to its clients, HALLIBURTON NUS has the variety of instrumentation to perform analyses on hazardous wastes, soils, waters, sludges, bioassays, water-formed deposits, and air-sampling media. A brief summary of the major equipment follows.

HALLIBURTON NUS Laboratory Services Group is equipped with 12 gas chromatograph/mass spectrometers (GC/MS) with data systems. A computer is interfaced to the mass spectrometers and provides continuous scanning of selected mass ranges. The computer is equipped with electronic storage devices for saving all GC/MS data, and computer software is available to allow for a search for specific ions and ion intensity plotting. Equipment also includes approximately 20 gas chromatographs (GC), all with packed or capillary columns and various detectors; 9 atomic absorption units, including 5 graphite furnaces; 2 mercury analyzers; and inductively coupled plasma (ICP) unit capable of simultaneous and sequential analysis; and a high-performance sequentially-operated unit that performs ICP emission spectrometry as well as flame and graphite furnace AA and provides dynamic compensation for accurate background correction.

Major equipment also includes 4 UV visible spectrophotometers, 2 liquid chromatographs, 3 TOC analyzers, and 5 TOX analyzers. In addition, the laboratory has diverse instrumentation for radiochemical analyses and screening of radioactive samples. These instruments include a gas proportional counter, a liquid scintillation counter, survey meters plus a variety of probes, alpha spectrometers, coincidence counting systems, and gamma spectrometer systems.

Complete listings of the major laboratory equipment used by the HALLIBURTON NUS laboratories are provided in Tables 8-1 and 8-2 at the end of this section. These tables provide the age, the manufacturer and model of the equipment, as well as the frequency of standardization and frequency of calibration.

## 8.2 Repair and Maintenance Capability

HALLIBURTON NUS employs two full-time instrument service engineers, who provide full-time instrument maintenance, repair, and calibration for the HALLIBURTON NUS laboratories.

## 8.3 Laboratory Facilities

The HALLIBURTON NUS laboratory facilities consist of two major laboratories: a 30,000 square foot facility in Pittsburgh, Pennsylvania, and a 28,000 square foot facility in Houston, Texas. These facilities are among the largest and most sophisticated of their kind in the nation. In addition to separate laboratories dedicated to the analysis of water, soils, gases, and hazardous wastes, each facility houses hazardous waste and soil preparation areas.

The enclosed floor plans (Figures 8-1 and 8-2) detail the laboratories. The facilities are comprised of a series of instrument and preparation laboratories which are housed in separate rooms. For example, the organic analysis preparation laboratories for both facilities, while in the general vicinity of the organic analysis laboratories, are housed in separate rooms. This design reduces the potential of extraction solvent peaks inadvertently appearing in analysis runs due to contamination.

Specific laboratories found in both the Pittsburgh and Houston facilities include wet chemistry, gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS), metals, sample preparation for inorganic analyses, sample preparation for organic analyses, solid waste testing and preparation, and bacteriological testing. Special areas are also allotted for general chemical storage and flammable solvent storage. The flammable storage areas are self-contained and are equipped with their own heating and cooling systems and halon fire-extinguishing systems. All chemical storage areas are enclosed in 4-hour rated fire walls.

The Pittsburgh facility's radioactive waste processing laboratory is used for special preparation and storage of radioactive samples. This laboratory has a separate air handling and plumbing system and a special sump for disposal of samples and contaminated reagents. The room is locked when not occupied and access is controlled.

Additional laboratories within the Pittsburgh facility include, BOD, trace analysis, radiochemistry, and soils preparation and soils testing.

Additional laboratories within the Houston facility include a sophisticated bioassay laboratory, and a microbiology laboratory.

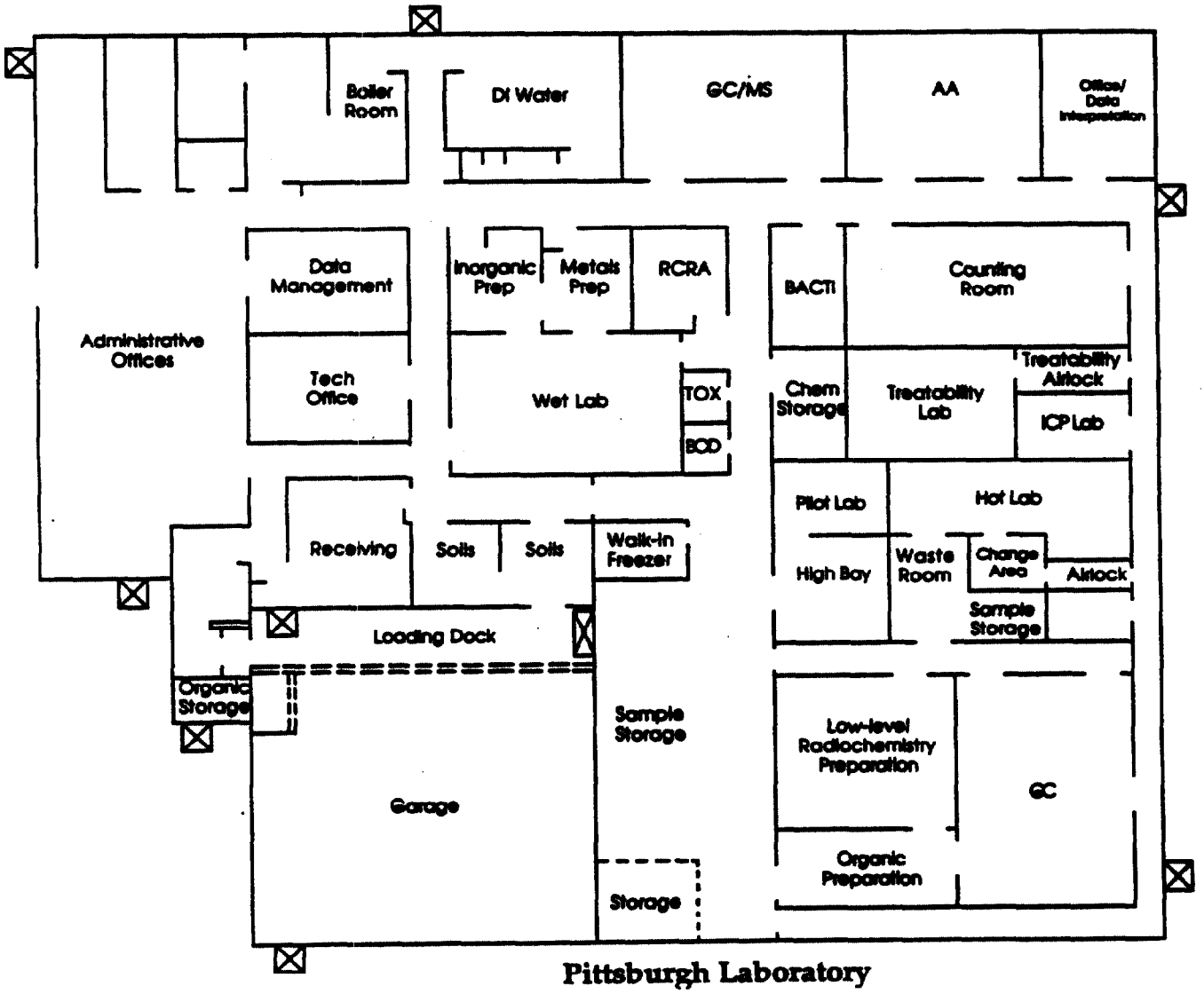
Both Pittsburgh and Houston facilities contain ultrapure water production systems which have been specifically designed to serve those facilities. Each system is equipped with an alarm that is activated when the purity of the water is unacceptable.

## 8.4 Operating Schedule

Both laboratory facilities operate under a business schedule of 8 A.M. to 5 P.M., Monday through Friday. Samples are received during that time and from 8 A.M. to 12 P.M. on Saturday.

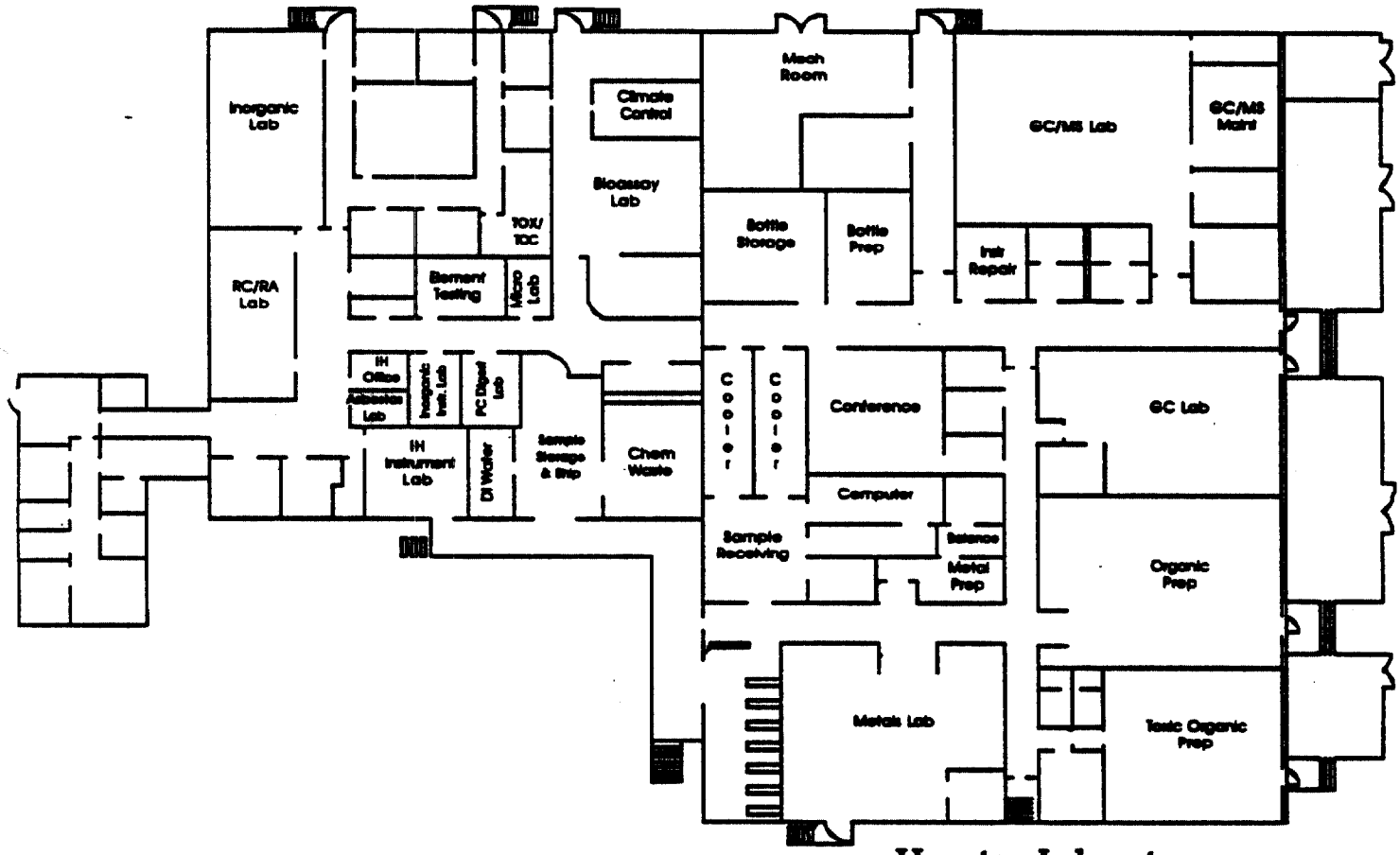
Several of the groups within each laboratory operate several shifts a day, 6 to 7 days a week. Additional shifts and days are scheduled as necessary to meet turnaround time requirements.

**FIGURE 8-1**
**HALLIBURTON NUS CORPORATION**
**PITTSBURGH, PENNSYLVANIA FACILITY**




**Pittsburgh Laboratory**

**FIGURE 8-2**
**HALLIBURTON NUS CORPORATION**
**HOUSTON, TEXAS FACILITY**




**Houston Laboratory**

# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Alpha Spectrometer (2) | 7 Yrs | Tennelec/TC 256 | Each Use | Semiannually |
| Alpha Spectrometer (30) | <1 Yr | Tennelec/TC256 | Each Use | Semiannually |
| Atomic Absorption/Emission | 13 Yrs | Perkin-Elmer/603 | Each Use | As Required |
| Atomic Absorption/Emission | <1 Yr | Perkin-Elmer/3100 | Each Use | As Required |
| Atomic Absorption/Graphite Furnace | 4 Yr | Perkin-Elmer/3030/HGA-600 | Each Use | As Required |
| Atomic Absorption/Graphite Furnace | 1 Yr | Perkin-Elmer 5100/HGA-600 | Each Use | As Required |
| Atomic Absorption/Autosampler | <1 Yr | Perkin-Elmer/AS-60 | Not Required | Not Requi |
| Atomic Absorption/Autosampler | 4 Yr | Perkin-Elmer/AS-60 | Not Required | Not Required |
| Auto Analyzer | 3 Yr | Alpkem RFA | Each Use | Not Required |
| Autoclave | 11 Yrs | Barnstead/Electric Manual | Not Required | Semiannually |
| Autoclave | 13 Yrs | Amsco/607A | Not Required | Semiannually |
| Coincidence Counting System (2) | 8 Yrs | EMI-Gencom Scintillators with lead shields interfaced with MCA | Each Use | Semiannually |
| Compression Testing | 30 Yrs | Wykeham Farrance Model #57 | Not Required | Annually |
| Conductivity Meter | 5 Yr | YSI/3Z | Each Use | Not Required |
| Dissolved Oxygen Analyzer | 5 Yr | YSI/58 | Each Use | Not Required |
| EDL Power Supply | 1 - 5 Yrs<br>1 - 4 Yrs | Perkin-Elmer/057-0761 | Not Required | Not Required |
| EDL Power Supply | <1 Yr | Perkin-Elmer/057-0759 | Not Required | Not Required |
| Flash Point Tester (2) | 12 Yrs | Pensky-Martens/13-497-5 | Not Required | Not Required |

# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 2**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Gamma Spectrometer System | 6 Yrs | Princeton Gamma-Tech Intrinsic germanium detector, Harshaw NaI (Tl) detector | Each Use | Semiannually |
| Gamma Spectrometer System | <1 Yr | Tennelec N-Type Intrinsic Germanium Detector | Each Use | Semiannually |
| Gas Chromatograph (8) | 2 - 13 Yrs<br>3 - 12 Yrs<br>1 - 11 Yrs<br>2 - 5 Yrs | Varian/3700, 5 with fused-silica capillary column | Each Use | As Required |
| Gas Chromatograph | 16 Yrs | Varian/1400 (Dual column with thermal conductivity detector) | Each Use | As Required |
| Gas Chromatograph | 11 Yrs | Hewlett-Packard/5730A (Dual Column) | Each Use | As Required |
| Gas Chromatograph, Autosampler (5) | 2 - 5 Yrs<br>2 - 4 Yrs | Varian/8000<br>Tekmar ALS | Not Required | Not Required |
| Gas Chromatograph Data System | 8 yrs | Hewlett-Packard/3380 A | Not Required | Not Required |
| Gas Chromatograph, Data System (6) | 3 Yrs | Nelson Analytical 2600 Series<br>2 - 760 Series interfaces<br>9 - 900 Series interfaces | Not Required | Not Required |
| Gas Chromatograph/Detectors (7) | 2 - 4 Yrs<br>3 - 6 Yrs<br>3 - 10 Yrs | Varian/ECD | Not Required | Not Required |
| Gas Chromatograph/Detector | 5 Yrs | Hewlett Packard/ECD | Not Required | Not Required |

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# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 3**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Gas Chromatograph/Detectors (6) | 2 - 6 Yrs<br>3 - 8 Yrs<br>3 - 12 Yrs | Varian/FID | Not Required | Not Required |
| Gas Chromatograph | 1 Yr | Carlo Erba 6000 (Cap Column) | Each Use | As Required |
| Gas Chromatograph | 1 Yr | Hewlett Packard 5890 (Dual Column) | Each Use | As Required |
| Gas Chromatograph Detectors (4) | 1 Yr | Carlo Erba ECD; HP/ECD; OI/PID and ELCD | Each Use | As Required |
| Gas Chromatograph/Detector | 4 Yrs | Hewlett-Packard/FID | Not Required | Not Required |
| Gas Chromatograph/Detector (1) | 9 Yrs | Tracor/Hall | Not Required | Not Required |
| Gas Chromatograph/Detector (1) | 2 Yr | HNU/PID | Not Required | Not Required |
| Gas Chromatograph/Purge and Trap Autosampler | 2 Yr | Tekmar ALS | Not Required | Not Required |
| Gas Chromatographer/Mass Spectrometer | 12 Yrs/<br>3 Yrs | Finnigan 4400/Varian 3400 (upgraded in 1990) | Each Use | As Required |
| Gas Chromatographer/Mass Spectrometer | 5 Yrs | Finnigan MAT 4500/9611 | Each Use | As Required |
| Gas Chromatograph/Mass Spectrometer | 11 Yrs/<br>3 Yrs | Finnigan 3200/Varian 3400 | Each Use | As Required |
| Gas Chromatograph/Mass Spectrometer (3) | 3 Yr | INCOS 50B/Varian 3400 | Each Use | As Required |

# BLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 4**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Gas Chromatograph/Mass Spectrometer Data System | 5 Yrs | Data General NOVA 4X, 70 megabyte Winchester disc drive and 15 megabyte streaming cartridge tape drive | Not Required | Not Required |
| Gas Chromatograph/Mass Spectrometer Data System (4) | 4 Yrs | Data General/NOVA 4X, dual acquisition, 70 megabyte Winchester disc drive and 15 megabyte streaming cartridge tape drive | Not Required | Not Required |
| Gas Chromatograph/Mass Spectrometer Data System (4) | 3 - 3 Yrs<br>1 - <1 Yr | Data General Model 10-SP, 71 megabyte Winchester disc drive, 15 megabyte streaming cartridge tape drive, and 5-1/4 inch floppy disk drive | Not Required | Not Required |
| Gas Proportional Counter (Low Background) | 7 Yrs | Tennelec/LB5100 Series II | Each Use | Semiannually |
| Gas Proportional Counter (Low Background) | 5 Yr | Tennelec Quad System/LB4000 Multi-Detector | Each Use | Semiannually |
| Glove Box (2) | <1 Yr<br>6 Yrs | Labconco/50350 | Not Required | Not Required |
| Hazardous Waste Extractor (2) | 7 Yrs | Manufactured to EPA Specifications | Not Required | Not Required |
| Hazardous Waste Filtration Systems | 2 - 8 Yrs<br>1 - 4 Yrs | Millipore 142 | Not Required | Not Required |
| Inductively Coupled Plasma Emission Spectrometer | <1 Yr | ARL 3560 AES | Each Use | Each Use |

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# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 5**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Inductively Coupled Plasma - Emission Spectrometer | 3 Yrs | Leeman Labs ICP-Spec III | Each Use | As Required |
| Infrared Spectrophotometer | 3 Yrs | Perkin-Elmer 710B, nulled optical | Semiannually | Not Required |
| Liquid Chromatograph | 3 Yr | Waters System Consisting of M680 Advanced Gradient Controller 2-M510 Solvent Delivery System M481 Lambda-Max Variable Wavelength Detector U6K Universal Injector instrument | Each Use | As Required |
| Liquid Scintillation Counter | 7 Yrs | Packard/Tri-Carb 4530 | Each Use | Monthly |
| Mercury Analyzer System | 3 Yrs | Perkin-Elmer/50B | Each Use | As Required |
| Microwave Digestion Unit/Capping Station | 4 Yrs | CEM MDS 18D | Not Required | Not Required |
| Mixer (includes bowls and beaters) (2) | <1 Yr | Hobart | Not Required | Not Required |
| Multi-Channel Analyzer | 6 Yrs | Canberra/Series 90 | Not Required | Not Required |
| Multi-Channel Analyzer | 6 Yrs | The Nucleus, Inc. | Not Required | Not Required |
| pH/mv Meter | 12 Yrs | Fisher/Accumet 750 | Each Use | Semiannually |
| pH/mv Meter (2) | 9 Yrs | Orion/407A | Each Use | Semiannually |
| pH/mv Meter (2) | 3 Yrs | Orion/501 | Each Use | Semiannually |
| pH/mv Meter | <1 Yr | Accumet 915 | Each Use | Semiannually |

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# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 6**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| pH/mv Meter | 1 Yr | Accumet 925 | Each Use | Semiannually |
| Semivolatile Autosampler (3) | <1 Yr | Leap Technologies | Not Required | Not Required |
| Software Package, A63-B1 | 3 Yrs | EG&G-Ortec | Not Required | Not Required |
| Sonicator (2) | 4 Yrs<br>4 Yrs | Heat Systems/W-375 | Not Required | Not Required |
| Sonicator | <1 Yr | Branson 1200 | Not Required | Not Required |
| Strip Chart Recorder/Mercury Analyzer | 4 Yrs | Varian Model 9176 | Not Required | Not Required |
| Survey Meter | 7 Yrs | Ludlum Measurements/5 G-M Meter | Each Use | Semiannually |
| Survey Meter | 7 Yrs | Ludlum Measurements/19 Micro R Meter | Each Use | Semiannually |
| Survey Meter | 7 Yrs | Ludlum Measurements/177 Alarm Ratemeter with beta shielded probe | Each Use | Semiannually |
| Survey Meter | 7 Yrs | Ludlum Measurements/12 Ratemeter with pancake probe | Each Use | Semiannually |
| Survey Meter | 7 Yrs | Ludlum Measurements/12 Ratemeter with alpha scintillation probe | Each Use | Semiannually |
| Survey Meter | 12 Yrs | Victoreen/740 F Ion Chamber | Each Use | Semiannually |
| Total Organic Carbon Analyzer | 9 Yrs | Dohrmann/DC-80 | Each Use | Not Required |
| Total Organic Carbon Analyzer | 3 Yr | Dohrmann/DC-180 | Each Use | Not Required |

# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 7**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Total Organic Halide Analyzer (3) | 9 Yrs<br>6 Yrs<br>4 Yrs | Dohrmann/DX20<br>Dohrmann/DX20<br>Dohrmann/DX20A | Each Use | Semiannually |
| Turbidimeter | 1 Yr | Monitek Model 21 | Each Use | Not Required |
| Ultrasonic Cell Disrupter (2) | 6 Yrs<br>3 Yrs | Heat Systems/W-375 | Not Required | Not Required |
| UV-Visible Spectrophotometer | 1 Yr | Milton Ray 301 | Each Use | Semiannu[illegible] |
| UV-Visible Spectrophotometer (3) | 1 - 5 Yrs<br>2 - 4 Yrs | B&L/Spec 21 | Each Use | Semiannu[illegible] |
| Volatile Organic Purge and Trap (3) | 9 Yrs | Tekmar/4000 | Not Required | Not Required |
| Volatile Organic Purge and Trap | 5 Yrs | Tekmar/LSC-1 | Not Required | Not Required |
| Volatile Organic Purge and Trap (2) | 3 Yrs | Tekmar/LSC-2 | Not Required | Not Required |
| Volatile Organic Purge and Trap | 1 Yr | Tekmar/2000 | Not Required | Not Required |
| Volatile Organic Purge Autosampler - Water | <1 Yr | Dynatech/PTA 30 | Not Required | Not Required |
| Volatile Organic Purge Autosample - Water/Soil | <1 Yr | Dynatech/PTA 30 | Not Required | Not Required |
| X-Ray Diffractometer | 18 Yrs | Phillips Electronics Instruments | As Needed for Quantitation | Semiannually |
| X-Ray Spectrometer | 18 Yrs | Phillips Electronics Instruments | Each Use | As Needed |

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# TABLE 8-1

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**PITTSBURGH, PENNSYLVANIA LABORATORY**
**PAGE 8**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Zero Headspace Extractor (ZHE) | 4 - 4 Yrs | Millipore | Not Required | Not Required |
| ZHE Rotary Agitator | 4 Yrs | Millipore | Not Required | Not Required |
| GC/MS 9 Track Tape System | 13 Yrs | Wangco 1045/Perkin Elmer ST2222 | Not Required | Not Required |
| Parr Oxygen Bomb Calorimeter | 2 Yrs | Parr 1341EB | Each Use | Not Required |
| Muffle Furnace | 1 Yr | Thermolyne 6020C | Not Required | 1 Year |
| Muffle Furnace | 1 Year | Blue M E-55563 | Not Required | 1 Year |

# TABLE 8-2

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**HOUSTON, TEXAS LABORATORY**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Atomic Absorption Emission Spectrophotometer | 1 Yr | Perkin-Elmer/3030 Zeeman | Each Use | As Required |
| Atomic Absorption Emission Spectrophotometer | 13 Yrs | Instrumentation Laboratories/251 | Each Use | As Required |
| Atomic Absorption Spectrophotometer | 11 Yrs | Perkin-Elmer 603 | Each Use | As Required |
| Atomic Absorption Graphite Furnace Spectrophotometer | 11 Yrs | Perkin-Elmer 2100 | Each Use | As Required |
| Atomic Absorption/Graphite Furnace | 4 Yrs | Perkin-Elmer/3030/GHA-500 | Each Use | As Requir |
| Atomic Absorption Vapor Generator Accessory | 9 Yrs | Varian/65 | Each Use | As Required |
| Autoanalyzer | 3 Yrs | Alpkem RFA 300 | Each Use | As Required |
| Autoclave | 16 Yrs | Barnstead/Control Manual | Not Required | Semiannually |
| Autosampler (3) | <1 Yr | CTC Analytics CTC A200S | Not Required | Not Required |
| Conductivity Meter | 12 Yrs | Leeds & Northrup/No. 4866 | Each Use | Not Required |
| Corrosion Test Apparatus (4) | 8 Yrs | Nace/TM-01-69 Specifications | As Required | As Required |
| Dissolved Oxygen Meter | 10 Yrs | YSI/54 | Each Use | Not Required |
| Dissolved Oxygen Meter | 9 Yrs | YS1/57 | Each Use | Not Required |
| Flash Point Apparatus | 4 Yrs | Seta-Flash OISF | Each Use | As Required |
| Gas Chromatograph | 3 Yrs | Varian/3300 | Each Use | As Required |
| Gas Chromatograph | 7 Yrs | Varian/3700 | Each Use | As Required |

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# TABLE 8-2

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**HOUSTON, TEXAS LABORATORY**
**PAGE 2**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Gas Chromatograph | 1 Yr | Hewlett-Packard/5890 | Each Use | As Required |
| Gas Chromatograph | 12 Yrs | Hewlett-Packard/5830A | Each Use | As Required |
| Gas Chromatograph (2) | 11 Yrs | Hewlett-Packard/5840A | Each Use | As Required |
| Gas Chromatograph | 4 Yrs | Hewlett-Packard/5890 | Each Use | As Required |
| Gas Chromatograph/Autosampler | 11 Yrs | Hewlett-Packard/7671A | Not Required | Not Required |
| Gas Chromatograph/Autosampler | 1 Yr | Hewlett-Packard/7673A | Not Required | Not Required |
| Gas Chromatograph/Data System | 1 Yr | Hewlett-Packard/3393A | Not Required | Not Required |
| Gas Chromatograph/Data System | 7 Yrs | Varian/Vista 401 | Not Required | Not Required |
| Gas Chromatograph/Detectors (2) | 7 Yrs | Varian/ECD | Not Required | Not Required |
| Gas Chromatograph/Detector | 7 Yrs | Tracor/Hall | Not Required | Not Required |
| Gas Chromatograph/Detectors (3) | 12 Yrs | Hewlett-Packard/ECD | Not Required | Not Required |
| Gas Chromatograph/Detectors (2) | 1 Yr | Hewlett-Packard/FID | Not Required | Not Required |
| Gas Chromatograph/Detectors (4) | 12 Yrs | Hewlett-Packard/FID | Not Required | Not Required |
| Gas Chromatograph/Detector | 12 Yrs | Hewlett-Packard/TCD | Not Required | Not Required |
| Gas Chromatograph/Detectors (2) | 12 Yrs | Hewlett-Packard/N-PD | Not Required | Not Required |
| Gas Chromatograph/Detectors (2) | 3 Yrs | Varian/FID-Capillary | Not Required | Not Required |

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# TABLE 8-2

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**HOUSTON, TEXAS LABORATORY**
**PAGE 3**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Gas Chromatograph/Mass Spectrometer (2) | 14 & 16 Yrs | Finnigan/3200F/9500 | Each Use | As Required |
| Gas Chromatograph/Mass Spectrometer (2)/Data System (2) | 8 & 3 Yrs | Finnigan/4500C/Varian 3406 | Each Use | As Required |
| Gas Chromatograph/Mass Spectrometer (2)/Data System (4) | 1 Yr | Finnigan Incos50/Varian 3400 | Each Use | As Required |
| Gas Chromatograph/Mass Spectrometer Autosampler | 1 Yr | Varian 8000 | Not Required | Not Required |
| Hazardous Waste Extractor (2) | 7 Yrs | Manufactured to EPA Specifications | Not Required | Not Requi |
| Inductively Coupled Plasma Emission Spectrometer/Atomic Absorption/Graphite Furnace | 5 Yrs | Perkin-Elmer ICP/5500/GHA/500 | Each Use | As Required |
| Inductively Coupled Plasma Emission Spectrophotometer | 1 Yr | Perkin-Elmer P40 | Each Use | As Required |
| Infrared Spectrophotometer | 3 Yrs | Perkin-Elmer 1310 | Each Use | As Required |
| Ion Chromatograph | 2 Yrs | Dionex/4000 | Each Use | Not Required |
| Ion Trap | 3 yrs | Finnigan/700 | Each Use | As Required |
| Liquid Chromatograph | 5 Yrs | Waters/440 UV Detector, 420-AC Fluorescent Detector, M45 Pump, and U6K Injector | Each Use | As Required |

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# TABLE 8-2

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**HOUSTON, TEXAS LABORATORY**
**PAGE 4**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Liquid Chromatograph/Gradient Controller Pump | 2 Yrs | Waters Model 510 Pump, Model 680 Controller | Not Required | Not Required |
| Liquid Chromatograph/Autosampler | 1 Yr | Waters Model 712 WISPNot Required Not Required | | |
| Liquid Sample Concentrator | 11 Yrs | Tekmar/LSC | Not Required | Not Required |
| Liquid Sample Concentrator | 1 Yr | Tekmar 2000 | Not Required | Not Required |
| Liquid Sample Concentrator (4) | 2-4 Yrs | Tekmar LGS-2 | Not Required | Not Required |
| Mercury Analyzer | 12 Yrs | Perkin-Elmer/Coleman 50 | Each Use | As Required |
| Microbalance | 5 Yrs | Cahn/28 | Monthly | Annually |
| Microscope | 16 Yrs | Millipore/No. 720672 | Not Required | Not Required |
| Microscope, Phase Contrast (2) | 16 Yrs | Leitz/SM-LUX | Not Required | Not Required |
| Microscope, Polarized Light | 4 Yrs | Leitz/Laborlux 12 Pol | Not Required | Not Required |
| Microscope, Polarized Light | 1 Yr | Nikon/Laboehot-Pol | Not Required | Not Required |
| Pensky-Martens Flash Point Tester | 8 Yrs | Fisher Scientific | Not Required | Not Required |
| pH Meter | 12 Yrs | Corning/12 | Each Use | Semiannually |
| pH/mv Meter | 7 Yrs | Orion Ionalyzer/901 | Each Use | Semiannually |
| Total Organic Carbon Analyzer | 3 Yrs | Dohrmann/DC-80 | Each Use | As Required |
| Total Organic Halide Analyzer (2) | 3 & 4 Yrs | Dohrmann/DX-20 | Each Use | Semiannually |

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# TABLE 8-2

**MAJOR LABORATORY EQUIPMENT**
**HALLIBURTON NUS ENVIRONMENTAL CORPORATION'S**
**HOUSTON, TEXAS LABORATORY**
**PAGE 5**

| INSTRUMENT | AGE | MANUFACTURER AND MODEL | FREQUENCY OF STANDARDIZATION | FREQUENCY OF CALIBRATION |
|---|---|---|---|---|
| Turbidimeter | 13 Yrs | Hach/2100A | Each Use | Not Required |
| UV-Visible Spectrophotometer with Sampler Accessory | 5 Yrs | Varian/DMS 80 | Each Use | Semiannually |
| Vis-Near Infrared Spectrophotometer | 11 Yrs | Bausch & Lomb/Spectronic 20 | Each Use | Semiannually |
| Vis-Spectrometer | <1 Yr | Milton Roy 301 | Each Use | Semiannually |

# 9.0 EQUIPMENT MAINTENANCE

LSG Procedure QA-13 (Appendix G) describes the procedures followed for preventive maintenance, including equipment such as balances, ovens, and refrigerators.

# 10.0 ANALYTICAL PROCEDURES AND DETECTION LIMITS

## 10.1 ANALYTICAL CAPABILITIES

The HALLIBURTON NUS Laboratory Services Group (LSG) provides a complete spectrum of environmental testing and analytical services ranging from basic wet chemistry analyses to sophisticated nonroutine organic, inorganic, and radiochemistry analyses. Analyses are performed on a wide variety of matrices; including water, wastewater, soils, sediments, sludges, hazardous wastes, low-level radioactive wastes, and air sampling media.

Presented in Table 10-1 is a list of many of the analytical services that HALLIBURTON NUS can provide. Additional analyses can be provided on specific request. Also found in Tables 10-1 and 10-2 is a summary of the method references that are used to perform the analyses, a designation of the appropriate CLEAN QA level that will be used to perform analyses for this program, and a list of the clean water detection limits that can be achieved using these methods. All detection limits as listed in the table apply to clean water samples and may be elevated in samples containing matrix interferences or requiring dilutions during sample preparation.

The methods that will be used for a particular project will be detailed in a project-specific plan. These methods will comply with Baker's work plan which is approved by CLEAN. For this reason, the method reference for a given analyte may vary from project to project. For example, the 1988 or 1990 CLP Statement of Work (SOW) may be used depending of the revision specified in the approved work plan.

The parameters listed in Table 10-1 apply to CLEAN QA Levels D, C, and E. HALLIBURTON NUS can also provide analyses for QA Level B at on-site or mobile laboratory facilities. The requirements for Level B are addressed in project-specific plans.

## 10.2 METHOD VARIANCES AND DISTRIBUTION

Any method variances from the procedures as specified in Table 10-1 will be handled on a project-specific basis and will be addressed in the applicable work plan.

Controlled copies of laboratory methods are available to analysts, in the Methods File, which is maintained in or near each laboratory. Each file contains the methods for tests performed in that laboratory.

## 10.3 SAMPLE HOLDING TIMES

All holding times are measured from the date of sample collection, regardless of the QA level. Tables 10-3 and 10-4 provide holding times for water and soil/sediment, respectively. The list of parameters on these tables include those commonly requested on CLEAN projects.

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **I. Target Compound List (TCL) and Priorty Pollutants** | | | |
| Volatile Organics[3] | CLP/D,C/See Table 10-2 | CLP/D,C/--- | CLP (High Conc.)/E/--- |
| Semivolatile Organics[3] | CLP/D,C/See Table 10-2 | CLP/D,C/--- | CLP (High Conc.)/E/--- |
| Pesticides/Polychlorinated Biphenyls (PCBs) | CLP/D,C/See Table 10-2 | CLP/D,C/--- | CLP (High Conc.)/E/--- |
| Aluminum[4] | CLP 200.7/D,C/0.2 | CLP 200.7/D,C/--- | SW 7020 or 6010/E/--- |
| Antimony[5] | CLP 204.2/D,C/0.06 | CLP 204.2/D,C/--- | SW 7040 or 6010/E/--- |
| Arsenic | CLP 206.2/D,C/0.01 | CLP 206.1/D,C/--- | SW 7060/E/--- |
| Barium[4] | CLP 200.7/D,C/0.2 | CLP 200.7/D,C/--- | SW 7080 or 6010/E/--- |
| Beryllium | CLP 200.7/D,C/0.005 | CLP 200.7/D,C/--- | SW 7090 or 6010/E/--- |
| Cadmium | CLP 200.7/D,C/0.005 | CLP 200.7/D,C/--- | SW 7130 or 6010/E/--- |
| Calcium[4] | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/--- | SW 7140 or 6010/E/--- |
| Chromium | CLP 200.7/D,C/0.01 | CLP 200.7/D,C/--- | SW 7190 or 6010/E/--- |
| Cobalt[4] | CLP 200.7/D,C/0.05 | CLP 200.7/D,C/--- | SW 7200 or 6010/E/--- |
| Copper | CLP 200.7/D,C/0.025 | CLP 200.7/D,C/--- | SW 7210 or 6010/E/--- |
| Iron[4] | CLP 200.7/D,C/0.1 | CLP 200.7/D,C/--- | SW 7380 or 6010/E/--- |
| Lead | CLP 239.2/D,C/0.003 | CLP 239.2/D,C/--- | SW 7420 or 6010/E/--- |
| Magnesium[4] | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/--- | SW 7450 or 6010/E/--- |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE TWO**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **I. Target Compound List (TCL) and Priorty Pollutants (Continued)** | | | |
| Manganese[4] | CLP 200.7/D,C/0.015 | CLP 200.7/D,C/--- | SW 7460 or 6010/E/--- |
| Mercury | CLP 245.1/D,C/0.0002 | CLP 245.5/D,C/--- | SW 7471/E/--- |
| Nickel | CLP 200.7/D,C/0.04 | CLP 200.7/D,C/--- | SW 7520 or 6010/E/--- |
| Potassium[4] | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/--- | SW 7610 or 6010/E/--- |
| Selenium | CLP 270.2/D,C/0.005 | CLP 270.2/D,C/--- | SW 7740/E/--- |
| Silver | CLP 200.7/D,C/0.01 | CLP 200.7/D,C/--- | SW 7760 or 7010/E/--- |
| Sodium[4] | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/--- | SW 7770 or 6010/E |
| Thallium[5] | CLP 279.2/D,C/0.01 | CLP 279.2/D,C/--- | SW 7840 or 6010/E/--- |
| Vanadium[4, 5] | CLP 286.2/D,C/0.05 | CLP 286.2/D,C/--- | SW 7910 or 6010/E/--- |
| Zinc | CLP 200.7/D,C/0.02 | CLP 200.7/D,C/--- | SW 7950 or 6010/E/--- |
| Metals Preparation | CLP/D,C/--- | CLP/D,C/--- | SW 3050[6] (waste), SW 3005, 3010, or 3020 (TCLP extracts)/E/--- |
| Cyanide | CLP 335.2/D/0.01 | CLP 335.2/D/--- | EPA 335.2/E/--- |
| Phenols[7] | EPA 420.1/D,C/0.01 | SW 9065/D,C/--- | SW 9065/E/--- |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE THREE**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **II. Appendix IX in Groundwater/Appendix VIII in Soil, Sediment, and Wastes** | | | |
| Aluminum | CLP 200.7/D,C/0.1 | CLP 200.7/D,C/---- | SW 6010 or 7020/E/---- |
| Antimony[5] | CLP 204.2/D,C/0.06 | CLP 204.2/D,C/---- | SW 6010 or 7040/E/---- |
| Arsenic | CLP 206.2/D,C/0.01 | CLP 206.2/D,C/---- | SW 7060/E/---- |
| Barium | CLP 200.7/D,C/0.2 | CLP 200.7/D,C/---- | SW 6010 or 7080/E/---- |
| Beryllium | CLP 200.7/D,C/0.005 | CLP 200.7/D,C/---- | SW 6010 or 7090/E/---- |
| Cadmium | CLP 200.7/D,C/0.005 | CLP 200.7/D,C/---- | SW 6010 or 7130/E/---- |
| Calcium | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/---- | SW 6010 or 7140/E/---- |
| Chromium | CLP 200.7/D,C/0.01 | CLP 200.7/D,C/---- | SW 6010 or 7190/E/---- |
| Cobalt | CLP 200.7/D,C/0.5 | CLP 200.7/D,C/---- | SW 6010 or 7200/E/---- |
| Copper | CLP 200.7/D,C/0.025 | CLP 200.7/D,C/---- | SW 6010 or 7210/E/---- |
| Iron | CLP 200.7/D,C/1.0 | CLP 200.7/D,C/---- | SW 6010 or 7380/E/---- |
| Lead[5] | CLP 239.2/D,C/0.005 | CLP 239.2/D,C/---- | SW 6010 or 7420/E/---- |
| Magnesium | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/---- | SW 6010 or 7450/E/---- |
| Manganese | CLP 200.7/D,C/0.015 | CLP 200.7/D,C/---- | SW 6010 or 7460/E/---- |
| Mercury | CLP 245.1/D,C/0.0002 | CLP 245.5/D,C/---- | SW 7471/E/---- |
| Nickel | CLP 200.7/D,C/0.04 | CLP 200.7/D,C/---- | SW 6010 or 7520/E/---- |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE FOUR**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **II. Appendix IX in Groundwater/Appendix VIII in Soil, Sediment, and Wastes (Continued)** | | | |
| Osmium | SW 7550/D,C/0.3 | SW 7550/D,C/---- | SW 7550/E/---- |
| Potassium | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/---- | SW6010 or 7610/E/---- |
| Selenium | CLP 270.2/D,C/0.005 | CLP 270.2/D,C/---- | SW 7740/E/---- |
| Silver | CLP 200.7/D,C/0.01 | CLP 200.7/D,C/---- | SW 6010 or 7760/E/---- |
| Sodium | CLP 200.7/D,C/5.0 | CLP 200.7/D,C/---- | SW 6010 or 7770/E/---- |
| Thallium[5] | CLP 279.2/D,C/0.01 | CLP 279.2/D,C/---- | SW 6010 or 7840/E/---- |
| Tin | SW 7870/D,C/1 | SW 7870/D,C/---- | SW 7870/E/---- |
| Vanadium[5] | CLP 286.2/D,C/0.05 | CLP 286.2/D,C/---- | SW 6010 or 7910/E/ |
| Zinc | CLP 200.7/D,C/0.02 | CLP 200.7/D,C/---- | SW 6010 or 7950/E/---- |
| Metals preparation | CLP/D,C/---- | CLP/D,C/---- | SW 3050[6] (waste), SW 3005, 3010, or 3020 (TCLP extracts)/E/---- |
| Cyanide | CLP 335.2/D,C/0.01 | CLP 335.2/D,C/---- | SW 9010/E/---- |
| Fluoride | SM 413B/C/0.1 | SM 413A/C/---- | SM 413A/E/---- |
| Sulfide | SW 9030/C/0.1 | SW 9030/C/---- | SW 9030 (with N2 generation)/E/---- |
| Volatile organics | CLP[8]/D,C/See Table 10-2 | CLP[8]/D,C/---- | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE FIVE**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **II. Appendix IX in Groundwater/Appendix VIII in Soil, Sediment, and Wastes (Continued)** | | | |
| Semivolatile organics | CLP[8]/D,C/See Table 10-2 | CLP[8]/D,C/--- | |
| TCL Pesticides/PCBs | CLP/D,C/See Table 10-2 | CLP/D,C/--- | |
| Herbicides | SW 8150/C/See Table 10-2 | SW 8150/C/--- | |
| Organophosphorus Pesticides | SW 8140/E/See Table 10-2 | SW 8140/C/--- | |
| **III. RCRA Hazardous Waste Characteristics and Land Disposal Restrictions** | | | |
| Corrosivity<br>• NACE<br>• pH | SW 1110/E/--- | SW 9040/C,E/--- | SW 9040/E/--- |
| Ignitability | | | SW 1010/E/--- |
| Reactivity<br>• Cyanide<br>• Sulfide | | | SW 7.3.3.2/E/---<br>SW 7.3.4.1/E/--- |
| TCLP/ZHE<br>• Extraction<br>• Arsenic (on leachate)<br>• Barium (on leachate)<br>• Cadmium (on leachate)<br>• Chromium (on leachate)<br>• Lead (on leachate)<br>• Mercury (on leachate)<br>• Selenium (on leachate) | | | SW 1311/C,E/---<br>SW 7060/C,E/0.003<br>SW 7080/C,E/0.1<br>SW 7130/C,E/0.005<br>SW 7190/C,E/0.01<br>SW 7420/C,E/0.05<br>SW 7470/C,E/0.0002<br>SW 7740/C,E/0.003 |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE SIX**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **III. RCRA Hazardous Waste Characteristics and Land Disposal Restrictions (Continued)** | | | |
| TCLP/ZHE (Continued)<br>• Silver (on leachate)<br>• Pesticides (on leachate)<br>• Herbicides (on leachate)<br>• Semivolatiles (on leachate)<br>• Volatiles(on leachate) | | | <br>SW 7760/C,E/0.01<br>SW 8080/C,E/See Table 10-2<br>SW 8150/C,E/See Table 10-2<br>SW 8270/C,E/See Table 10-2<br>SW 8240/C,E/See Table 10-2 |
| Paint Filter Liquids Test | | | SW 9095/E/---- |
| **IV. California List - Metals and Halogenated Organic Compounds - Appendix III, 40 CFR 268 - (Refer to Appendix IX Methods)** | | | |
| Dioxin | | EPA 625,SIM for TCDD/E/---- | EPA 625 SIM for TCDD/E/---- |
| **V. Radiochemistry** | | | |
| Gross Alpha | EPA 900.0/C,E/1 pCi/L | | |
| Gross Beta | EPA 900.0/C,E/2 pCi/L | | |
| Radium-226 | EPA 903.0 or 903.1/C,E/ 0.5 pCi/L | EPA 903.0 or 903.1[9]/C,E/---- | |
| Radium-228 | EPA 904.0/C,E/1 pCi/L | EPA 904.0[9]/C,E/---- | |
| Strontium-89 and -90 | EPA 905.0/C,E/2 pCi/L | EPA 905.0[9]/C,E/---- | |
| Gamma Spectrometry | ----/C,E/---- | ----/C,E/---- | |
| Alpha Spectroscopy | ----/C,E/---- | ----/C,E/---- | |
| Uranium, Total | EPA 908.0/C,E/1pCi/L | ----/C,E/---- | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE SEVEN**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **VI. Miscellaneous Inorganics** | | | |
| Petroleum Hydrocarbons | EPA 418.1/C/2 | SW 3550, EPA 418.1/C/--- | |
| Oil and Grease | EPA 413.1/C/5 | SW 3550, EPA 413.1/C/--- | |
| Cation Exchange Capacity | | SW 9081/C/--- | |
| Miscellaneous Anions[10] | | | |
| • Bromide (+ Iodide) | EPA 320.1/C/2 | | |
| • Chloride | SM 407B/C/2 | SM 407B/C/--- | |
| • Fluoride | SM 413A/C/2 | SM 413A/C/--- | |
| • Nitrate ($NO_2$-$NO_3$) | EPA 353.2/C/0.01 | EPA 353.2/C/--- | |
| • Nitrate | EPA 352.1/C/0.1 | EPA 352.1/C/--- | |
| • Phosphate | EPA 365.2/C/0.01 | EPA 365.2/C/--- | |
| • Sulfate | EPA 375.4/C/1 | EPA 375.4/C/--- | |
| Acidity | SM 402/C/1 | | |
| Alkalinity | SM 403/C/1 | | |
| Ammonia (N) | EPA 350.3 or 350.2/C/0.1 | EPA 350.2/C/--- | |
| Biochemical Oxygen Demand (BOD) | SM 507/C/1 | | |
| Boron | SM 404A/C/0.2 | | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE EIGHT**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **VI. Miscellaneous Inorganics (Continued)** | | | |
| Chemical Oxygen Demand (COD) | EPA 410.1 or 410.4/C/5 | EPA 410.1 or 410.4/C/--- | |
| Hardness | SM 314B/C/2 | | |
| Hexavalent Chromium | SM 312B/C/0.01 | SW 3060,SM 312B/C/--- | |
| Nitrite | EPA 354.1/C/0.01 | EPA 354.1/C/--- | |
| pH | EPA 150.1/C/--- | SW 9040/C/--- | SW 9040/C,E/--- |
| Total Dissolved Solids (TDS) | EPA 160.1/C/1 | | |
| Total Kjeldahl Nitrogen (TKN) | EPA 150.3/C/0.1 | EPA 150.3/C/0.1 | |
| Total Organic Carbon (TOC) | EPA 415.1/C/1 | Walkley-Black/C/--- | |
| Total Solids | EPA 160.3/C/1 | SM 209/C/--- | |
| Total Suspended Solids | EPA 160.2/C/1 | | |
| Specific Conductance | EPA 120.1/C/5mhos/cm | | |
| Surfactants | SM 512B/C/0.05 | | |
| Turbidity | EPA 180.1/C/0.01 NTU | | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE NINE**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[3] |
| **VII. Miscellaneous Metals** | | | |
| Aluminum | EPA 202.2/C/0.003 | EPA 202.2/C/--- | |
| Beryllium | EPA 210.2/C/0.0005 | SW 7091/C/--- | |
| Cadmium | EPA 213.2/C/0.000 | SW 7131/C/--- | |
| Chromium | EPA 218.2/C/0.001 | SW 7191/C/--- | |
| Iron | EPA 236.2/C/0.002 | EPA 236.2/C/--- | |
| Manganese | EPA 243.2/C/0.0001 | EPA 243.2/C/--- | |
| Molybdenum | EPA 246.2/C/0.0005 | SW 7481/C/--- | |
| Molybdenum | EPA 246.1/C/0.03 | SW 7480/C/--- | |
| Nickel | EPA 249.2/C/0.003 | EPA 249.2/C/--- | |
| Silver | EPA 272.2/C/0.0005 | EPA 272.2/C/--- | |
| Tin | EPA 282.2/C/0.005 | EPA 282.2/C/--- | |
| Titanium | EPA 283.1/C/0.5 | EPA 283.1/C/--- | |
| Titanium | EPA 283.2/C/0.005 | EPA 283.2/C/--- | |
| Zinc | EPA 289.2/C/0.001 | EPA 289.2/C/--- | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE TEN**

| PARAMETER | WATER | SOIL/SEDIMENT | WASTE/TCLP EXTRACTS |
|---|---|---|---|
| | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] | METH. REF[1]/QA LEVEL/DL[2] |
| **VIII. Miscellaneous Organics** | | | |
| Purgeable Halocarbons | EPA 601/C/1 µg/L[11] | SW 8010/C/— | |
| Purgeable Aromatics | EPA 602/C/1 µg/L[11] | SW 8020/C/— | |
| Fingerprinting (Modified California Test) | | | GC-FID/E/NA |
| **IX. Geotechnical** | | | |
| Atterberg Limits | | ASTM D4318/E/NA | |
| British Thermal Units (BTU) | | ASTM 3286/E/NA | ASTM 3286/E/NA |
| California Bearing Ratio | | ASTM D1883/E/NA | |
| Grain Size | | ASTM D422/E/NA | |
| Moisture Content | | ASTM D2216/E/NA | |
| Moisture Density - Standard Proctor | | ASTM D698/E/NA | |
| Moisture Density - Modified Proctor | | ASTM D1883/E/NA | |
| Permeability | | SW 9100/E/NA | |
| Specific Gravity | | ASTM D854/E/NA | |
| Unconfined Compression | | ASTM D2166/E/NA | |

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE ELEVEN**

1 All methods are subject to the quality control protocols as described in Section 11.0.

2 All detection limits are matrix dependent. The detection limits as listed in this table apply to clean water samples that are free of matrix interferences. The detection limits for TCL parameters by Levels D and C are the Contract Required Quantitaiton Limits (CRQLs) for organics in low-level water or the Contract Requried Detection Limits (CRDLs) for inorganics as found in the CLP protocols. Unless otherwise noted, the detection limits are expressed as mg/L. For metals, ICP may be substituted for graphite furnace methods for Levels D and C as long as the required detection limits can be met. The detection limits for non-CLP analyses may vary, depending on instrumentation.

3 For Level D and when specified in the work plan for Level C, analysis will include a GC/MS library search for 10 additional peaks in the volatile fraction and 20 additional peaks in the semivolatile fraction.

4 Included in TCL only.

5 For Level C, inductively coupled plasma (ICP) will be used when specified in the work plan.

Additonal sample preparations, including ashing, may be required for complex sample matrices.

7 Included on priority pollutant list only.

8 Consists of analysis for the Appendix IX compounds as listed in Table 10-2, but does not include GC/MS library search for tentatively identified compounds (TICs).

9 Analysis will follow acid digestion.

10 Ion chromatography can be substituted for the individual wet chemistry methdods.

11 The detection limit is an estimate and varies with the specific compound.

CLP (organic parameters) refers to "Statement of Work of Organics Analysis, Multi-Media, Multi-Concentraiton," SOW 288 or Document No. OLM01.0.

CLP (inorganic parameters) refers to "Statement of Work of Inorganics Analysis, Multi-Media, Multi-Concentration," SOW 788 or Document No. ILM01.0.

CLP (high conc.) refers to "Statement of Work for Organics Analysis, Multi-Media, High-Concentration," USEPA Contract Laboratory Program, January 1988.

**TABLE 10-1**
**ANALYSES, METHOD REFERENCES, QA LEVEL, AND DETECTION LIMITS**
**PAGE TWELVE**

SW refers to "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods," SW-846, 3rd edition.

EPA (inorganic parameters) refers to "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1979, revised March 1983.

EPA (organic parameters) refers to "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," Appendix A to 40 CFR 136.

EPA (radiochemistry) refers to "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032.

SM refers to "Standard Methods for the Examination of Water and Wastewater," APHA-AWWA-WPCF, 16th edition.

ASTM refers to "Annual Book of ASTM Standards."

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Volatile Compounds** | | | | | | |
| Acetone | X | X | | 10 | 10 | 1200 |
| Acrolein | X | | X | 100 | | |
| Acrylonitrile | X | | X | 100 | | |
| Benzene | X | X | X | 10 | 10 | 1200 |
| Bromoform | X | X | X | 10 | 10 | 1200 |
| 2-Butanone (Methyl ethyl ketone) | X | X | | 10 | 10 | 1200 |
| Carbon tetrachloride | X | X | X | 10 | 10 | 1200 |
| Carbon disulfide | X | X | | 10 | 10 | 1200 |
| Chlorobenzene | X | X | X | 10 | 10 | 1200 |
| Chlorodibromoethane | X | X | X | 10 | 10 | 1200 |
| Chloroethane | X | X | X | 10 | 10 | 1200 |
| 2-Chloroethyl vinyl ether | X | | X | 10 | | |
| Chloroform | X | X | X | 10 | 10 | 1200 |
| Dichlorobromomethane | X | X | X | 10 | 10 | 1200 |
| 1,1-Dichloroethane | X | X | X | 10 | 10 | 1200 |
| 1,2-Dichloroethane | X | X | X | 10 | 10 | 1200 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE TWO**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (ug/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Volatile Compounds (Continued)** | | | | | | |
| 1,1-Dichloroethylene | X | X | X | 10 | 10 | 1200 |
| 1,2-Dichloropropane | X | X | X | 10 | 10 | 1200 |
| cis-1,3-Dichloropropylene | X | X | X | 10 | 10 | 1200 |
| trans-1,3-Dichloropropylene | X | X | | 10 | 10 | 1200 |
| 2-Hexanone | X | X | | 10 | 10 | 1200 |
| Ethylbenzene | X | X | X | 10 | 10 | 120[illegible] |
| Methyl bromide | X | X | X | 10 | 10 | 120[illegible] |
| Methyl chloride | X | X | X | 10 | 10 | 1200 |
| Methylene chloride | X | X | X | 10 | 10 | 1200 |
| 4-Methyl-2-pentanone | X | X | | 10 | 10 | 1200 |
| 1,1,2,2-Tetrachloroethane | X | X | X | 10 | 10 | 1200 |
| Styrene | X | X | | 10 | 10 | 1200 |
| Tetrachloroethylene | X | X | X | 10 | 10 | 1200 |
| Toluene | X | X | X | 10 | 10 | 1200 |
| 1,2-trans-Dichloroethylene | X | X | X | 10 | 10 | 1200 |
| 1,1,1-Trichloroethane | X | X | X | 10 | 10 | 1200 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE THREE**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| Volatile Compounds (Continued) | | | | | | |
| 1,1,2-Trichloroethane | X | X | X | 10 | 10 | 1200 |
| Trichloroethylene | X | X | X | 10 | 10 | 1200 |
| Vinyl acetate | X | | | 10 | | |
| Vinyl chloride | X | X | X | 10 | 10 | 1200 |
| Xylene, total | X | X | | 10 | 10 | 1200 |
| Acetonitrile | X | | | 10 | | |
| 2-Chloro-1,3-butadiene | X | | | 5 | | |
| 3-Chloropropene | X | | | 5 | | |
| 1,2-Dibromoethane | X | | | 10 | | |
| Dibromomethane | X | | | 5 | | |
| trans-1,4-dichloro-2-butene | X | | | 5 | | |
| Dichlorodifluoromethane | X | | | 5 | | |
| 1,4-Dioxane | X | | | 100 | | |
| Ethyl cyanide | X | | | 10 | | |
| Ethyl methacrylate | X | | | 5 | | |
| Iodomethane | X | | | 5 | | |

TABLE 10-2
CLEAN WATER MATRIX DETECTION LIMITS
ORGANIC COMPOUNDS
PAGE FOUR

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Volatile Compounds (Continued)** | | | | | | |
| Isobutyl alcohol | X | | | 5 | | |
| Pentachloroethane | X | | | 10 | | |
| Methacrylonitrile | X | | | ND | | |
| 1,1,1,2-Tetrachloroethane | X | | | 5 | | |
| Trichloromonofluoromethane | X | | | 5 | | |
| 1,2,3-Trichloropropane | X | | | 5 | | |
| **Acid Compounds** | | | | | | |
| 2-Chlorophenol | X | X | X | 10 | 330 | 10,000 |
| 2,4-Dichlorophenol | X | X | X | 10 | 330 | 10,000 |
| 2,4-Dimethylphenol | X | X | X | 10 | 330 | 10,000 |
| 4,6-Dinitro-o-cresol | X | X | X | 25 | 800 | 25,000 |
| 2,4-Dinitrophenol | X | X | X | 25 | 800 | 25,000 |
| 2-Nitrophenol | X | X | X | 10 | 330 | 10,000 |
| 4-Nitrophenol | X | X | X | 25 | 800 | 25,000 |
| p-Chloro-m-cresol | X | X | X | 10 | 330 | 10,000 |
| Pentachlorophenol | X | X | X | 25 | 800 | 25,000 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE FIVE**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Acid Compounds (Continued)** | | | | | | |
| Phenol | X | X | X | 10 | 330 | 10,000 |
| 2,4,6-Trichlorophenol | X | X | X | 10 | 330 | 10,000 |
| 2-Methylphenol | X | X | | 10 | 330 | 10,000 |
| 4-Methylphenol | X | X | | 10 | 330 | 10,000 |
| 2,4,5-Trichlorophenol | X | X | | 25 | 800 | 25,000 |
| 2,6-Dichlorophenol | X | | | 10 | | |
| 2,3,4,6-Tetrachlorophenol | X | | | 10 | | |
| 3-Methylphenol | X | | | 10 | | |
| 2,4,5-Trichlorophenol | X | | | 10 | | |
| 2-sec-butyl-4,6-dinitrophenol | X | | | 20 | | |
| **Base/Neutral Compounds** | | | | | | |
| Acenaphthene | X | X | X | 10 | 330 | 10,000 |
| Acenaphthylene | X | X | X | 10 | 330 | 10,000 |
| Aniline | X | | | 10 | | |
| Anthracene | X | X | X | 10 | 330 | 10,000 |
| Benzidine | X | | X | 50 | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE SIX**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| Benzo(a)anthracene | X | X | X | 10 | 330 | 10,000 |
| Benzo(a)pyrene | X | X | X | 10 | 330 | 10,000 |
| 3,4-Benzofluoranthene | X | X | X | 10 | 330 | 10,000 |
| Benzo(ghi)perylene | X | X | X | 10 | 330 | 10,000 |
| Benzo(k)fluoranthene | X | X | X | 10 | 330 | 10,000 |
| Benzyl alcohol | X | | | 10 | | |
| bis(2-Chloroethoxy)methane | X | X | X | 10 | 330 | 10, |
| bis(2-Chloroethyl)ether | X | X | X | 10 | 330 | 10,000 |
| 2,2'-oxybis(1-Chloropropane) | X | X | X | 10 | 330 | 10,000 |
| bis(2-Ethylhexyl)phthalate | X | X | X | 10 | 330 | 10,000 |
| 4-Bromophenyl phenyl ether | X | X | X | 10 | 330 | 10,000 |
| Butylbenzyl phthalate | X | X | X | 10 | 330 | 10,000 |
| 2-Chloronaphthalene | X | X | X | 10 | 330 | 10,000 |
| 4-Chloroaniline | X | X | | 10 | 330 | 10,000 |
| 4-Chlorophenyl phenyl ether | X | X | X | 10 | 330 | 10,000 |
| Chrysene | X | X | X | 10 | 330 | 10,000 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE SEVEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| Dibenzo(a,h)anthracene | X | X | X | 10 | 330 | 10,000 |
| Dibenzofuran | X | X | | 10 | 330 | 10,000 |
| 1,2-Dichlorobenzene | X | X | X | 10 | 330 | 10,000 |
| 1,3-Dichlorobenzene | X | X | X | 10 | 330 | 10,000 |
| 1,4-Dichlorobenzene | X | X | X | 10 | 330 | 10,000 |
| 3,3'Dichlorobenzidine | X | X | X | 10 | 330 | 10,000 |
| Diethyl phthalate | X | X | X | 10 | 330 | 10,000 |
| Dimethyl phthalate | X | X | X | 10 | 330 | 10,000 |
| Di-n-butylphthalate | X | X | X | 10 | 330 | 10,000 |
| 2-Nitroaniline | X | X | | 25 | 800 | 25,000 |
| 3-Nitroaniline | X | X | | 25 | 800 | 25,000 |
| 2,4-Dinitrotoluene | X | X | X | 10 | 330 | 10,000 |
| 2,6-Dinitrotoluene | X | X | X | 10 | 330 | 10,000 |
| Di-n-octyl phthalate | X | X | X | 10 | 330 | 10,000 |
| 1,2-Diphenylhydrazine (as azobenzene) | X | | X | 10 | 330 | 10,000 |
| Fluoranthene | X | X | X | 10 | 330 | 10,000 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE EIGHT**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (ug/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| Fluorene | X | X | X | 10 | 330 | 10,000 |
| Hexachlorobenzene | X | X | X | 10 | 330 | 10,000 |
| Hexachlorobutadiene | X | X | X | 10 | 330 | 10,000 |
| Hexachlorocyclopentadiene | X | X | X | 10 | 330 | 10,000 |
| Hexachloroethane | X | X | X | 10 | 330 | 10,000 |
| Indeno (1,2,3-cd)pyrene | X | X | X | 10 | 330 | 10,000 |
| Isophorone | X | X | X | 10 | 330 | 10,[illegible] |
| 2-Methylnaphthalene | X | X | | 10 | 330 | 10,000 |
| Naphthalene | X | X | X | 10 | 330 | 10,000 |
| Nitrobenzene | X | X | X | 10 | 330 | 10,000 |
| N-Nitrosodimethylamine | X | | X | 10 | | |
| N-Nitrosodi-n-propylamine | X | X | X | 10 | 330 | 10,000 |
| N-Nitrosodiphenylamine | X | X | | 10 | 330 | 10,000 |
| Phenanthrene | X | X | X | 10 | 330 | 10,000 |
| Pyrene | X | X | X | 10 | 330 | 10,000 |
| Pyridine | X | | | 5 | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE NINE**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (ug/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| 1,2,4-Trichlorobenzene | X | X | X | 10 | 330 | 10,000 |
| 4-Nitroaniline | X | X | | 25 | 800 | 25,000 |
| Carbazole | | X | | 10 | 330 | 10,000 |
| Acetophenone | X | | | 10 | | |
| 2-Acetylaminofluorene | X | | | 10 | | |
| 4-Aminobiphenyl | X | | | 10 | | |
| Benzenethiol | X | | | 10 | | |
| 2-Picoline | X | | | 10 | | |
| p-Benzoquinone | X | | | 10 | | |
| Dibenzo(a,e)pyrene | X | | | 10 | | |
| Dibenzo(a,h)pyrene | X | | | 20 | | |
| Dibenzo(a,i)pyrene | X | | | 10 | | |
| 3,3'-Dimethylbenzidine | X | | | 50 | | |
| p-Dimethylaminoazobenzene | X | | | 10 | | |
| 7,12-Dimethylbenzo(a)anthracene | X | | | 10 | | |
| 3,3'-Dimethylbenzidine | X | | | 50 | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE TEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| Alpha, alpha-dimethyl-phenethylamine | X | | | 10 | | |
| m-Dinitrobenzene | X | | | 10 | | |
| Diphenylamine | X | | | 10 | | |
| Hexachlorodibenzo-p-dioxins | X | | | ND | | |
| Hexadichlorodibenzofurans | X | | | ND | | |
| Hexachlorophene | X | | | 1000 | | |
| Hexachloropropene | X | | | 10 | | |
| Isosafrole | X | | | 10 | | |
| Malonitrile | X | | | 5 | | |
| Methapyrilene | X | | | 10 | | |
| 3-Methylcholanthrene | X | | | 10 | | |
| 4,4'-Methylene-bis-(2-chloroaniline) | X | | | 50 | | |
| Methyl methanesulfonate | X | | | 50 | | |
| 1,4-Naphthoquinone | X | | | 10 | | |
| 1-Naphthylamine | X | | | 10 | | |
| 2-Naphthylamine | X | | | 10 | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE ELEVEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| N-Nitrosodi-n-butylamine | X | | | 10 | | |
| N-Nitrosodiethylamine | X | | | 10 | | |
| N-Nitrosomethylethylamine | X | | | 10 | | |
| N-Nitrosomorpholine | X | | | 10 | | |
| N-Nitrosopiperidine | X | | | 10 | | |
| N-Nitrosopyrrolidine | X | | | 10 | | |
| 5-Nitro-o-toluidine | X | | | 10 | | |
| Pentachlorobenzene | X | | | 10 | | |
| Pentachlorodibenzo-p-dioxins | X | | | ND | | |
| Pentachlorodibenzofurans | X | | | ND | | |
| Phenacetin | X | | | 10 | | |
| Safrole | X | | | 10 | | |
| 1,2,4,5-Tetrachlorobenzene | X | | | 10 | | |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | X | | X | 0.1 | | |
| Tetrachlorodibenzofurans | X | | | ND | | |
| Aramite | X | | | ND | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE TWELVE**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Base/Neutral Compounds (Continued)** | | | | | | |
| 1,2-Dibromo-3-chloropropane | X | | | ND | | |
| 0,0-Diethyl-0-2-pyrazinyl phosphorothioate | X | | | ND | | |
| Ethyl methanesulfonate | X | | | ND | | |
| 4-Nitroquinoline-1-oxide | X | | | ND | | |
| o-Toluidene | X | | | ND | | |
| p-Phenylenediamine | X | | | ND | | |
| Tetrachlorodibenzo-p-dioxins | X | | | ND | | |
| 1,2,4-Trichlorobenzene | X | | | ND | | |
| 0,0,0-Triethyl-phosphosphorothioate | X | | | ND | | |
| Sym-trinitrobenzene | X | | | ND | | |
| **Pesticides/Polychlorinated Biphenyls (PCBs)** | | | | | | |
| Aldrin | X | X | X | 0.05 | 1.7 | 5 |
| Aroclor 1016 | X | X | X | 1.0 | 33 | 100 |
| Aroclor 1221 | X | X | X | 2.0 | 67 | 200 |
| Aroclor 1232 | X | X | X | 1.0 | 33 | 100 |
| Aroclor 1242 | X | X | X | 1.0 | 33 | 100 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE THIRTEEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Pesticides/Polychlorinated Biphenyls (PCBs) (Continued)** | | | | | | |
| Aroclor 1248 | X | X | X | 1.0 | 33 | 100 |
| Aroclor 1254 | X | X | X | 1.0 | 33 | 100 |
| Aroclor 1260 | X | X | X | 1.0 | 33 | 100 |
| alpha-BHC | X | X | X | 0.05 | 1.7 | 5 |
| beta-BHC | X | X | X | 0.05 | 1.7 | 5 |
| delta-BHC | X | X | X | 0.05 | 1.7 | 5 |
| gamma-BHC (lindane) | X | X | X | 0.05 | 1.7 | 5 |
| Chlordane | X | X | X | 0.05 | 1.7 | 5 |
| Chlorobenzilate | X | | | 5 | | |
| 4,4'DDD | X | X | X | 0.10 | 3.3 | 10 |
| 4,4'DDE | X | X | X | 0.10 | 3.3 | 10 |
| 4,4'DDT | X | X | X | 0.10 | 3.3 | 10 |
| Dieldrin | X | X | X | 0.10 | 3.3 | 10 |
| Disulfoton | X | | | 10 | | |
| Endosulfan sulfate | | X | X | 0.10 | 3.3 | 10 |
| alpha-Endosulfan | X | X | X | 0.05 | 1.7 | 5 |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE FOURTEEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Pesticides/Polychlorinated Biphenyls (PCBs) (Continued)** | | | | | | |
| beta-Endosulfan | X | X | X | 0.10 | 3.3 | 10 |
| Endrin | X | X | X | 0.10 | 3.3 | 10 |
| Endrin aldehyde | X | X | X | 0.10 | 3.3 | 10 |
| Endrin ketone | | X | | 0.10 | 3.3 | 10 |
| Famphur | X | | | 10 | | |
| Heptachlor | X | X | X | 0.05 | 1.7 | 5 |
| Heptachlor epoxide | X | X | X | 0.05 | 1.7 | |
| Isodrin | X | | | 5 | | |
| Kepone | X | | | 5 | | |
| Methoxychlor | X | X | | 0.5 | 17 | 50 |
| Methyl parathion | X | | | 10 | | |
| Parathion | X | | | 10 | | |
| Phorate | X | | | 10 | | |
| Pronamide | X | | | 10 | | |
| Toxaphene | X | X | X | 5.0 | 170 | 500 |
| Tetraethyldithio-pyrophosphate | X | | | 10 | | |

**TABLE 10-2**
**CLEAN WATER MATRIX DETECTION LIMITS**
**ORGANIC COMPOUNDS**
**PAGE FIFTEEN**

| PARAMETER | APPENDIX IX | TCL | PRIORITY POLLUTANTS | DETECTION LIMIT[1] WATER (µg/L) | DETECTION LIMIT[1] LOW SOIL (ug/kg) | DETECTION LIMIT[1] MEDIUM SOIL (ug/kg) |
|---|---|---|---|---|---|---|
| **Pesticides/Polychlorinated Biphenyls (PCBs) (Continued)** | | | | | | |
| Diallate | X | | | ND | | |
| Pentachloronitrobenzene | X | | | ND | | |
| **Herbicides** | | | | | | |
| 2,4-Dichlorophenoxy-acetic acid | X | | | 1.3 | | |
| Silvex | X | | | 1.3 | | |
| 2,4,5-T | X | | | 1.3 | | |

ND - Not Determined

[1] Detection limits for soils are based on wet weight.

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| INORGANIC TESTS | | | |
| Acidity | P, G | Cool, 4°C | 14 days |
| Alkalinity | P, G | Cool, 4°C | 14 days |
| BOD | P, G | Cool, 4°C | 48 hours |
| Bromide | P, G | None | 28 days |
| Chloride | P, G | None | 28 days[5] |
| Chromium, Hexavalent | P, G | Cool, 4°C | 24 hours |
| COD | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Color | P, G | Cool, 4°C | 48 hours |
| Cyanide, Total and Amendable to Chlorination | P, G | Cool, 4°C; NaOH to pH >12[6] | 14 days |
| Fluoride | P | None | 28 days |
| Hardness | P, G | $HNO_3$ to pH <2 | 6 months |
| MBAS | P, G | Cool, 4°C | 48 hours |
| Mercury | P, G | $HNO_3$ to pH <2 | 28 days - NPDES/RCRA; 14 days - NPDWR[7] |
| Metals, except Boron, $Cr^{+6}$, and Mercury | P, G | $HNO_3$ to pH <2 | 6 months |
| Nitrogen Ammonia | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE TWO**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| INORGANIC TESTS (Continued) | | | |
| Nitrogen<br>Kjeldahl, Total | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Nitrate-Nitrite | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days - NPDES/RCRA; 14 days - NPDWR |
| Nitrate | P, G | Cool, 4°C | 48 hours |
| Nitrite | P, G | Cool, 4°C | 48 hours |
| Oil and Grease | AG | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Organic Carbon | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Phenolics | AG | Cool 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Phosphorus<br>Elemental | G | Cool, 4°C | 48 hours |
| Orthophosphate | P, G | Filter immediately; Cool, 4°C | 48 hours |
| Hydrolyzable | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 48 hours |
| Total | P, G | Cool, 4°C; $H_2SO_4$ to pH <2 | 28 days |
| Solids<br>Dissolved | P, G | Cool, 4°C | 7 days |
| Total | P, G | Cool, 4°C | 7 days |
| Suspended | P, G | Cool, 4°C | 7 days |

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE THREE**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| INORGANIC TESTS (Continued) | | | |
| Solids<br>Settleable | P, G | Cool, 4°C | 48 hours |
| Volatile | P, G | Cool, 4°C | 7 days |
| Specific Conductance | P, G | Cool, 4°C | 28 days |
| Sulfate | P, G | Cool, 4°C | 28 days |
| Sulfide | P, G | Cool, 4°C; Zinc acetate + NaOH to pH >9 | 7 days |
| Total Petroleum Hydrocarbons | AG | Cool, 4°C, HCl to pH <2 | 28 days |
| TOX | AG w/TLC | Cool, 4°C, add 1 ml $H_2SO_4$ pH <2 | 7 days |
| Turbidity | P, G | Cool, 4°C | 48 hours |
| BACTERIOLOGICAL TESTS | | | |
| Coliform, Fecal and Total | P, G | Cool, 4°C; 0.008% $Na_2S_2O_3$ | 90 hours - NPDWR; 6 hours - NPDES/RCRA |
| Fecal Streptococci | P, G | Cool, 4°C, 0.008% $Na_2S_2O_3$ | 30 hours - NPDWR; 6 hours - NPDES/RCRA |

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE FOUR**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| ORGANIC CHEMISTRY TESTS[8] | | | |
| Acrolein and Acrylonitrile | G with TLS | Cool, 4°C[9]; pH 5-10 | 14 days |
| Purgeable Halocarbons | G with TLS | Cool, 4°C[10] | 14 days |
| Purgeable Aromatics | G with TLS | 4 drops conc. HCL/40 ml vial; Cool, 4°C[10] | 14 days (7 days w/o HCL pres.) |
| Trihalomethanes/VOCs | G with TLS[11] | Cool, 4°C; $Na_2S_2O_3$[12] | 14 days - NPDES/RCRA; 28 days - NPDWR |
| Benzidines | G with TLC | Cool, 4°C[9] | 7 days until extraction, 7 days after extraction |
| Chlorinated Hydrocarbons | G with TLC | Cool, 4°C | 7 days until extraction, 40 days after extraction |
| Haloethers | G with TLC | Cool, 4°C[9] | 7 days until extraction, 40 days after extraction |
| Nitroaromatics and Isophorone | G with TLC | Cool, 4°C; store in dark | 7 days until extraction, 40 days after extraction |
| Nitrosamines | G with TLC | Cool, 4°C[9] | 7 days until extraction, 40 days after extraction |
| PCBs | G with TLC | Cool, 4°C | 7 days until extraction, 40 days after extraction |

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE FIVE**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| ORGANIC CHEMISTRY TESTS[8] (Continued) | | | |
| Pesticides | G with TLC | Cool, 4°C; pH 5-9 | 7 days until extraction, 40 days after extraction |
| Phenols | G with TLC | Cool, 4°C[9] | 7 days until extraction, 40 days after extraction |
| Phthalate Esters | G with TLC | Cool, 4°C | 7 days until extraction, 40 days after extraction |
| Polynuclear Aromatic Hydrocarbons | G with TLC | Cool, 4°C[9]; store in dark | 7 days until extraction, 40 days after extraction |
| TCDD | G with TLC | Cool, 4°C[9] | 7 days until extraction, 40 days after extraction |
| Herbicides | G with TLC | Cool, 4°C | 7 days until extraction, 30 days after extraction |
| RADIOCHEMISTRY TESTS | | | |
| Gamma Spectrometry | P, G | $HNO_3$ to pH <2 | |
| Gross Alpha | P, G | $HNO_3$ to pH <2 | 6 months |
| Gross Beta | P, G | $HNO_3$ to pH <2 | 6 months |
| Iodine 131 | P, G | None | 3 weeks |
| Radium | P, G | $HNO_3$ to pH <2 | 6 months |
| Strontium | P, G | $HNO_3$ to pH <2 | |

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE SIX**

| Parameter | Container[1] | Preservative[2] [3] | Maximum Holding Time[4] |
|---|---|---|---|
| RADIOCHEMISTRY TESTS (Continued) | | | |
| Tritium | P, G | None | |
| Uranium (Radiochemical) | P, G | HCl to pH <2 | |
| Alpha Spectroscopy | P, G | $HNO_3$ to pH <2 | |
| Technetium-99 | P, G | $HNO_3$ to pH <2 | |

TABLE 10-3 NOTES

1. AG - amber glass
   G - glass
   P - polyethylene
   TLC - teflon-lined cap
   TLS - teflon-lined septum

2. Sample preservation should be performed immediately upon sample collection. For composite samples, samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

3. If the dissolved content is to be measured, samples should be filtered on site immediately before adding preservatives.

4. The holding times listed are the maximum times that samples may be held before analysis and still be considered valid under EPA regulations. Holding times are measured from sampling.

5. This is for NPDES and RCRA analyses; for drinking water analyses the maximum holding time is 7 days.

6. Add 0.6 g ascorbic acid if residual chlorine is present.

**TABLE 10-3**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**WATER SAMPLES**
**PAGE SEVEN**

7. Samples in glass containers may be held up to 38 days under NPDWR.

8. When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine (if present) with 0.008 percent sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are:

   - If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ±0.2 to prevent rearrangement of benzidine.

   - Extracts may be stored up to 7 days before analysis for benzidine if storage is conducted under an inert (oxidant-free) atmosphere.

9. Add $Na_2S_2O_3$ if residual chlorine is present (0.008 percent).

10. If residual chlorine is present, add sodium thiosulfate.

11. Samples are to be collected in duplicate; provide two vials per sample. Also provide duplicate trip blanks for each sample set.

12. Omit $Na_2S_2O_3$ if maximum trihalomethane potential is to be determined.

These requirements are based on 40CFR136, Table II; SW-846, third edition, revision 0, Table 2-16; and EPA 570/9-90/08, Table IV-4 and IV-5.

**TABLE 10-4**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**NON-AQUEOUS SAMPLES**

| Parameter | Container[1] | Preservative[2] | Maximum Holding Time[3] |
|---|---|---|---|
| VOLATILE ORGANICS | | | |
| Concentrated Waste | 8 oz. wide-mouth glass with TLC | None | 14 days |
| Soil/Sediment | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days |
| Sludge | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days |
| SEMIVOLATILE ORGANICS, PESTICIDES/PCBS, AND HERBICIDES | | | |
| Concentrated Waste | 8 oz. wide-mouth glass with TLC | None | 14 days until extraction, 40 days thereafter |
| Soil/Sediment | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days until extraction, 40 days thereafter |
| Sludge | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days until extraction, 40 days thereafter |
| METALS | | | |
| Concentrated Waste | 8 oz. wide-mouth glass with TLC | None | 6 months (except mercury and hexavalent chromium); 28 days - mercury, 24 hrs - hexavalent chromium |

**TABLE 10-4**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**NON-AQUEOUS SAMPLES**
**PAGE TWO**

| Parameter | Container[1] | Preservative[2] | Maximum Holding Time[3] |
|---|---|---|---|
| METALS (Continued) | | | |
| Soil/Sediment | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 6 months (except mercury and hexavalent chromium); 28 days - mercury, 24 hrs - hexavalent chromium |
| Sludge | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 6 months (except mercury and hexavalent chromium); 28 days - mercury, 24 hrs - hexavalent chromium |
| CYANIDE AND MISCELLANEOUS INORGANICS | | | |
| Concentrated Waste | 8 oz. wide-mouth glass with TLC | None | 14 days - cyanide, all others unspecified |
| Soil/Sediment | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days - cyanide, all others unspecified |
| Sludge | 8 oz. wide-mouth glass with TLC | Cool, 4°C | 14 days - cyanide, all others unspecified |

**TABLE 10-4**
**CONTAINER, PRESERVATION AND HOLDING TIME REQUIREMENTS**
**NON-AQUEOUS SAMPLES**
**PAGE THREE**

TABLE 10-4 NOTES

1. TLC - teflon-lined cap.

2. Soil/sediment and sludge samples should be cooled to 4°C for all parameters.

3. The holding times listed are the maximum times that samples can be held before analysis and still be considered valid under EPA regulations. Holding time is measured from sampling.

The requirements for organic parameters are based on SW-846, Table 4-1, 3rd edition.

# 11.0 CALIBRATION AND QUALITY CONTROL

This section describes the calibration and quality control procedures that will be used for quality assurance Levels D, C, and E. The levels are based on the requirements specified in "Sampling and Chemical Anlaysis Quality Assurance Requirements for the Navy Installation Restoration Program," June 1988. Included in this section is a discussion of calibration procedures and the types of quality control checks that will be performed, the frequency of these checks, acceptance criteria used to evaluate precision and accuracy, and documentation and review and approval procedures for quality control data.

## 11.1 LEVEL D PROTOCOLS - ORGANIC PARAMETERS

Level D protocols are derived from "Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration," U.S. EPA Contract Laboratory Program. A summary of these requirements is presented below.

Protocols are provided for both the February 1988 and the 1990 (Document No. OLM01.0) Statements of Work (SOW). The protocol used will be determined by the CLEAN-approved project work plan.

Regardless of the protocol, all holding times will be measured from the time of sample collection. The applicable holding times are found in Tables 10-3 and 10-4 of this quality assurance project plan. Continuous extractions must be initiated within the specified holding times on these tables, while all other extractions must be <u>completed</u> within these holding times.

### 11.1.1 <u>Sample Preparation - SOW 288</u>

A. Method Blank

- Requirement

  - A method blank must be prepared with each set of 20 samples of similar matrix (LLW, LLS, MLS), or each time samples are extracted by manual or continuous techniques, whichever is more frequent. Separate blanks are required

for manual and continuous extractions. For water samples, the blank is 1 liter of carbon-treated deionized water. For soil matrices, the blank is prepared by performing all manipulations on all reagents added to an empty beaker.

- Criteria

  - The blank is used to monitor the analytical system for the introduction of positive error due to trace contamination. Acceptance criteria are listed in 11.1.2D and 11.1.3C. Samples that contain any of the target compounds found in a nonconforming blank must be re-extracted.

B. Surrogate Spike

- Requirement

  - All samples, method blanks, and duplicate matrix spikes must be spiked with one or more surrogates standards at the start of sample preparation.

- Criteria

  - Surrogate spikes are used primarily to monitor the analytical system. Since the sample matrix rather than a blank matrix is spiked, surrogate recovery is also sensitive to sample matrix interferences. Acceptance criteria are listed in 11.1.2F and 11.1.3E. Samples with nonconforming surrogate recoveries must be re-extracted.

C. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

- Requirement

  - Matrix spikes must be prepared in duplicate and analyzed with each sample delivery group (SDG) or with each set of twenty samples of similar concentration (LLW, LLS, MLS), whichever is more frequent. Field duplicates will be split and used for MS/MSD analyses.

- Criteria

  - The MS/MSD is used to measure both precision and accuracy as RPD and percent recovery, respectively. Advisory limits are listed in 11.1.2G and 11.1.3F.

### 11.1.2 GC/MS Analysis - SOW 288

A. GC/MS Tune

- Requirement

  - Prior to calibration and sample analysis, and every 12.0 hours thereafter, the GC/MS must meet BFB or DFTPP tuning criteria. A tune is also performed whenever instrument maintenance has been performed that could affect the tune (i.e., cleaning of the ion source).

- Criteria

  - The tune criteria listed in Table 11-1 must be met before analysis can proceed.

B. Initial Calibration

- Requirement

  - A five-point calibration must be run initially and whenever continuing calibration criteria cannot be met. The five-point calibration consists of all Target Compound List (TCL) volatiles at the 10, 20, 50, 100, and 200 µg/l levels and all TCL semi-volatiles at 20, 50, 80, 120, and 160 total nanograms.

- Criteria

  - The five-point curve is valid only if the following criteria are met:

- Relative retention times (RRT) of each volatile (VOA) and each base-neutral and acid (BNA) compound in each of the standards should agree within 0.06 RRT units.

- Percent relative standard deviation (RSD) of the response factors (RF) of each calibration check compound (CCC) must be $\leq$30 percent. The CCC's for volatiles and semi-volatiles are listed in Table 11-2.

- RF of each VOA system performance check compound (SPCC) must be >0.300 ($\geq$0.250 for bromoform). The SPCC's are listed in Table 11-2.

- RF of each BNA SPCC must be $\geq$0.050. The SPCC's are listed in Table 11-2.

C. Continuing Calibration

- Requirement

  - A single calibration standard must be run at the start of each 12-hour period of analysis following a successful tune.

- Criteria

  - The following criteria must be met before sample analysis can proceed:

  - Percent difference of the RF of each CCC must be $\leq$25 percent relative to the average RF from the initial calibration.

  - RF of each VOA SPCC must be $\geq$0.300, ($\geq$0.250 for bromoform).

  - RF of each BNA SPCC must be $\geq$0.50.

**TABLE 11-1**
**BFB AND DFTPP TUNING CRITERIA**

| BFB KEY IONS AND ABUNDANCE CRITERIA | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 50 | 15.0 - 40.0 percent of the base peak |
| 75 | 30.0 - 66.0 percent of the base peak |
| 95 | Base peak, 100 percent relative abundance |
| 96 | 5.0 - 9.0 percent of mass 174 |
| 173 | Less than 2.0 percent of mass 174 |
| 174 | Greater than 50.0 percent of the base peak |
| 175 | 5.0 - 9.0 percent of mass 174 |
| 176 | Greater than 95.0 percent but less than 101.0 percent of mass 174 |
| 177 | 5.0 - 9.0 percent of mass 176 |

| DFTPP KEY IONS AND ABUNDANCE CRITERIA | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 51 | 30.0 - 60.0 percent of mass 198 |
| 68 | Less than 2.0 percent of mass 69 |
| 70 | Less than 2.0 percent of mass 69 |
| 127 | 40.0 - 60.0 percent of mass 198 |
| 197 | Less than 1.0 percent of mass 198 |

**TABLE 11-1**
**BFB AND DFTPP TUNING CRITERIA**
**PAGE TWO**

| DFTPP KEY IONS AND ABUNDANCE CRITERIA (Continued) | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 198 | Base peak, 100 percent relative abundance |
| 199 | 5.0 - 9.0 percent of mass 198 |
| 275 | 10.0 - 30.0 percent of mass 198 |
| 365 | Greater than 1.00 percent of mass 198 |
| 441 | Present but less than mass 443 |
| 442 | Greater than 40.0 percent of mass 198 |
| 443 | 17.0 - 23.0 percent of mass 442 |

**TABLE 11-2**
**CALIBRATION CHECK COMPOUNDS**
**AND SYSTEM PERFORMANCE CHECK COMPOUNDS**

| GC/MS Fraction | CCC | SPCC |
|---|---|---|
| Volatiles | 1,1-Dichloroethene<br>Chloroform<br>1,2-Dichloropropane<br>Toluene<br>Ethylbenzene<br>Vinyl Chloride | Chloromethane<br>1,1-Dichloroethane<br>Bromoform<br>1,1,2,2-Tetrachloroethane<br>Chlorobenzene |
| Base-Neutrals | Acenaphthene<br>1,4-Dichlorobenzene<br>Hexachlorobutadiene<br>N-Nitroso-di-n-phenylamine<br>Di-n-octylphthalate<br>Fluoranthene<br>Benzo(a)pyrene | N-Nitroso-Di-N-Propylamine<br>Hexachlorocyclopentadiene |
| Acids | 4-Chloro-3-Methylphenol<br>2,4-Dichlorophenol<br>2-Nitrophenol<br>Phenol<br>Pentachlorophenol<br>2,4,6-Trichlorophenol | 2,4-Dinitrophenol<br>4-Nitrophenol |

D. Method Blank

- Requirement

  - A method blank must be analyzed at the frequency specified in 11.1.1A.

- Criteria

  - Each method blank must conform to the following criteria:

  - The extracted ion current profile (EICP) area of each internal standard must be 1/2 to 2 times that of the most recent 12-hour calibration standard.

  - Retention time (RT) of each internal standard must be ±30 seconds of that of the most recent 12-hour calibration standard.

  - All surrogate recoveries must be within the acceptance limits (see 11.1.2F).

  - (VOA only) Blank must not contain methylene chloride, acetone, 2-butanone, or toluene, at levels greater than 5 times the required detection limit (RDL), or any other volatile TCL compound at levels at or above the RDL. (RDLs are listed in Table 10-2).

  - (BNA only) Blank must not contain common phthalate esters at levels greater than 5 times the RDL, or any other semi-volatile target compound at levels at or above the RDL. (RDLs are listed in Table 10-2).

E. Sample analysis

- Requirement

  - The analyses of each sample, blank, and MS/MSD must meet the criteria listed below.

- Criteria

  - EICP of each internal standard must be 1/2 to 2 times that of the most recent 12-hour calibration standard.

  - Retention time of each internal standard must be $\pm 30$ seconds of that of the most recent 12-hour calibration standard.

  - Surrogate recoveries must be within the acceptance limits. (See 11.1.2F).

  - The concentration of all TCL compounds must be $\leq$ the concentration of the highest initial calibration standard.

F. Surrogate Spike

- Requirement

  - Each surrogate spike compound must be quantitated for each sample, blank, and MS/MSD.

- Criteria

  - If the following criteria are not met, the sample must be re-extracted and reanalyzed:

Recovery Limits (%)

| Compound/Fraction | LLW | LLS/MLS |
|---|---|---|
| Toluene-$d_8$/VOA | 88-100 | 81-117 |
| 4-Bromofluorobenzene/VOA | 86-115 | 74-121 |
| 1,2 Dichloroethane-$d_4$/VOA | 76-114 | 70-121 |
| Phenol-$d_5$/Acid* | 10-94 | 24-113 |
| 2-Fluorophenol/Acid* | 21-100 | 25-121 |
| 2,4,6-Tribromophenol/Acid* | 10-123 | 19-122 |
| Nitrobenzene-$d_5$/BN* | 35-114 | 23-120 |
| 2-Flurobiphenyl/BN* | 43-116 | 30-115 |
| Terphenyl-$d_{14}$/BN* | 33-141 | 18-137 |

* One base-neutral and/or acid surrogate may exceed these limits as long as all base-neutral or acid recoveries are $\geq$10 percent.

G. Matrix Spike Duplicates (MS/MSD)

- Requirement

  - Matrix spikes must be analyzed at the frequency specified in 11.1.1C.

- Criteria
  - Advisory limits, listed in Table 11-3, have been established for percent recovery.

**TABLE 11-3**
**MATRIX SPIKE PERCENT RECOVERY LIMITS[1]**

| Compound/Fraction | LLW | LLS/MLS |
|---|---|---|
| | % Recovery | % Recovery |
| 1,1-Dichloroethene/VOA | 61-145 | 59-172 |
| Trichloroethene/VOA | 71-120 | 62-137 |
| Chlorobenzene/VOA | 75-130 | 60-133 |
| Toluene/VOA | 76-125 | 59-139 |
| Benzene/VOA | 76-127 | 66-142 |
| 1,2,4-Trichlorobenzene/BNA | 39-98 | 38-107 |
| Acenaphthene/BNA | 46-118 | 31-137 |
| 2,4-Dinitrotoluene/BNA | 24-96 | 28-89 |
| Pyrene/BNA | 26-127 | 35-142 |
| N-Nitrosodi-n-propylamine/BNA | 41-116 | 41-126 |
| 1,4-Dichlorobenzene/BNA | 36-97 | 28-104 |
| Pentachlorophenol-BNA | 9-130 | 17-109 |
| Phenol-BNA | 12-89 | 26-90 |
| 2-Chlorophenol/BNA | 27-123 | 25-102 |
| 4-Chloro-3-methylphenol/BNA | 23-97 | 26-103 |
| 4-Nitrophenol/BNA | 10-80 | 11-114 |

[1] Limits are advisory.

H. Qualitative Identification

- Requirement

  - The quantitation reports and chromatograms of all samples, blanks, and MS/MSDs must be examined for the presence of target and nontarget compounds.

- Criteria

  - Target compounds shall be identified by comparison of the sample and standard mass spectra generated during a 12-hour period. A compound is positively identified if the following criteria are met:

    - The RRT of the sample component is within 0.06 RRT units of the standard component.

    - All ions present in the standard mass spectra at a relative intensity greater than 10 percent (most abundant ion in the spectrum equal 100 percent) must be present in the sample spectrum.

    - The relative intensities of ions specified in the above paragraph must agree within ±20 percent.

    - Ions greater than 10 percent in the sample spectrum, but not present in the standard spectrum must be considered and accounted for by the analyst making the comparison. When GC/MS computer data processing programs are used to obtain the sample component spectrum, both the processed and the raw spectra must be evaluated. The verification process should favor false positives for volatiles and false negatives for semi-volatiles.

- Criteria

  - Nontarget compounds shall be identified by executing 10 VOA and 20 BNA library searches for the nontarget components of greatest apparent concentration in the sample. Components with responses of less than 10 percent of the nearest internal standard do not require a library search. Use the following guidelines in making tentative identifications:

    - Relative intensities of major ions in the reference spectrum. (Ions greater than 10 percent of the most abundant ion should be present in the sample spectrum.)

    - The relative intensities of the major ions should agree within ±20 percent. (Example: For an ion with an abundance of 50 percent of the standard spectra, the corresponding sample ion abundance must be between 30 and 70 percent.)

    - Molecular ions present in reference spectrum should be present in sample spectrum.

    - Ions present in the sample spectrum, but not in the reference spectrum should be reviewed for possible background contamination or the presence of co-eluting compounds.

    - Ions present in the reference spectrum, but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or the presence of co-eluting compounds. Data system library reduction programs can sometimes create these discrepancies.

- If, in the opinion of the mass-spectral specialist, no valid tentative identification can be made, the compound should be reported as "unknown". The mass-spectral specialist should give additional classification of the unknown compound (i.e., unknown aromatic, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weights can be distinguished, include them.

I. Quantitation

- Requirement

  - Each compound identified in each sample, blank, or MS/MSD must be quantitated.

- Criteria

  - Target compounds identified shall be quanitated by the internal standard method. The EICP area of characteristic ions of target analytes are used. The quantification is performed using the response factor generated during each 12-hour shift.

  - An estimated concentration for tentatively identified compounds shall be quanitated by the internal standard method. For quantitation, the nearest internal standard free of interferences must be used. A response factor of 1.00 shall be used to estimate the concentration.

### 11.1.3 GC Analysis - SOW 288

A. Retention Time Window Study

- Requirement

  - A retention time window study must be performed for each GC column used.

- Criteria

  - Retention time shift of the surrogate dibutylchlorendate (DBC) must be <2.0 percent difference for packed columns, <0.3 percent difference for narrow-bore capillary columns, and <1.5 percent difference for large-bore capillary columns.

B. 72-Hour Standardization Sequence (Quantitation and Confirmation Runs)

- Requirement

  - Analyze evaluation mixes A, B, C; individual mixes A and B; and each multi-response compound at the start of analysis and every 72 hours thereafter. Evaluation mixes A, B, and C consist of aldrin, endrin; 4,4'-DDT, and DBC at low, medium, and high concentrations, respectively. The individual mixes A and B are described in Table 11-4.

  - Analyze evaluation mix B and individual mixes A or B alternately between each set of 5 samples.

  - Analyze individual mixes A and B after the last sample.

- Criteria

  - Percent RSD of aldrin, endrin, 4,4'-DDT, and DBC calibration factors must be $\leq$10.0 percent.

  - The percent breakdown of endrin and DDT in evaluation mix B must be $\leq$20.0 percent.

  - Separation between peaks must be $\geq$25% for quantitation runs.

**TABLE 11-4**
**PESTICIDE/PCB INDIVIDUAL STANDARD MIXTURE**
**PRIMARY ANALYSIS**

| Compound | ng/µL | Compound | ng/µL |
|---|---|---|---|
| Gamma-BHC | 0.020 | Alpha-BHC | 0.020 |
| Heptachlor | 0.020 | Beta-BHC | 0.040 |
| Aldrin | 0.020 | Delta-BHC | 0.020 |
| Heptachlor epoxide | 0.020 | | |
| Endosulfan I | 0.020 | p,p'-DDE | 0.020 |
| Dieldrin | 0.020 | Endrin | 0.020 |
| p,p'-DDT | 0.040 | p,p'-DDD | 0.020 |
| Endrin aldehyde | 0.025 | Endosulfan sulfate | 0.020 |
| Endosulfan II | 0.020 | Endrin ketone | 0.020 |
| Methoxychlor | 0.060 | Dibutylchlorendate | 0.050 |

**TABLE 11-4**
**PESTICIDE/PCB INDIVIDUAL STANDARD MIXTURES**
**CONFIRMATION ANALYSIS**
(CONTINUED)

| Individual Standard Mix A | ng/µL | Individual Standard Mix B | ng/µL |
|---|---|---|---|
| Gamma-BHC | 0.005 | Alpha-BHC | 0.005 |
| Heptachlor | 0.010 | Beta-BHC | 0.010 |
| Aldrin | 0.010 | Delta-BHC | 0.010 |
| Heptachlor epoxide | 0.010 | Aldrin | 0.010 |
| Endosulfan I | 0.010 | p,p-DDE | 0.010 |
| Dieldrin | 0.010 | Endrin | 0.010 |
| p,p'-DDT | 0.020 | p,p'-DDD | 0.020 |
| Endrin aldehyde | 0.025 | Endosulfan sulfate | 0.020 |
| Endosulfan II | 0.020 | Endrin ketone | 0.020 |
| Methoxychlor | 0.100 | Alpha chlordane | 0.020 |
| Dibutylchlorendate | 0.050 | Gamma chlordane | 0.020 |
| | | Dibutylchlorendate | 0.050 |

- The percent difference in the retention time of DBC must be <2.0 percent for each packed column determination, <0.3 percent for each narrow-bore capillary column determination, and <1.5 percent for each large-bore capillary column determination.

- The percent difference of alternating calibration factors of components in individual mixes A and B and multi-response compounds must be ≤15.0 percent during quantitation runs and ≤20.0 percent during confirmation runs.

C. Method Blank

- Requirement

  - A method blank must be analyzed at the frequency specified in 11.1.1A. The blank must be run on each GC used for quantitation or confirmation of samples from the batch.

- Criteria

  - Each method blank must not contain any target pesticide/PCB compounds at levels above the RDL.

D. Sample Analysis

- Requirement

  - The analysis of each sample, blank, and MS/MSD must meet the criteria specified below.

  - All positive results obtained by GC must be confirmed using a dissimilar column.

- Criteria

  - The response of all target compounds must be <100 percent full scale. If the response for any compound is greater than 100 percent of full scale, dilute the extract so that the peak

will be between 50 and 100 perc full scale and reanalyze. Use this dilution for confirmation and quantitation.

NOTE: For dilutions greater than 10-fold, inject a second aliquot 10 times more concentrated to determine if other compounds of interest are present at lower concentrations. Computer reproductions of chromatograms manipulated to ensure all peaks are on scale over a 100-fold range are an accepted substitute. They can, however, be no greater than a 100-fold range. (This is to prevent retention time shifts by column or detector overload.) Linearity must be demonstrated over the 100-fold range using higher concentrations of the evaluation mixture.

- If identification of compounds of interest is prevented by interferences, further cleanup is required.

- If pesticides or PCBs are identified, their presence must be confirmed using a dissimilar GC column. GC/MS confirmation is also required when pesticides or PCBs are present at sufficient levels.

E. Surrogate Spike

- Requirement

  - The surrogate spike must be quanitated for each sample, blank, and MS/MSD.

- Criteria

  - These limits are advisory. Re-extraction and reanalysis are not required when the limits are exceeded.

Recovery Limits (%,

| Compound | LLW | LLS/MLS |
|---|---|---|
| dibutylchlorendate | 24-154 | 20-150 |

F. Blank Spike (Pesticides/PCBs)

- Requirement
  - One blank spike per batch will be prepared by adding the compounds specified in Table 11-10 (See Level C protocol) to deionized water or the blank spike soil matrix (See Section 11.7)
- Criteria
  - Acceptance criteria listed in Section 11.7.

G. Matrix Spike Duplicates

- Requirement
  - Matrix spikes must be analyzed at the frequency specified in 11.1.1C.
- Criteria
  - Advisory limits, listed below, have been established for RPD and percent recovery. These limits are not to be used to determine whether a sample should be re-extracted.

| Compound/Fraction | LLW | RPD | LLS/MLS | RPD |
|---|---|---|---|---|
| | % Recovery | | % Recovery | |
| Lindane | 56-123 | 15 | 46-127 | 50 |
| Heptachlor | 40-131 | 20 | 35-130 | 31 |
| Aldrin | 40-120 | 22 | 34-132 | 43 |
| Dieldrin | 52-126 | 18 | 31-134 | 38 |
| Endrin | 56-121 | 21 | 42-139 | 45 |
| 4,4'-DDT | 38-127 | 27 | 23-134 | 50 |

H. Qualitative Identification

- Requirement

  - The chromatograms of all samples, blanks, and MS/MSDs must be examined for the presence of target pesticides and PCBs using the criteria listed below.

- Criteria

  - A target compound is present if the retention time (RT) of the sample component falls within the retention time window of a standard, chromatographed within a 72-hour period on both the initial and confirmation runs.

I. Quantitation

- Requirement

  - Each compound present in each sample, blank, or MS/MSD must be quantitated.

- Criteria

  - Quantitation must be based on a wide-bore capillary column chromatogram.

  - Quantitation is based on the calibration factors of external standard run within the 72-hour sequence.

### 11.1.4 Sample Preparation - 1990 SOW (Document No. OLM01.0)

A. Method Blank

- Requirement

  - For semivolatiles, a method blank must be prepared with each set of 20 samples of similar matrix (LLW, LLS, MLS), or each time samples are extracted by manual or continuous techniques, whichever is more frequent. Separate blanks are required for manual and continuous extractions. For water samples, the blank is 1 liter of carbon-treated deionized water. For soil matrices, the blank is prepared by performing all manipulations on all reagents added to an empty beaker. Volatiles analysis requires one method blank for each 12-hour calibration period. The LLS and MLS volatile blank will consist of a purified solid matrix carried through the analytical procedure.

- Criteria

  - The blank is used to monitor the analytical system for the introduction of positive error due to trace contamination. Acceptance criteria are listed in 11.1.5D and 11.1.5C. Samples that contain any of the target compounds found in a nonconforming blank must be re-extracted.

B. Surrogate Spike

- Requirement

  - All samples, method blanks, and duplicate matrix spikes must be spiked with one or more surrogates standards at the start of sample preparation.

- Criteria

  - Surrogate spikes are used primarily to monitor the analytical system. Since the sample matrix rather than a blank matrix is spiked, surrogate recovery is also sensitive to sample matrix interferences. Acceptance criteria are listed in 11.1.5F and 11.1.5E. Samples with nonconforming surrogate recoveries must be re-extracted and reanalyzed for semivolatiles, and reanalyzed for volatiles.

C. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

- Requirement

  - Matrix spikes must be prepared in duplicate and analyzed with each sample delivery group (SDG) or with each set of twenty samples of similar concentration (LLW, LLS, MLS), whichever is more frequent. Field duplicates will be split and used for MS/MSD analyses.

- Criteria

  - The MS/MSD is used to measure both precision and accuracy as RPD and percent recovery, respectively. Advisory limits are listed in 11.1.5G.

### 11.1.5 GC/MS Analysis - 1990 SOW (Document No. OLM01.0)

A. GC/MS Tune

- Requirement

  - Prior to calibration and sample analysis, and every 12.0 hours thereafter, the GC/MS must meet BFB or DFTPP tuning criteria. A tune is also performed whenever instrument maintenance has been performed that could affect the tune (i.e., cleaning of the ion source).

- Criteria

  - The tune criteria listed in Table 11-5 must be met before analysis can proceed.

B. Initial Calibration

- Requirement

  - A five-point calibration must be run initially and whenever continuing calibration criteria cannot be met. The five-point calibration consists of all Target Compound List (TCL) volatiles at the 10, 20, 50, 100, and 200 µg/l levels and all TCL semi-volatiles at 20, 50, 80, 120, and 160 total nanograms.

- Criteria (Volatiles)

  - The five-point curve is valid only if the criteria in Table 11-6 are met.

  - The response factors of the compounds listed in Table 11-6 must meet the minimum RRF criteria at each concentration level and maximum %RSD criteria for the initial calibration, with allowance made for up to two volatile compounds. However, the RRFs for those two compounds

must be greater than or equal to 0.010, and the %RSD of those two compounds must be less than or equal to 40.0% for the initial calibration to be acceptable.

**TABLE 11-5**
**BFB AND DFTPP TUNING CRITERIA**

| BFB KEY IONS AND ABUNDANCE CRITERIA | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 50 | 8.0 - 40.0 percent of mass 95 |
| 75 | 30.0 - 66.0 percent of mass 95 |
| 95 | Base peak, 100 percent relative abundance |
| 96 | 5.0 - 9.0 percent of mass 174 |
| 174 | 50.0 - 120.0 percent of mass 95 |
| 175 | 4.0 - 9.0 percent of mass 174 |
| 176 | 93.0 - 101.0 percent of mass 174 |
| 177 | 5.0 - 9.0 percent of mass 176 |

Note: All ion abundance must be normalized to m/z95, the nominal base peak, even through the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.

| DFTPP KEY IONS AND ABUNDANCE CRITERIA | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 51 | 30.0 - 80.0 percent of mass 198 |
| 68 | Less than 2.0 percent of mass 69 |
| 69 | present |
| 70 | Less than 2.0 percent of mass 69 |
| 127 | 25.0 - 75.0 percent of mass 198 |
| 197 | Less than 1.0 percent of mass 198 |

**TABLE 11-5**
**BFB AND DFTPP TUNING CRITERIA**
**PAGE TWO**

| DFTPP KEY IONS AND ABUNDANCE CRITERIA (Continued) | |
|---|---|
| **MASS** | **ION ABUNDANCE CRITERIA** |
| 198 | Base peak, 100 percent relative abundance (see note) |
| 199 | 5.0 - 9.0 percent of mass 198 |
| 275 | 10.0 - 30.0 percent of mass 198 |
| 365 | Greater than 0.75 percent of mass 198 |
| 441 | Present but less than mass 443 |
| 442 | 40.0 - 110.0 percent of mass 198 |
| 443 | 15.0 - 24.0 percent of mass 442 |

Note: All ion abundances MUST be normalized to m/z 198, the nominal base peak, even though the ion abundance of m/z 442 may be up to 110 percent that of m/z 198.

**TABLE 11-6**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF VOLATILE ORGANIC COMPOUNDS**

| VOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| Bromomethane | 0.100 | 20.5 | 25.0 |
| Vinyl chloride | 0.100 | 20.5 | 25.0 |
| 1,1-Dichloroethene | 0.100 | 20.5 | 25.0 |
| 1,1-Dichloroethane | 0.200 | 20.5 | 25.0 |
| Chloroform | 0.200 | 20.5 | 25.0 |
| 1,2-Dichloroethane | 0.100 | 20.5 | 25.0 |
| 1,1,1-Trichloroethane | 0.100 | 20.5 | 25.0 |
| Carbon tetrachloride | 0.100 | 20.5 | 25.0 |
| Bromodichloromethane | 0.200 | 20.5 | 25.0 |
| cis-1,3-Dichloropropene | 0.200 | 20.5 | 25.0 |
| Trichloroethene | 0.300 | 20.5 | 25.0 |
| Dibromochloromethane | 0.100 | 20.5 | 25.0 |
| 1,1,2-Trichloroethane | 0.100 | 20.5 | 25.0 |
| Benzene | 0.500 | 20.5 | 25.0 |
| trans-1,3-Dichloropropene | 0.100 | 20.5 | 25.0 |
| Bromoform | 0.100 | 20.5 | 25.0 |

**TABLE 11-6**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF VOLATILE ORGANIC COMPOUNDS**
**PAGE TWO**

| VOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| Tetrachloroethene | 0.200 | 20.5 | 25.0 |
| 1,1,2,2-Tetrachloroethane | 0.500 | 20.5 | 25.0 |
| Toluene | 0.400 | 20.5 | 25.0 |
| Chlorobenzene | 0.500 | 20.5 | 25.0 |
| Ethylbenzene | 0.100 | 20.5 | 25.0 |
| Styrene | 0.300 | 20.5 | 25.0 |
| Xylenes (total) | 0.300 | 20.5 | 25.0 |
| Bromofluorobenzene | 0.200 | 20.5 | 25.0 |

- Because performance data indicate erratic and poor linearity, the following compounds have no maximum %RSD, or maximum %difference criteria; however, these compounds <u>must</u> meet a minimum RRF criterion of 0.010:

| | |
|---|---|
| Acetone | 1,2-Dichloropropane |
| 2-Butanone | 2-Hexanone |
| Carbon disulfide | Methylene chloride |
| Chloroethane | |
| 4-Methyl-2-pentanone | |
| Chloromethane | Toluene-$d_8$ |
| 1,2-Dichloroethene (total) | 1,2-Dichloroethane-$d_4$ |

- As with the initial calibration, up to two volatile compounds in Table 11-6 may fail to meet the minimum RRF or maximum %D criteria, but the RRFs of those two compounds must be greater than or equal to 0.010, and the percent differences must be less than or equal to 40.0% for the continuing calibration to be acceptable.

• Criteria (Semivolatiles)

- The five point curve is valid only if the criteria in Table 11-7 are met.

  - Response factor criteria have been established for the calibration of the semivolatile target compounds and semivolatile surrogate compounds.

  - The response factors of the compounds listed in Table 11-7 must meet the minimum RRF criteria at each concentration level and maximum %RSD criteria for the initial calibration, with allowance made for up to four semivolatile target and surrogate compounds. However, the RRFs for those four compounds must be greater than 0.010, and the %RSD of those four compounds must be less than or equal to 40.0% for the initial calibration to be acceptable.

- Because performance data indicate erratic and poor linearity and sensitivity, the following compounds have no maximum %RSD, or maximum %difference criteria; however, these compounds must meet a minimum RRF criterion of 0.010:

| | |
|---|---|
| 2,2'-oxybis(1-Chloropropane) | 4-Nitroaniline |
| 4-Chloroaniline | 4,6-Dinitro-2-methylphenol |
| Hexachlorobutadiene | N-Nitrosodiphenylamine |
| Hexachlorocyclopentadiene | Di-n-butylphthalate |
| 2-Nitroaniline | Butylbenzylphthalate |
| Dimethylphthalate | 3,3'-Dichlorobenzidine |
| 3-Nitroaniline | bis(2-Ethylhexyl)phthalate |
| 2,4-Dinitrophenol | Di-n-octylphthalate |
| 4-Nitrophenol | 2,4,6-Tribromophenol |
| Diethylphthalate | |

- In addition, Carbazole, a new target compound for which there is insufficient performance data, must only meet a minimum RRF criterion of 0.010.

- As with the initial calibration, up to four semivolatile target compounds in Table 11-7 may fail to meet the minimum RRF or maximum %D criteria, but the RRFs of those four compounds must be greater than or equal to 0.010, and the percent differences must be less than or equal to 40.0% for the continuing calibration to be acceptable.

**TABLE 11-7**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF SEMIVOLATILE ORGANIC COMPOUNDS**

| SEMIVOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| Phenol | 0.800 | 20.5 | 25.0 |
| bis(2-Chloroethyl)ether | 0.700 | 20.5 | 25.0 |
| 2-Chlorophenol | 0.800 | 20.5 | 25.0 |
| 1,3-Dichlorobenzene | 0.600 | 20.5 | 25.0 |
| 1,4-Dichlorobenzene | 0.500 | 20.5 | 25.0 |
| 1,2-Dichlorobenzene | 0.400 | 20.5 | 25.0 |
| 2-Methylphenol | 0.700 | 20.5 | 25.0 |
| 4-Methylphenol | 0.600 | 20.5 | 25.0 |
| N-Nitroso-Di-propylamine | 0.500 | 20.5 | 25.0 |
| Hexachloroethane | 0.300 | 20.5 | 25.0 |
| Nitrobenzene | 0.200 | 20.5 | 25.0 |
| Isophorone | 0.400 | 20.5 | 25.0 |
| 2-Nitrophenol | 0.100 | 20.5 | 25.0 |

**TABLE 11-7**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF SEMIVOLATILE ORGANIC COMPOUNDS**
**PAGE TWO**

| SEMIVOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| 2,4-Dimethylphenol | 0.200 | 20.5 | 25.0 |
| bis(2-Chloroethoxy)methane | 0.300 | 20.5 | 25.0 |
| 2,4-Dichlorophenol | 0.200 | 20.5 | 25.0 |
| 1,2,4-Trichlorobenzene | 0.200 | 20.5 | 25.0 |
| Naphthalene | 0.700 | 20.5 | 25.0 |
| 4-Chloro-3-methylphenol | 0.200 | 20.5 | 25.0 |
| 2-Methylnaphthalene | 0.400 | 20.5 | 25.0 |
| 2,4,6-Trichlorophenol | 0.200 | 20.5 | 25.0 |
| 2,4,5-Trichlorophenol | 0.200 | 20.5 | 25.0 |
| 2-Chloronaphthalene | 0.800 | 20.5 | 25.0 |
| Acenaphthylene | 1.300 | 20.5 | 25.0 |
| 2,6-Dinitrotoluene | 0.200 | 20.5 | 25.0 |
| Acenaphthene | 0.800 | 20.5 | 25.0 |
| Dibenzofuran | 0.800 | 20.5 | 25.0 |
| 2,4-Dinitrotoluene | 0.200 | 20.5 | 25.0 |
| 4-Chlorophenyl-phenylether | 0.400 | 20.5 | 25.0 |
| Fluorene | 0.900 | 20.5 | 25.0 |
| 4-Bromophenyl-phenylether | 0.100 | 20.5 | 25.0 |
| Hexachlorobenzene | 0.100 | 20.5 | 25.0 |

**TABLE 11-7**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF SEMIVOLATILE ORGANIC COMPOUNDS**
**PAGE THREE**

| SEMIVOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| Pentachlorophenol | 0.050 | 20.5 | 25.0 |
| Phenanthrene | 0.700 | 20.5 | 25.0 |
| Anthracene | 0.700 | 20.5 | 25.0 |
| Fluoranthene | 0.600 | 20.5 | 25.0 |
| Pyrene | 0.600 | 20.5 | 25.0 |
| Benzo(a)anthracene | 0.800 | 20.5 | 25.0 |
| Chrysene | 0.700 | 20.5 | 25.0 |
| Benzo(b)fluoranthene | 0.700 | 20.5 | 25.0 |
| Benzo(k)fluoranthene | 0.700 | 20.5 | 25.0 |
| Benzo(a)pyrene | 0.700 | 20.5 | 25.0 |
| Indeno(1,2,3-cd)pyrene | 0.500 | 20.5 | 25.0 |
| Dibenzo(a,h)anthracene | 0.400 | 20.5 | 25.0 |
| Benzo(g,h,i)perylene | 0.500 | 20.5 | 25.0 |
| Nitrobenzene-$d_5$ | 0.200 | 20.5 | 25.0 |
| 2-Fluorobiphenyl | 0.700 | 20.5 | 25.0 |
| Terphenyl-$d_{14}$ | 0.500 | 20.5 | 25.0 |
| Phenol-$d_5$ | 0.800 | 20.5 | 25.0 |
| 2-Fluorophenol | 0.600 | 20.5 | 25.0 |
| 2-Chlorophenol-$d_4$ | 0.800 | 20.5 | 25.0 |

**TABLE 11-7**
**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION OF SEMIVOLATILE ORGANIC COMPOUNDS**
**PAGE FOUR**

| SEMIVOLATILE COMPOUND | MINIMUM RRF | MAXIMUM %RSD | MAXIMUM %DIFF |
|---|---|---|---|
| 1,2-Dichlorobenzene-$d^4$ | 0.400 | 20.5 | 25.0 |

C. Continuing Calibration

- Requirement

  - A single calibration standard must be run at the start of each 12-hour period of analysis following a successful tune.

- Criteria

  - The criteria on Table 11-6 or 11-7 must be met before sample analysis can proceed.

D. Method Blank

- Requirement

  - A method blank must be analyzed at the frequency specified in 11.1.4A.

- Criteria

  - Each method blank must conform to the following criteria:

    - The extracted ion current profile (EICP) area of each internal standard must be 1/2 to 2 times that of the most recent 12-hour calibration standard.

    - Retention time (RT) of each internal standard must be ±30 seconds of that of the most recent 12-hour calibration standard.

    - All surrogate recoveries must be within the acceptance limits (see 11.1.5F).

- (VOA only) Blank must not contain methylene chloride, acetone, or 2-butanone, at levels greater than 5 times the contract required quantitation limit (CRQL) or any other volatile TCL compound at levels above the CRQL. (CRQLs are listed in Table 10-2.)

- (BNA only) Blank must not contain common phthalate esters at levels greater than 5 times the CRQL, or any other semivolatile target compound at levels above the CRQL. (CRQLs are listed in Table 10-2).

E. Sample analysis

- Requirement

  - The analyses of each sample, blank, and MS/MSD must meet the criteria listed below.

- Criteria

  - EICP of each internal standard must be 1/2 to 2 times that of the most recent 12-hour calibration standard.

  - Retention time of each internal standard must be ±30 seconds of that of the most recent 12-hour calibration standard.

  - Surrogate recoveries must be within the acceptance limits. (See 11.1.5F.)

  - The concentration of all TCL compounds must be $\leq$ the concentration of the highest initial calibration standard.

F. Surrogate Spike

- Requirement

  - Each surrogate spike compound must be quantitated for each sample, blank, and MS/MSD.

- Criteria

  - If the following criteria are not met, the sample must be re-extracted and reanalyzed:

| SURROGATE RECOVERY LIMITS | | |
|---|---|---|
| COMPOUND | %R WATER | %R SOIL |
| Nitrobenzene-$d_5$ | 35-114 | 23-120 |
| 2-Fluorobiphenyl | 43-116 | 30-115 |
| Terphenyl-$d_{14}$ | 33-141 | 18-137 |
| Phenyl-$d_5$ | 10-110 | 24-113 |
| 2-Fluorophenol | 21-110 | 25-121 |
| 2,4,6-Tribromophenol | 10-123 | 19-122 |
| 2-Chlorophenol-$d_4$ | 33-110 | 20-130 (advisory) |
| 1,2-Dichlorobenzene-$d_4$ | 16-110 | 20-130 (advisory) |
| Toluene-$d_8$ | 88-110 | 84-138 |
| Bromofluorobenzene | 86-115 | 59-113 |
| 1,2-Dichloroethane-$d_4$ | 76-114 | 70-121 |

* One base-neutral and/or acid surrogate may exceed these limits as long as all BN or acid recoveries are $\geq$10 percent.

G. Matrix Spike Duplicates (MS/MSD)

- Requirement

  - Matrix spikes must be analyzed at the frequency specified in 11.1.1D.

- Criteria

  - Advisory limits, listed in Tables 11-8 and 11-9 have been established for percent recovery.

**TABLE 11-8**

| MATRIX SPIKE RECOVERY AND RELATIVE PERCENT DIFFERENCE LIMITS FOR SEMIVOLATILES | | | | |
|---|---|---|---|---|
| **COMPOUND** | **%R WATER** | **RPD WATER** | **%R SOIL** | **RPD SOIL** |
| Phenol | 12-110 | 42 | 26-90 | 35 |
| 2-Chlorophenol | 27-123 | 40 | 25-102 | 50 |
| 1,4-Dichlorobenzene | 36-97 | 28 | 28-104 | 27 |
| N-Nitroso-di-n-propylamine | 41-116 | 38 | 41-126 | 38 |
| 1,2,4-Trichlorobenzene | 39-98 | 28 | 38-107 | 23 |
| 4-Chloro-3-methylphenol | 23-97 | 42 | 26-103 | 33 |
| Acenaphthene | 46-118 | 31 | 31-137 | 19 |
| 4-Nitrophenol | 10-80 | 50 | 11-114 | 50 |
| 2,4-Dinitrotoluene | 24-96 | 38 | 28-89 | 47 |
| Pentachlorophenol | 9-103 | 50 | 17-109 | 47 |
| Pyrene | 26-127 | 31 | 35-142 | 36 |

**TABLE 11-9**

| MATRIX SPIKE RECOVERY AND RELATIVE PERCENT DIFFERENCE LIMITS FOR VOLATILES | | | | |
|---|---|---|---|---|
| **COMPOUND** | **%R WATER** | **RPD WATER** | **%R SOIL** | **RPD SOIL** |
| 1,1-Dichloroethane | 61-145 | 14 | 59-172 | 22 |
| Trichloroethene | 71-120 | 14 | 62-137 | 24 |
| Benzene | 76-127 | 11 | 66-142 | 21 |
| Toluene | 76-125 | 13 | 59-139 | 21 |
| Chlorobenzene | 75-130 | 13 | 60-133 | 21 |

H. Qualitative Identification

- Requirement

  - The quantitation reports and chromatograms of all samples, blanks, and MS/MSDs must be examined for the presence of target and nontarget compounds.

- Criteria

  - Target compounds shall be identified by comparison of the sample and standard mass spectra generated during a 12-hour period. A compound is positively identified if the following criteria are met:

    - The RRT of the sample component is within 0.06 RRT units of the standard component.

    - All ions present in the standard mass spectra at a relative intensity greater than 10 percent (most abundant ion in the spectrum equals 100 percent) must be present in the sample spectrum.

    - The relative intensities of ions specified in the above paragraph must agree within ±20 percent.

    - Ions greater than 10 percent in the sample spectrum, but not present in the standard spectrum, must be considered and accounted for by the analyst making the comparison. When GC/MS computer data processing programs are used to obtain the sample component spectrum, both the processed and the raw spectra must be evaluated. The verification process should favor false positives for volatiles and false negatives for semivolatiles.

- Criteria

  - Nontarget compounds shall be identified by executing 10 VOA and 20 BNA library searches for the nontarget components of greatest apparent concentration in the sample. Components with responses of less than 10 percent of the nearest internal standard do not require a library search. Use the following guidelines in making tentative identifications:

    - Relative intensities of major ions in the reference spectrum. (Ions greater than 10 percent of the most abundant ion should be present in the sample spectrum.)

    - The relative intensities of the major ions should agree within ±20 percent. (Example: For an ion with an abundance of 50 percent of the standard spectra, the corresponding sample ion abundance must be between 30 and 70 percent.)

    - Molecular ions present in reference spectrum should be present in sample spectrum.

    - Ions present in the sample spectrum, but not in the reference spectrum should be reviewed for possible background contamination or the presence of co-eluting compounds.

    - Ions present in the reference spectrum, but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting compounds. Data system library reduction programs can sometimes create these discrepancies.

- If, in the opinion of the mass-spectral specialist, no valid tentative identification can be made, the compound should be reported as "unknown". The mass-spectral specialist should give additional classification of the unknown compound (i.e., unknown aromatic, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weights can be distinguished, include them.

I. Quantitation

- Requirement

  - Each compound identified in each sample, blank, or MS/MSD must be quantitated.

- Criteria

  - Quantitation must be based on a wide-bore capillary column chromatogram.

  - Quantitation is based on the calibration factors of external standard run within the 72-hour sequence.

### 11.1.6 GC Analysis - 1990 SOW (Document No. OLM01.O) - To Be Developed

## 11.2 LEVEL C PROTOCOLS - ORGANIC PARAMETERS

### 11.2.1 Sample Preparation - SOW 288

A. Method Blank

- Requirement

  - A method blank must be prepared with each batch of samples of similar matrix. (A batch consists of all the samples prepared together, not to exceed 20 samples). For water samples, the blank consists of 1 liter of carbon-treated

deionized water. For soil/waste matrices, the blank is prepared by performing all manipulations on all reagents added to an empty beaker.

- Criteria

  - Acceptance criteria for Level D apply. (See 11.1.2D and 11.1.3C)

B. Surrogate Spike (Volatiles and Semivolatiles)

- Requirement

  - All samples, method blanks, and duplicate matrix spikes must be spiked with one or more surrogates at the start of sample preparation.

- Criteria

  - Acceptance criteria for Level D apply to GC/MS volatiles and semivolatiles. (See 11.1.2F.) Acceptance criteria for volatiles, pesticides/PCBs, and herbicides by GC are described in Section 3.2 of LSG Procedure QA-8, Laboratory Quality Control (Appendix H). Samples with nonconforming surrogate recoveries must be rerun (VOAs) and/or re-extracted and rerun (extractables).

C. Blank Spike (GC analyses only)

- Requirement

  - One blank spike per batch will be prepared by adding the compounds specified in Table 11-10 to deionized water or the blank spike soil matrix. (See Section 11.7)

- Criteria

  - Acceptance criteria listed in Section 11.8 apply.

D. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

- Requirement

  - Matrix spikes will be prepared in duplicate and analyzed with each group of 20 samples of similar matrix from the same site. Field duplicates will be split and used for MS/MSD analysis.

- Criteria

  - Acceptance criteria for Level D apply to GC/MS volatiles and semivolatiles and pesticides/PCBs by GC. (See 11.1.2G and 11.1.3G.) Acceptance criteria for volatiles and herbicides by GC are described in Section 3.2 of LSG Procedure QA-8, Laboratory Quality Control (Appendix H).

**TABLE 11-10**
**BLANK SPIKE FOR PESTICIDES/PCBS**

| COMPOUND | Suggested Conc. in Spike Soln. (µg/ml) | ml Spike Soln./ Final Extract Vol. | Suggested Conc. in Extract[1] |
|---|---|---|---|
| **LLW (LOW LEVEL WATER)** | | | |
| Lindane | 0.20 | 1.0/10 | 0.02 |
| Heptachlor | 0.20 | 1.0/10 | 0.02 |
| Aldrin | 0.20 | 1.0/10 | 0.02 |
| Dieldrin | 0.50 | 1.0/10 | 0.05 |
| Endrin | 0.50 | 1.0/10 | 0.05 |
| DDT | 0.50 | 1.0/10 | 0.05 |
| Aroclor 1016 | 2.5 | 1.0/10 | 0.25 |
| Aroclor 1260 | 5.0 | 1.0/10 | 0.50 |
| **LLS (LOW LEVEL SOIL)** | | | |
| Lindane | 0.20 | 2.0/20 | 0.02 |
| Heptachlor | 0.20 | 2.0/20 | 0.02 |
| Aldrin | 0.20 | 2.0/20 | 0.02 |
| Dieldrin | 0.50 | 2.0/20 | 0.05 |
| Endrin | 0.50 | 2.0/20 | 0.05 |
| DDT | 0.50 | 2.0/20 | 0.05 |
| Aroclor 1016 | 2.5 | 2.0/20 | 0.25 |
| Aroclor 1260 | 5.0 | 2.0/20 | 0.50 |

**TABLE 11-10**
**BLANK SPIKE FOR PESTICIDES/PCBS**
**PAGE TWO**

| Compound | Suggested Conc. in Spike Soln. (µg/ml) | ml Spike Soln./ Final Extract Vol. | Suggested Conc. in Extract[1] |
|---|---|---|---|
| **MLS (Medium Level Soil)** | | | |
| Lindane | 0.20 | 0.2/2 | 0.02 |
| Heptachlor | 0.20 | 0.2/2 | 0.02 |
| Aldrin | 0.20 | 0.2/2 | 0.02 |
| Dieldrin | 0.50 | 0.2/2 | 0.05 |
| Endrin | 0.50 | 0.2/2 | 0.05 |
| DDT | 0.50 | 0.2/2 | 0.05 |
| Aroclor 1016 | 2.5 | 0.2/2 | 0.25 |
| Aroclor 1260 | 5.0 | 0.2/2 | 0.50 |

[1] Extracts for pesticides will be analyzed at a 1/4 dilution.

### 11.2.2 TCL and Priority Pollutant Volatiles and Semivolatiles by GC/MS

A. GC/MS Tune - Requirements and criteria for Level D apply. (See 11.1.2A.)

B. Initial Calibration - Requirements and criteria for Level D apply. (See 11.1.2B.)

C. Continuing Calibration - Requirements and criteria for Level D apply. (See 11.1.2C.)

D. Method Blank - Requirements and criteria for Level D apply. (See 11.1.2D.)

E. Sample Analysis - Criteria for Level D apply. (See 11.1.2E.)

F. Surrogate Spike - Requirements and criteria for Level D apply. (See 11.1.2F.)

G. Matrix Spike Duplicates (MS/MSD) - Requirements and criteria for Level D apply. (See 11.1.2G.)

H. Qualitative Identification - Requirements and criteria for target compounds for Level D apply. (See 11.1.2H.) Nontarget identifications (TICs), if required, will be made using the criteria in 11.1.2H also.

I. Quantitation - Requirements and criteria for Level D apply. (See 11.1.2H.)

### 11.2.3 Pesticides/PCBs by GC

A. 72-Hour Standardization Sequence (Quantitation and Confirmation Runs) - Requirements and criteria for Level D apply. (See 11.1.3B.)

B. Method Blank

- Requirement
  - One per batch of samples of similar matrix.

C. Blank Spike

- Requirement
  - One per batch of samples of similar matrix. (See Table 11-10 for compounds and amounts.)
- Criteria
  - Control limits for percent recovery are calculated as described in Section 11.8.

D. Sample Analysis - Requirements and criteria for Level D apply. (See 11.1.3D.)

E. Surrogate Spike

- Requirement
  - As specified for Level D. (See 11.1.3E.)
- Criteria
  - Acceptance criteria are described in Section 3.2 of LSG Procedure QA-8.0, Laboratory Quality Control (Appendix H).

F. Matrix Spike/Matrix Spike Duplicate (MS/MSD) - Requirements and criteria for Level D apply. (See 11.1.3G.)

G. Qualitative Identification - Requirements and criteria for Level D apply. (See 11.1.3H.)

H. Quantitation - Requirements and criteria for Level D apply. (See 11.1.3I.)

### 11.2.4 Volatiles, Drinking Water Pesticides, and Herbicides by GC

A. Initial and Continuing Calibration

- Requirement
  - Three-point initial calibration, followed by one-point continuing calibration every 12 hours that analyses are performed. Standards will contain all analytes of interest.
- Criteria
  - Response factor for continuing calibration must be within 15 percent of initial calibration. If criteria are not met, initial three-point calibration is repeated.

B. Method Blank

- Requirement
  - One per batch of samples of similar matrix. Analyzed after calibration.
- Criteria
  - As specified for Level D. (See 11.1.2D and 11.1.3C.)

C. Blank Spike

- Requirement
  - One per batch of samples of similar matrix.
- Criteria
  - Acceptance limits for percent recovery are described in Section 11.8.

D. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

- Requirement
  - Matrix spikes must be analyzed at the frequency specified in 11.1.3G.
- Criteria
  - As described in 11.1.3G.

E. Sample Analysis

- Requirement
  - All positive identifications must be confirmed by analysis using a second GC column.
- Criteria
  - The retention time of the sample components are compared to the retention time of the continuing calibration standard.

### 11.2.5 Sample Preparation - 1990 SOW (Document No. OLM01.0)

A. Method Blank

- Requirement
  - A method blank must be prepared with each batch of samples of similar matrix. (A batch consists of all samples prepared together, not to exceed 20 samples.) For water samples, the blank consists of 1 liter of carbon-treated deionized water. For soil/waste matrices, the blank is prepared by performing all manipulations on all reagents added to an empty beaker.

- Criteria
  - Acceptance criteria for Level D apply. (See 11.1.5D.)

B. Surrogate Spike (Volatiles and Semi-Volatiles)

- Requirement
  - All samples, method blanks, and duplicate matrix spikes must be spiked with one or more surrogates at the start of sample preparation.
- Criteria
  - Acceptance criteria for Level D apply to GC/MS volatiles and semivolatiles. (See 11.1.5F.) Acceptance criteria for volatiles, pesticides/PCBs, and herbicides by GC are described in Section 3.2 of LSG Procedure QA-8, Laboratory Quality Control (Appendix H). Samples with nonconforming surrogate recoveries must be rerun (VOAs) and/or re-extracted and rerun (extractables).

C. Blank Spike (GC analyses only)

- Requirement
  - One blank spike per batch will be prepared by adding the compounds specified in Table 11-10 to deionized water or the blank spike soil matrix. (See Section 11.7.)
- Criteria
  - Acceptance criteria listed in Section 11.8 apply.

D. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

- Requirement

  - Matrix spikes will be prepared in duplicate and analyzed with each group of 20 samples of similar matrix from the same site. Field duplicates will be split and used for MS/MSD analysis.

- Criteria

  - Acceptance criteria for Level D apply to GC/MS volatiles and semivolatiles. (See 11.1.5G.) Acceptance criteria for pesticides/PCBs by GC are being developed. Acceptance criteria for volatiles and herbicides by GC are described in Section 3.2 of LSG Procedure QA-8, Laboratory Quality Control (Appendix H).

### 11.2.6 TCL and Priority Pollutant Volatiles and Semivolatiles by GC/MS

A. GC/MS Tune - Requirements and criteria for Level D apply. (See 11.1.5A.)

B. Initial Calibration - Requirements and criteria for Level D apply. (See 11.1.5B.)

C. Continuing Calibration - Requirements and criteria for Level D apply. (See 11.1.5C.)

D. Method Blank - Requirements and criteria for Level D apply. (See 11.1.5D.)

E. Sample Analysis - Criteria for Level D apply. (See 11.1.5E.)

F. Surrogate Spike - Requirements and criteria for Level D apply. (See 11.1.5F.)

G. Matrix Spike Duplicates (MS/MSD) - Requirements and criteria for Level D apply. (See 11.1.5G and Tables 11-8 and 11-9)

H. Qualitative Identification - Requirements and criteria for target compounds for Level D apply. (See 11.1.5H.) Nontarget identifications (TICs), if required, will be made using the criteria in 11.1.5H also.

I. Quantitation - Requirements and criteria for Level D apply. (See 11.1.5I.)

### 11.2.7 Pesticides/PCBs by GC - 1990 SOW (Document No. OLM01.0) - To Be Developed

## 11.3 LEVEL E PROTOCOLS - ORGANIC PARAMETERS

The requirements and acceptance criteria described for Level C apply, with the following exceptions:

- Matrix spike/matrix spike duplicate analyses are not required.
- Second GC column confirmation of identified compounds are not required.

## 11.4 CALIBRATION AND QUALITY CONTROL FOR METALS AND CYANIDE

Contract Laboratory Program methods, and calibration and quality control protocols will be used for Level C as well as Level D analyses for the metals that are addressed in the CLP SOW and for cyanide. (The primary difference between Levels C and D will be in the techniques used for analysis and deliverables. For example, Level C may not require lower limits of detection for As, Se, Pb, Sb, or Tl, so that ICP would be used instead of GFAA.)

Level E analyses will follow Level C and Level D protocol except that duplicate and matrix spike analyses on CLEAN samples are not required.

### 11.4.1 Level C and D Protocols for Metals by Graphite Furnace AA

Calibration and quality control requirements for the analysis of metals by graphite furnace AA for samples requiring Level C and Level D quality control are listed on Tables 11-11 and 11-12.

11.4.2 Level C and D Protocols for Metals by Simultaneous ICP

Calibration and quality control requirements for the analysis of metals by simultaneous ICP under CLEAN Level C and level D quality control protocols are listed on Tables 11-13 through 11-15.

11.4.3 Level C and D Protocols for Metals by Sequential ICP

Calibration and quality control requirements for the analysis of metals by sequential ICP under CLEAN Level C and level D quality control protocols are listed on Tables 11-13 through 11-15.

11.4.4 Level C and D Protocols for Mercury by Cold Vapor AA

Calibration and quality control requirements for the analysis of mercury by cold vapor AA under CLEAN Level C and Level D quality control protocols are listed on Table 11-16.

11.4.5 Level C and D protocols for Metals by Flame AA

Calibration and quality control requirements for the analysis of metals by flame AA under CLEAN Level C and Level D quality control protocols are listed on Tables 11-17 and 11-18.

11.4.6 Level C and D Protocols for Cyanide

Calibration and quality control requirements for the analysis of cyanide under CLEAN Level C and Level D quality control protocols are listed on Table 11-19.

# FIGURE 11-1
# FURNACE ATOMIC ABSORPTION SPIKE ANALYSIS SCHEME

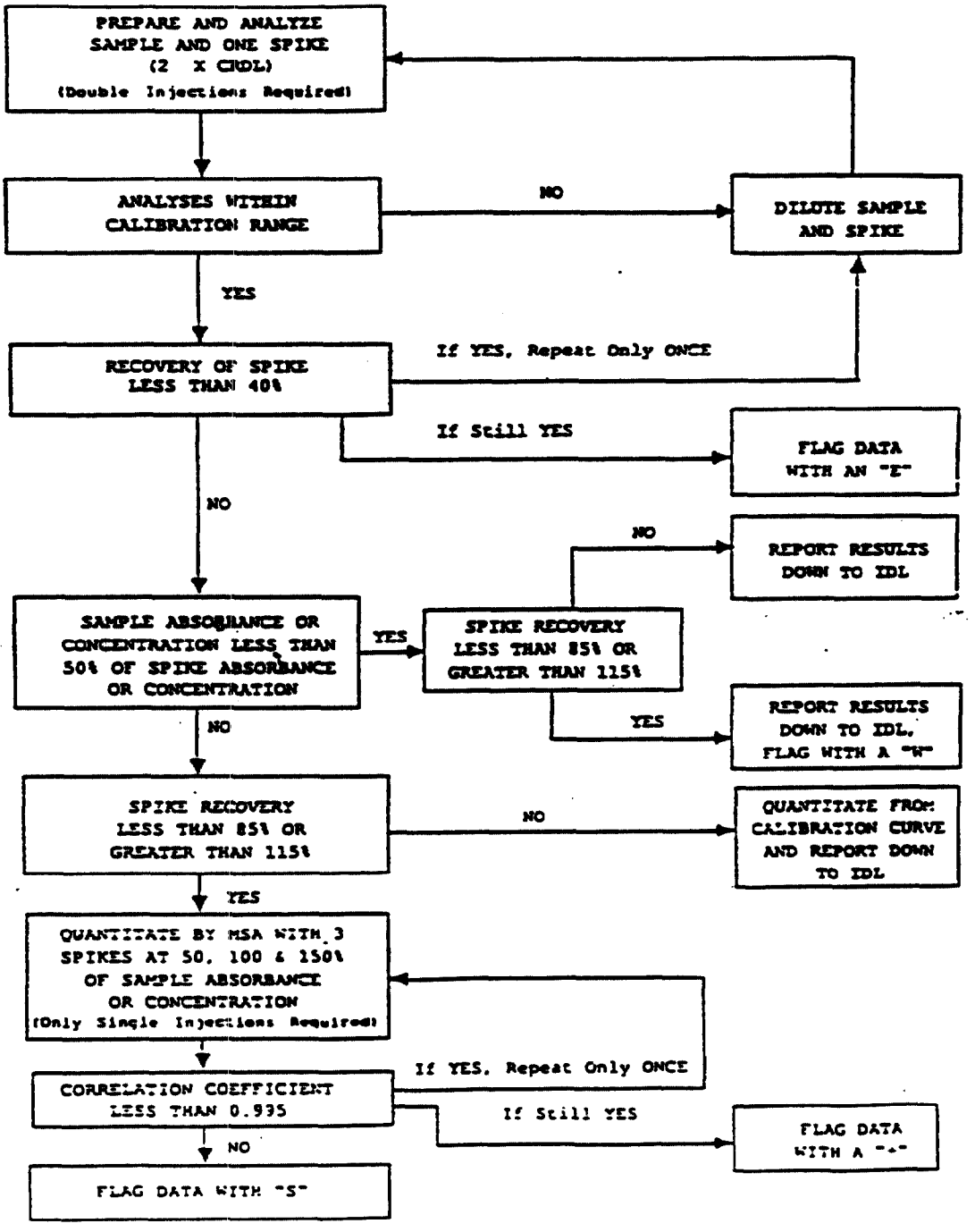

**TABLE 11-11**
**LEVEL C AND D PROTOCOL FOR**
**GRAPHITE FURNACE AA**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration (IC) | Instrument blank and 3 standards (minimum) with 1 standard at the CRDL. | Each analytical run or every 24 hours of operation, whichever is more frequent. | • r $\leq$0.995<br>• Sensitivity $\geq$element -specific value. | • Remake standards.<br>• Repeat instrument set up and calibration.<br>• If above fail, notify group leader. |
| Independent Calibration Verification (ICV) | 1 independent standard. | Immediately following each IC. | %R = 90.0-110% | Same as IC. |
| Initial Calibration Blank (ICB) | Instrument blank. | Immediately following each ICV. | -CRDL <ICB result <CRDL | • Check instrument blank against fresh reagent water.<br>• Rezero and recalibrate as necessary. |
| CRA Standard | 1 standard at the CRDL concentration. | Immediately following each ICB. | CRA standard result discernible from instrument blank result. | Same as IC. |

**TABLE 11-11**
**LEVEL C AND D PROTOCOL FOR**
**GRAPHITE FURNACE AA**
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis | 10 analytical samples or 2 hour period of analysis (maximum), whichever is greater, which includes the following. | | | |
| | Each standard, sample, and quality control sample must be injected in duplicate; each sample, lab control standard, and preparation blank must be spiked following digestion as a check for matrix interferences. | Each sample. | • CV of duplicate injections of each solution ≤20%.<br>• Percent recovery of post digestion spike evaluated as shown in Figure 11-1. | • Rerun samples with C >20%. If still >20%, i the result with an "M".<br>• See Figure 11-1 for appropriate actions. |

**TABLE 11-11**
**LEVEL C AND D PROTOCOL FOR**
**GRAPHITE FURNACE AA**
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Method blank (MB). Blank taken through sample preparation. | 1 per SDG or preparation batch, whichever is more frequent. | -CRDL < MB result <CRDL | • MB result <CRDL: Reject data for all samples for which CRDL ≤sample result <10 x MB result.<br>• MB result <-CRDL: Reject data for all samples for which the sample result is <10 x CRDL. Redigest the samples. |
| | Lab control standard (LCS). Independent standard taken through sample preparation. | 1 per SDG or preparation batch, whichever is more frequent. | • Aqueous LCS: 80.0-120% recovery (exception: Ag and Sb) or limits listed in QC Test File, whichever is more strisngent.<br>• Solid LCS: See QC Test File. | Reject all data from this batch. Redigest samples. |

**TABLE 11-11**
**LEVEL C AND D PROTOCOL FOR**
**GRAPHITE FURNACE AA**
**PAGE FOUR**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate | 1 sample per matrix per SDG. (Do not select a field blank.) | • Both values ≤5 x CRDL: RPD ≤20.0%<br>• Both values <IDL: Precision is not calculated.<br>• At least one value <5 x CRDL and >IDL: Range <CRDL. | Flag all results for the element for samples associated with the duplicate with an "*". |
| | Matrix spike (See Table 11-12 for spiking levels.) | 1 sample per matrix per SDG. (Do not select a field blank. Post digestion spike not required on this sample.) | %R = 75.0-125% | Flag all results for the element for samples associated with the spiked sample with an "N". |
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or the ICV standard) | Immediately following each set of up to 20 injections or 2 hour period since the ICV or last CCV, whichever is more frequent. | %R = 90.0-110% | • Reject all data obtained since the last acceptable CCV or ICV.<br>• Troubleshoot the system and recalibrate. |

**TABLE 11-11**
**LEVEL C AND D PROTOCOL FOR**
**GRAPHITE FURNACE AA**
**PAGE FIVE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Continuing Calibration Blank (CCB) | 1 instrument blank | Immediately following each CCV | -CRDL < CCB result <CRDL | • Reject all data obtained since the last acceptable CCB or ICV.<br>• Troubleshoot the system and recalibrate. |
| Repeat sample, CCV, and CCB sequence until sample analyses are complete. Each run must end with conforming CCB and CCV. | | | | |

**TABLE 11-12**
**SPIKING LEVELS FOR SPIKE SAMPLE**
**ANALYSIS FOR GFAA**

| ELEMENT | WATER (µg/L) | SOIL[1] (mg/kg) |
|---|---|---|
| Antimony | 100 | 20 |
| Arsenic | 40 | 8 |
| Cadmium | 5 | 1 |
| Iron | | |
| Lead | 20 | 4 |
| Selenium | 10 | 2 |
| Thallium | 50 | 10 |

(1) The levels shown indicate concentrations in the final digestate of the spiked sample (200 mL final volume for all metals) when the wet weight of 1 gram of sample is taken for analysis. Adjustment must be made to maintain these spiking levels when the weight of sample taken deviates by more than 10% of these values.

**TABLE 11-13**
**LEVEL C AND D PROTOCOL FOR**
**SIMULTANEOUS AND SEQUENTIAL ICP**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration (IC) | Instrument blank and a 5 mg/L standard (10 mg/L for Na, 50 mg/L for K, 100 mg/L for Tl). | Each analytical run or every 24 hours of operation, whichever is more frequent. | NA | NA |
| Independent Calibration Verification (ICV) | 1 independent standard run at each wavelength that will be used for sample analysis. | Immediately following each IC. | %R = 90.0-110% | • Remake standards.<br>• Repeat instrument set-up and calibration.<br>• If above fail, notify group leader. |
| Initial Calibration Blank (ICB) | Instrument blank. | Immediately following each ICV. | -CRDL <ICB Result <CRDL | • Check instrument blank against fresh reagent water.<br>• Rezero or recalibrate as necessary. |

**TABLE 11-13**
**LEVEL C AND D PROTOCOL FOR SIMULTANEOUS AND SEQUENTIAL ICP**
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| CRI Standard | 1 standard at 2 x CRDL concentration. | Immediately following each ICB, every eight hours of operation thereafter, and at the end of the run following the final CCB. | Result discernible from instrument blank result | Same as ICV. |
| ICP Interference Check Sample Analysis | Solution of interferents and solution of interferents plus analytes. (See Table 11-14) | Immediately following each CRI standard. | Recovery of analytes in solution of interferents plus analytes = 80.0-120% | Same as ICV. |

**.'ABLE 11-13**
**LEVEL C AND D PROTOCOL FOR**
**:IMULTANEOUS AND SEQUENTIAL ICP**
**'AGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or the ICV standard). | Immediately following each set of up to 10 analytical samples or 2-hour period of analysis since the ICV or last CCV, whichever is more frequent. | %R = 90.0-110% | • Reject all data obtained since the last acceptable CCV or ICV.<br>• Troubleshoot the system and recalibrate. |
| Continuing Calibration Blank (CCB) | 1 instrument blank | Immediately following each CCV. | -CRDL <CCB Result <CRDL | • Reject all data obtained since the last acceptable CCB or ICB.<br>• Troubleshoot the system and recalibrate. |

**TABLE 11-13**
**LEVEL C AND D PROTOCOL FOR SIMULTANEOUS AND SEQUENTIAL ICP**
**PAGE FOUR**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis | Every 10 analytical samples or 2-hour period of analysis (maximum), whichever is greater, including the following: | NA | NA | NA |
| | Method blank (MB). Blank taken through sample preparation | 1 per SDG or preparation batch, whichever is more frequent. | -CRDL <MB Result <CRDL | • MB Result <CRDL: Reject data for all samp for which CRDL ≤samp.. result <10 x mB result. Redigest samples.<br>• MB Result <-CRDL: Reject data for all samples for which the sample result is <10 x CRDL. Redigest the samples. |

**TABLE 11-13**
**LEVEL C AND D PROTOCOL FOR SIMULTANEOUS AND SEQUENTIAL ICP**
**PAGE FIVE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Lab control standard (LCS). Independent standard taken through sample preparation | 1 per SDG or preparation batch, whichever is more frequent. | • Aqueous LCS: 80.0 -120% recovery or limits listed in QC Test File, whichever is more stringent. | Reject all data from this batch. Redigest samples. |
| | Duplicate | 1 sample per matrix per SDG. (Do not select a field blank.) | • Both values ≥5 x CRDL: RPD ≤ 20.0%<br>• Both values <IDL: Precision is not calculated.<br>• At least one value <5 x CRDL and >IDL: Range <CRDL. | Flag all results for the element for samples associated with the duplicate with an "*". |

**TABLE 11-13**
**LEVEL C AND D PROTOCOL FOR**
**SIMULTANEOUS AND SEQUENTIAL ICP**
**PAGE SIX**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Matrix spike. (See Table 11-15 for spiking levels.) | 1 sample per matrix per SDG. (Do not select a field blank.) | %R = 75-125% | Flag all results for the element for samples associated with the spiked sample with an "N". |
| Repeat CCV, CCB, and sample sequence until sample analyses are complete. Each run must end with conforming CCB and CCV. | | | | |

**TABLE 11-14**
**INTERFERANT AND ANALYTE ELEMENTAL CONCENTRATIONS USED FOR ICP INTERFERENCE CHECK SAMPLE**

| ANALYTES | (mg/L) | INTERFERENTS | (mg/L) |
|---|---|---|---|
| Ag | 1.0 | Al | 500 |
| Ba | 0.5 | Ca | 500 |
| Be | 0.5 | Fe | 200 |
| Cd | 1.0 | | |
| Co | 0.5 | | |
| Cr | 0.5 | | |
| Cu | 0.5 | | |
| Mn | 0.5 | | |
| Ni | 1.0 | | |
| Pb | 1.0 | | |
| V | 0.5 | | |
| Zn | 1.0 | | |

**TABLE 11-15**
**SPIKING LEVELS FOR ICP/FAA SPIKE SAMPLE ANALYSIS**

| ELEMENT | WATER (µg/L) | SOIL[1] (mg/kg) |
|---|---|---|
| Aluminum | 2,000 | * |
| Antimony | 500 | 100 |
| Arsenic | 2,000 | 400 |
| Barium | 2,000 | 400 |
| Beryllium | 50 | 10 |
| Cadmium | 50 | 10 |
| Calcium | * | * |
| Chromium | 200 | 40 |
| Cobalt | 500 | 100 |
| Copper | 250 | 50 |
| Iron | 1,000 | * |
| Lead | 500 | 100 |
| Magnesium | * | * |
| Manganese | 500 | 100 |
| Nickel | 500 | 100 |
| Potassium | * | * |
| Selenium | 2,000 | 400 |
| Silver | 50 | 10 |
| Sodium | * | * |
| Thallium | 2,000 | 400 |
| Vanadium | 500 | 100 |
| Zinc | 500 | 100 |

**TABLE 11-15**
**SPIKING LEVELS FOR ICP/FAA SPIKE SAMPLE ANALYSIS**
**PAGE TWO**

* No spike required. NOTE: Elements without spike levels and not designated with an asterisk, must be spiked at appropriate levels.

[1] The levels shown indicate concentrations in the final digestate of the spiked sample (200 mL) when the wet weight of 1 gram of sample is taken for analysis. Adjustment must be made to maintain these spiking levels when the weight of sample taken deviates by more than 10% of these values.

**TABLE 11-16**
**LEVEL C AND D PROTOCOL FOR**
**COLD VAPOR MERCURY ANALYSES**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| (IC) Initial Calibration | Blank and standards at 0.5, 1.0, 5.0, and 10.0 µg/L taken through same preparation as samples. | Each analytical run. | • r ≤ 0.995<br>• Sensitivity ≤50%T | • Remake standards.<br>• Repeat instrument set-up, sample and standard digestion, and calibration.<br>• If above fail, notify group leader. |
| Independent Calibration Verification (ICV) | 1 independent standard taken through same preparation as samples. | Immediately following each IC. | %R = 80.0-120% | Same as IC. |
| Initial Calibration Blank (ICB) | 1 blank taken through same preparation as samples. | Immediately following each ICV. | -CRDL < ICB Result < CRDL | • ICB result >CRDL: Reject data for all samples for which CRDL ≤ sample result ≤ 10 x ICB.<br>• Result < -CRDL: Reject data for all samples for which the sample result < 10 x CRDL. |
| CRA Standard | 1 standard at CRDL concentration taken through same preparation as samples. | Immediately following each ICB. | CRA standard result discernible from ICB result. | Same as IC. |

**TABLE 11-16**
**LEVEL C AND D PROTOCOL FOR**
**COLD VAPOR MERCURY ANALYSES**
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis | 10 analytical samples or 2 hour period of analysis (maximum), whichever is greater, which includes the following: | NA | NA | NA |
| | Solid lab control standard (solid reference material) taken through same preparation as samples. | 1 per batch of soil samples prepared for analysis. | See QC test file. | Reject the data from this batch. |
| | Duplicate | 1 sample per matrix per SDG. (Do not select a field blank.) | • Both values ≤5 x CRDL: RPD ≤20.0%<br>• Both values <IDL: Precision is not calculated.<br>• At least one value <5 x CRDL and >IDL: Range <CRDL. | Flag all results for the element for samples associated with the duplicate with an "*". |
| | Matrix spike. | 1 sample per matrix per SDG spiked with 1 µg/L or 1 mg/kg Hg. (Do not selecte a field blank.) | %R = 75.0-125% | Flag all results for the element for samples associated with the spiked sample with an "N". |

**TABLE 11-16**
**LEVEL C AND D PROTOCOL FOR**
**COLD VAPOR MERCURY ANALYSES**
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or an ICV standard) taken through same preparation as samples. | Immediately following each set of up to 10 analytical samples or 2 hour period of analysis since the last ICV or CCV, whichever is greater. | %R - 80.0-110% | • Reject all data obtained since the last acceptable CCV or ICV.<br>• Troubleshoot the system and recalibrate. |
| Continuing Calibration Blank (CCB) | 1 blank taken through same preparation as samples. | Immediately following each CCV. | -CRDL <Result <CRDL | • Reject all data obtained since the last acceptable CCB or ICB.<br>• Troubleshoot the system and recalibrate. |
| Repeat sample, CCV, and CCB sequence until sample analyses are complete. Each run must end with conforming CCB and CCV. | | | | |

**TABLE 11-17**
**LEVEL C AND D PROTOCOL FOR**
**FLAME AA**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration (IC) | Instrument blank and 3 standards (minimum) with 1 standard at the CRDL. | Each analytical run or every 24 hours of operation, whichever is more frequent. | • $r \leq 0.995$<br>• Sensitivity $\geq$element -specific value. | • Remake standards<br>• Repeat instrument set-up and calibration.<br>• If above fail, notify group leader. |
| Independent Calibration Verification (ICV) | 1 independent standard. | Immediately following each IC. | %R = 90.0-110% | Same as IC. |
| Initial Calibration Blank (ICB) | Instrument blank. | Immediately following each ICV. | -CRDL <ICB Result <CRDL | • Check instrument blank against fresh reagent water.<br>• Rezero to recalibrate as necessary. |
| CRA Standard | 1 standard at the CRDL concentration. | Immediately following each ICB. | Results discernible from instrument blank result. | Same as IC. |
| Sample Analysis | 10 analytical samples or 2-hour period of analysis (maximum), whichever is greater, including the following: | NA | NA | NA |

**TABLE 11-17**
**LEVEL C AND D PROTOCOL FOR**
**FLAME AA**
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Method blank (MB). Blank taken through sample preparation. | 1 per SDG or preparation batch, whichever is more frequent. | -CRDL <MB Result <CRDL | • MB Result >CRDL:<br><br>Reject data for all samples for which CRDL ≤sample result <10 x MB result. Redigest samples.<br><br>• MB Result <-CRDL:<br><br>Reject data for all samples for which the sample result is <10 x CRDL. Redigest the samples. |
| | Lab control standard (LCS). Independent standard taken through sample preparation. | 1 per SDG or preparation batch, whichever is more frequent. | • Aqueous LCS: 80.0-120% recovery or limits listed in QC Test File, whichever is more stringent.<br>• Solid LCS: See QC Test File. | Reject all data from this batch. Redigest samples. |

**TABLE 11-17**
**LEVEL C AND D PROTOCOL FOR**
**FLAME AA**
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate | 1 sample per matrix per SDG. (Do not select a field blank.) | • Both values ≥5 x CRDL: RPD ≤20.0%<br>• Both values <IDL: Precision is not calculated.<br>• At least one value <5 x CRDL and >IDL: Range <CRDL. | Flag all results for the element for samples associated with the duplicate with an "*". |
| | Matrix spike. (See Table 11-18 for spiking levels.) | 1 sample per matrix per SDG. (Do not select a field blank. | %R = 75.0-125% | Flag all results for the element for samples associated with the spiked sample with an "N". |

**TABLE 11-17**
**LEVEL C AND D PROTOCOL FOR**
**FLAME AA**
**PAGE FOUR**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or the ICV standard). | Immediately following each set of up to 10 analytical samples or 2-hour period of analysis since the ICV or last CCV, whichever is msore frequent. | %R = 90.0-110% | • Reject all data obtained since the last acceptable CCV or ICV.<br>• Troubleshoot the system and recalibrate. |
| Continuing Calibration Blank (CCB) | 1 instrument blank | Immediately following each CCV. | -CRDL <CCB Result <CRDL | • Reject all data obtained since the last acceptable CCB or ICB.<br>• Troubleshoot the system and recalibrate. |
| Repeat sample, CCV, and CCB sequence until sample analyses are complete. Each run must end with conforming CCB and CCV. | | | | |

**TABLE 11-18**
**SPIKING LEVELS FOR ICP/FAA**
**SPIKE SAMPLE ANALYSIS**

| ELEMENT | WATER (µg/L) | SOIL[1] (mg/kg) |
|---|---|---|
| Aluminum | 2,000 | * |
| Antimony | 500 | 100 |
| Arsenic | 2,000 | 400 |
| Barium | 2,000 | 400 |
| Beryllium | 50 | 10 |
| Cadmium | 50 | 10 |
| Calcium | * | * |
| Chromium | 200 | 40 |
| Cobalt | 500 | 100 |
| Copper | 250 | 50 |
| Iron | 1,000 | * |
| Lead | 500 | 100 |
| Magnesium | * | * |
| Manganese | 500 | 100 |
| Nickel | 500 | 100 |
| Potassium | * | * |
| Selenium | 2,000 | 400 |
| Silver | 50 | 10 |
| Sodium | * | * |
| Thallium | 2,000 | 400 |
| Vanadium | 500 | 100 |
| Zinc | 500 | 100 |

**TABLE 11-18**
**SPIKING LEVELS FOR ICP/FAA**
**SPIKE SAMPLE ANALYSIS**
**PAGE TWO**

* No spike required. NOTE: Elements without spike levels and not designated with an asterisk, must be spiked at appropriate levels.

1 The levels shown indicate concentrations in the final digestate of the spiked sample (200 mL) when the wet weight of 1 gram of sample is taken for analysis. Adjustment must be made to maintain these spiking levels when the weight of sample taken deviates by more than 10% of these values.

**TABLE 11-19**
**LEVEL C AND D PROTOCOL FOR CYANIDE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration (IC) | Reagent blank and 3 standards (minimum). One standard must be at the CRDL. At least one standard must be distilled. | Each analytical run. | • r $\leq$0.995<br>• Response factor of distilled standard must agree with undistilled standards within 15% | • Remake standards.<br>• Repeat calibration.<br>• If above fail, notify group leader. |
| ependent alibration Verification (ICV)/Lab Control Standard (LCS) | 1 independent, distilled standard to be run with the associated samples. | Immediately following each IC; one per batch of up to 20 samples. | %R = 85.0-115% | Reject the data from this batch |
| Independent Calibration Blank (ICB) | Reagent Blank (RB) | Immediately following each ICV | -CRDL <RB result <CRDL | • Prepare a fresh reagent reagent blank.<br>• Rezero or recalibrate as necessary. |
| Sample Analysis | 10 analytical samples (maximum) including the following | NA | NA | NA |

**TABLE 11-19**
**LEVEL C AND D PROTOCOL FOR CYANIDE**
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Method Blank (MB) | 1 per SDG or preparation batch, whichever is more frequent. | -CRDL <MB result <CRDL | • MB result >CRDL: Reject data for all samples for which CRDL ≤sample result <10 x MB result. Redistill samples.<br>• MB result <-CRDL: Reject data for all samples having results <10 x CRDL. Redistill the samples. |
| | Duplicate | 1 sample per matrix per SDG. (Do not select a field blank.) | • Both values ≤5 x CRDL: RPD ≤20.0%<br>• Both values <IDL: Precision is not calculated.<br>• At least one value <5 X CRDL and >IDL: Range <CRDL. | Flag all results for the element for samples associated with the duplicate with an "*". |
| | Matrix spike. (See Note 1 for spiking instructions.) | 1 sample per matrix per SDG. (Do not select a field blank.) | %R = 75.0-125% | Flag all results for the element for samples associated with the spiked sample with an "N". |

**TABLE 11-19**
**LEVEL C AND D PROTOCOL FOR CYANIDE**
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or an independent standard; it need not be redistilled. | Immediately following each set of up to 10 analytical samples or 2-hour period of analysis since the ICV or last CCV was run, whichever is more frequent. | %R = 85.0-115% | • Reject all data obtained since the last acceptable CCV or ICV.<br>• Troubleshoot the system and recalibrate. |
| Continuing Calibration Blank (CCB) | 1 reagent blank | Immediately following each CCV. | -CRDL <CCB result <CRCL | • Reject all data obtained since the last acceptable CCB or ICB.<br>• Troubleshoot the system and recalibrate. |
| Repeat samples, CCV, and CCB sequence until sample analyses are complete. Each run must end with conforming CCB and CCV. | | | | |

**TABLE 11-19**
**LEVEL C AND D PROTOCOL FOR CYANIDE**
**PAGE FOUR**

Note 1: 100 µg must be added per each liter of aqueous sample. If the sample volume is 500 mL, then 50 µg of cyanide must be added. If the volume is 50 mL, then 5 µg of cyanide must be added.

For soil samples, 25 µg of cyanide must be added per each gram of solid sample taken for analysis. The spiking level is dependent on the weight of the sample taken and the final distillate volume. If one gram of sample is taken for analysis and the final distillate volume is 250 mL, the distillate must contain cyanide at a concentration of 100 µg/L. If five grams of sample are taken, the distillate must contain cyanide at a concentration of 500 µg/L. Assuming a sample of one gram, the manual colorimetric method calls for a cyanide concentration of 25 µg per the 500 mL mixture of the sample, reagents, and water before distillation. The final distillate, in this case, contains cyanide at a concentration of 100 µg/L.

## 11.5 CALIBRATION AND QUALITY CONTROL FOR WET CHEMISTRY PARAMETERS

Calibration and quality control requirements are specified for CLEAN Level C analyses. Requirements for CLEAN Level D or E will be specified for individual analytes on a project-specific basis.

### 11.5.1 Level C Protocols for Instrumental Methods, and Manual Colorimetric, Turbidimetric, and Potentiometric Methods

Calibration and quality requirements for wet chemistry analyses by instrumental methods, and manual colorimetric, turbidimetric, and potentiometric methods under CLEAN level C are listed on Table 11-20.

### 11.5.2 Level C Protocols for Gravimetric Methods

Calibration and quality requirements for wet chemistry analyses by gravimetric methods under CLEAN Level C are listed on Table 11-21.

### 11.5.3 Level C Protocols for Manual Titrimetric Methods

Calibration and quality requirements for wet chemistry analysis by manual titrimetric methods under CLEAN level C are listed on Table 11-22.

## 11.6 INSTRUMENT DETECTION LIMITS (IDLs)

Instrument detection limits are determined for inorganic TALs by the procedures specified in the CLP inorganics statement of works. IDLs for other parameters are determined by the procedures specified in Appendix B to 40 CFR 136.

**TABLE 11-20**
**LEVEL C PROTOCOLS FOR INSTRUMENTAL AND MANUAL COLORIMETRIC, TURBIDIMETRIC, AND POTENTIOMETRIC METHODS***

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration (IC) | Instrument blank and 3 standards (minimum), with one standard at the reporting limit (RL). For initial calibrations that are not performed with each run, three aliquots of each concentration must be run and the average of the three aliquots used to calculate r. | Hexavalent chromium: annually<br>Nitrate: each run<br>Phosphorus: quarterly<br>Ammenable cyanide: annually<br>Sulfate: quarterly | • If $r \leq 0.995$, quantitate from the best fit line.<br>• If $r > 0.995$, draw the curve. If it is reasonable based on previous calibration, quantitate from the curve or its second order equation. If it is not reasonable, take the corrective actions listed. | • Remake standards and repeat initial calibration.<br>• If this fails, notify group leader. |
| Calibration Blank (CB) | 1 reagent blank used to set the zero point for the analysis. | At the start of each analytical run. | NA | NA |

* Applicable to instrumental techniques (autoanalyzer, ion chromatograph, TOC analyzer, etc.) and to manual colorimetric determinations of hexavalent chromium, nitrate, phosphorous, and ammenable cyanide; turbidimetric determination of sulfite; and potentiometric analyses.

**TABLE 11-20**
**LEVEL C PROTOCOLS FOR INSTRUMENTAL AND MANUAL COLORIMETRIC, TURBIDIMETRIC, AND POTENTIOMETRIC METHODS***
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration Verification (ICV)/ Lab Control Standard (LCS) | 1 independent standard. | Daily at the start of each run. | %R - 90.0-110% (85.0-115% for amenable cyanide) or within limits published in QC Test File, whichever is more stringent. | Repeat CCV analysis. If it fails, recalibrate prior to continuation of sample analysis. |
| Sample Analysis | Every 10 analytical samples or 12-hour period of analysis, whichever is more frequent, to include the following: | NA | NA | NA |
| | Method Blank (MB). Applicable to ammenable cyanide or solid matrices only. | 1 per preparation batch. | MB result < reporting limit (RL). | Reject all data from the batch for which RL ≤ sample result <10 x MB result. Qualify remaining results determination of fluoride and ammonia. |

**TABLE 11-20**
**LEVEL C PROTOCOLS FOR INSTRUMENTAL AND MANUAL COLORIMETRIC, TURBIDIMETRIC, AND POTENTIOMETRIC METHODS***
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate | 1 in 20 project samples per matrix. | See QC Test File. | Aqueous Samples: Rerun original and duplicate, and 25% of positive samples in this batch.<br>• If precision of initial and rerun sample results is:<br>- Within acceptance criteria, report the initial results for all samples in this batch.<br>- outside acceptance criteria, reject the initial results for all samples in this batch.<br>• If precision or rerun original and duplicate results is:<br>- within acceptance criteria: report the original rerun result. |

**TABLE 11-20**
**LEVEL C PROTOCOLS FOR INSTRUMENTAL AND MANUAL COLORIMETRIC, TURBIDIMETRIC, AND POTENTIOMETRIC METHODS***
**PAGE FOUR**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate (Continued) | | | Aqueous Samples: (Continued)<br>- outside acceptance criteria: report average of all results for the sample with qualification.<br>Non-Aqueous Samples: Report average of original and duplicate results with qualification. |
| | Matrix Spike (MS) | 1 in 20 project samples per matrix. | %R = 75.0-125% | Qualify the unspiked sample result to indicate the MS recovery. |
| Continuing Calibration Verification (CCV) | 1 standard (may be a calibration standard or an independent standard). | Immediately following each set of up to 10 analytical samples or 12-hour period of analysis, whichever is more frequent. | %R = 90.0-110% (85.0-15% for ammenable CN) or within limits published in QC Test File, whichever is more stringent. | • Reject all data obtained since the last acceptable ICV or CCV.<br>• Troubleshoot the system.<br>• Re-establish continuing calibration or recalibrate. |

**TABLE 11-20**
**LEVEL C PROTOCOLS FOR INSTRUMENTAL AND MANUAL COLORIMETRIC, TURBIDIMETRIC, AND POTENTIOMETRIC METHODS***
**PAGE FIVE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Repeat sample and CCV analysis sequence until sample analyses are complete. Each run must end with a conforming CCV. | | | | |

**TABLE 11-21**
**LEVEL C PROTOCOLS FOR**
**GRAVIMETRIC METHODS***

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Balance Calibration Verification | Weigh each of three balance weights covering the range of 10's of mg to 10's of grams. | Each day the balance is used. | Balance reading ±0.0005 gm of true mass of each weight. | • Rezero and repeat the measurements.<br>• If still nonconforming, recalibrate the balance and repeat the verification measurements.<br>• If still nonconforming, notify the group leader. Do not use the balance for sample analysis. |
| Calibration Blank | Verify the zero setting of the balance. | Prior to and following each measurement. | Balance reads 0.0000 gm. | Rezero and repeat the previous measurement. |
| Sample Analysis | Every 20 project samples or 12-hour period of analysis, whichever is more frequent, to include the following: | NA | NA | NA |

* Applicable to TDS, TSS, and oil and grease extraction/gravimetric determinations.

**TABLE 11-21**
**LEVEL C PROTOCOLS FOR**
**GRAVIMETRIC METHODS***
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Method Blank (MB): An aliquot of reagent water or solvent taken through the procedure. | With each set of up to 20 project samples run. | MB result < reporting limit (RL). | Reject all data from the batch for which RL ≤ sample result <10 x MB result. Qualify remaining results. |
| | Lab Control Standard (LCS): 1 independent standard. | With each set of up to 20 project samples run. | See QC Test File. | • Reject all data from the batch.<br>• Troubleshoot the analytical system. |
| | Duplicate | 1 in 20 project samples of similar matrix. | See QC Test File. | Aqueous Samples: Rerun original and duplicate, and 25% of positive samples in this batch.<br>• If precision of initial and rerun sample results is:<br>- within acceptance criteria, report the initial results for all samples in this batch. |

**TABLE 11-21**
**LEVEL C PROTOCOLS FOR**
**GRAVIMETRIC METHODS***
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate (Continued) | | | Aqueous Samples: (Continued)<br>- outside acceptance criteria, reject the initial results for all samples in this batch.<br>• If precision or rerun original and duplicate results is:<br>- within acceptance criteria: report the original rerun result.<br>- outside acceptance criteria: report average of all results for the sample with qualification.<br><br>Non-Aqueous Samples: Report average of original and duplicate results with qualification. |

**TABLE 11-22**
**LEVEL C PROTOCOLS FOR MANUAL TITRIMETRIC WET CHEMISTRY METHODS***

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Initial Calibration | Standardize the titrant against a primary standard. Perform in duplicate. | Chloride: monthly<br>Bromide: monthly<br>Alkalinity: monthly<br>COD: daily | Duplicate measurements must agree within 0.1 mL. | Repeat standardization until criteria are met. |
| Calibration Blank | 1 reagent blank used to set the zero point for analysis. | At the start of each analytical run. | NA | NA |
| Initial Calibration Verification (ICV)/ Lab Control Standard (LCS) | 1 independent standard. | Daily at the start of each run. | %R - 90.0-110% or within limits stated on the QC Test File, whichever is more stringent. | • Reject all data from the batch.<br>• Troubleshoot the analytical system. |
| Sample Analysis | Every 10 analytical samples or 12-hour period of analysis, whichever is more frequent, to include the following: | NA | NA | NA |
| | Method Blank (MB) - solid matrices only. | With each batch of up to 20 samples prepared for analysis. | MB result < reporting limit (RL). | Reject all data from the batch for which RL ≤ sample result <10 x MB result. Qualify remaining results. |

* Applicable to manual chloride, bromide, alkalinity, and COD determinations.

**TABLE 11-22**
**LEVEL C PROTOCOLS FOR MANUAL**
**TITRIMETRIC WET CHEMISTRY METHODS***
**PAGE TWO**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate | 1 in 20 project samples of similar matrix. | See QC Test File. | Aqueous Samples: Rerun original and duplicate, and 25% of positive samples in this batch.<br>• If precision of initial and rerun sample results is:<br>- within acceptance criteria, report the initial results for all samples in this batch.<br>- outside acceptance criteria, reject the initial results for all samples in this batch.<br>• If precision or rerun original and duplicate results is:<br>- within acceptance criteria: report the original rerun result. |

**TABLE 11-22**
**LEVEL C PROTOCOLS FOR MANUAL**
**TITRIMETRIC WET CHEMISTRY METHODS***
**PAGE THREE**

| SEQUENCE | IMPLEMENTATION | FREQUENCY | ACCEPTANCE CRITERIA | CORRECTIVE ACTION |
|---|---|---|---|---|
| Sample Analysis (Continued) | Duplicate (Continued) | | | - outside acceptance criteria: report average of all results for the sample with qualification.<br>Non-Aqueous Samples: Report average of original and duplicate results with qualification. |
| | Matrix Spike (MS) | 1 in 20 project samples of similar matrix. (Not applicable to alkalinity determinations.) | %R = 75.0-125% | Qualify the unspiked sample result to indicate MS recovery. |
| Continuing Calibration Verification (CCV)/ Lab Control Standard (LCS) | 1 standard (may be a calibration standard or ICV standard). | Immediately following each set of up to 10 analytical samples or 12-hour period of analysis, whichever is more frequent. | %R = 90.0-110% or within limits stated on the QC Test File, whichever is more stringent. | • Reject all data obtained since the last acceptable ICV/LCS or CCV/LCS.<br>• Troubleshoot the analytical system.<br>• Re-establish continuing calibration or recalibrate. |

## 11.7 PREPARATION OF BLANK SPIKE MATRICES

### 11.7.1 Blank Spike Water Matrix Preparation

Blank spikes for water matrices are prepared by spiking standard materials other than those used for calibration (i.e., from a different lot of material) into reagent water. Carbon-treated deionized water is used for organic parameters. The reagent water is prepared by passing tap water through a series of carbon and ion exchange resin beds. The deionizing system is monitored by a conductivity meter equipped with an audible alarm. The alarm sounds when the conductivity of the make-up water falls. Two sets of beds are maintained so that as one set of beds becomes exhausted, water flow can be diverted to a fresh set of beds.

### 11.7.2 Preparation of the Blank Spike Solid Matrix

Blank spikes for organic and wet chemistry parameters in soil or waste matrices are prepared by spiking standard materials other than those used for calibration into the blank spike solid matrix, which is sand that has been treated as described below to remove trace contamination.

- Blank Spike Solid Matrix for Organic Parameters (by GC)

  The sand is washed sequentially with hexane, methylene chloride, and methanol to remove trace contaminants. The sand is then dried at 180°C to volatilize the solvent. The dried sand is stored in glass jars that have been cleaned in the same manner as the sand. The jars are sealed with Teflon tape and stored in a desiccator.

- Blank Spike Solid Matrix for Miscellaneous Inorganic Parameters

  The sand is thoroughly rinsed with tap water followed by deionized water. The cleaned sand is dried at 180°C, then stored in glass jars that have been cleaned in the same manner as the sand. The jars are sealed with Teflon tape and stored in a desiccator.

An unspiked aliquot of each lot of the solid matrix is assayed to check for residual trace contamination prior to its use in sample analysis. If contamination is present, the sand is cleaned and assayed again. If contamination persists at a constant, baseline level, the solid matrix may be used so long as the true value of the spiked blank spike is adjusted to account for the presence of the analyte.

Blank spikes for metals parameters in soil or waste matrices are NIST or commercially prepared reference materials. If an analyte parameter is not included in the reference material, an aqueous blank spike is prepared and taken through the soil/waste digestion procedure.

## 11.8 CONTROL LIMITS FOR BLANK SPIKES

Control limits for blank spikes are based on actual data generated in the laboratory, with criteria from the Contract Laboratory Program (CLP) Statement of Work providing minimum criteria. Internally established control limits are based on the most recent 20 to 100 values for precision and accuracy obtained for the parameter. LSG Procedure QA-8, Laboratory Quality Control, describes LSG's procedures for calculating precision and accuracy. The method for calculating control limits is summarized in Section 3.2 of the procedure. This section also discusses the treatment of outliers.

Control limits will be calculated when 20 points have been generated for a parameter, and will be updated semi-annually thereafter if 5 or more new points have been generated since statistics were last calculated.

New limits are tested by determining the percentage of points falling in the $x \pm s$ range. It is expected that ~64 percent of the points will fall within this range. If <50 percent of the points fall in the range, additional method development is performed to ensure that the analytical system is under control.

## 11.9 CONTROL CHARTS FOR BLANK SPIKES

Blank spike recoveries will be plotted on control charts. % Recovery will be plotted on the Y-axis, and the batch number (if the data are "batched" in the LIMS) or date of analysis will be plotted chronologically, by date of analysis, on the X-axis.

The analytical system is out of control and corrective action is required wher. .v-r 1 point is outside the control limits or 2 consecutive points are outside the warning limits.

# 12.0 OUT-OF-CONTROL EVENTS AND CORRECTIVE ACTION

An anomalous event that is contrary to good laboratory practice and/or the requirements of LSG's quality assurance program and this quality assurance plan is an out-of-control event. The treatment of these events is outlined through the examples that follow.

## 12.1 CORRECTIVE ACTION DURING CHECK-IN

The Log-in Clerk or Sample Custodian checks the samples, field, trip, and rinsate blanks against the shipping document or field chain-of-custody. If discrepancies exist, he/she will document them and notify the Laboratory Project Manager. The Laboratory Project Manager will then notify the Baker Project Manager and attempt to resolve the discrepancies. All communication is documented. (See Section 3.8 of LSG Procedure QA-7 [Appendix D]).

## 12.2 CORRECTIVE ACTION DURING ANALYSIS

Prior to and during sample analysis, the analyst monitors the analytical system to ensure that the elements critical to producing data of acceptable quality (tune, initial calibration, calibration verification, method blank results, results of matrix spike/matrix spike duplicate analyses, etc.) meet the specified criteria. If a criterion is not met, the analyst takes the appropriate corrective action, and documents the event and the corrective actions as detailed in LSG Procedure QA-15, Corrective Action (Appendix I), Section 3.1.

# 13.0 DOCUMENT CONTROL

The control of documents is outlined in Section 6.0 of this plan in conjunction with the following LSG Procedures.

- QA-7, Laboratory Sample Tracking (Appendix D)
- QA-20, Quality Assurance Records (Appendix J)

# 14.0 DATA REDUCTION, EVALUATION, AND REPORTING

## 14.1 DATA REDUCTION

Data reduction, evaluation, and reporting is detailed in LSG Procedure QA-10, Data Handling. (See Appendix K.)

## 14.2 DELIVERABLES

| QA LEVEL | METHOD REQUIREMENT | DELIVERABLES |
|---|---|---|
| All Level D Organics | | Case narrative (cross-reference table showing client ID, lab ID, sample matrix, dates of sample collection, dates of sample receipt, and required analyses). Deliverables specified by CLP plus method blank spike or LCS control charts. |
| Level D Metals | | Deliverables specified by CLP plus method blank spike or LCS control charts. |
| Level D Cyanides | | Deliverables specified by CLP plus method blank spike or LCS control charts. |
| Level C Organics | Case comments | As per Level D |
| | Method blank spikes | Control chart |

| QA LEVEL | METHOD REQUIREMENT | DELIVERABLES |
|---|---|---|
| Level C Organics (Continued) | Sample results | Form I if TCL; modified Form I if priority pollutants; otherwise LIMS report, Section A (see Figure 14-1); sample chromatograms and enhanced and unenhanced mass spectra for positive identifications. Enhanced spectra for continuing calibration associated with positive identifications. |
| | Surrogate Recovery | Form II if TCL or priority pollutants; otherwise LIMS report, Section C (see Figure 14-2). |
| | Matrix spike/matrix spike duplicate; 1 in 20 per matrix | Forms III and I if TCL; Form III and modified Form I if priority pollutants; otherwise, LIMS report, Section H (see Figure 14-3). |
| | Method blank | Forms IV and I if TCL; modified Form IV and I if priority pollutants; otherwise, LIMS report, Section E (see Figure 14-4) |
| | GC/MS tuning | Form V. |
| | Initial calibration data | Form VI for GC/MS analyses; Form IX for GC analyses (TCL and priority pollutants); otherwise, Figure 14-5 (instrument-generated print-outs providing all of the required information may be substituted). |

| QA LEVEL | METHOD REQUIREMENT | DELIVERABLES |
|---|---|---|
| Level C Organics (Continued) | Continuing calibration data | Form VII for GC/MS analyses; Form IX for GC analyses (TCL or priority pollutants); otherwise, Figure 14-6 (instrument generated print-outs providing all of the required information may be substituted). |
| | Internal standard area | Form VIII |
| | Second GC column confirmations | Chromatograms for confirmations. |
| | TICs (if requested) | Enhanced and unenhanced spectra. Comparison of enhanced spectra to 3 best library matches. |
| Level C Metals | Case comments | As per Level D. |
| | Sample results | Form I |
| | Initial and continuing calibration | Form II, Part 1. |
| | Calibration blanks | Form III. |
| | Method blank taken through digestion | Form III. |
| | ICP interference check sample | Form IV. |
| | Matrix spike recovery, 1 in 20 per matrix | Form V, Part 1. |
| | Post-digestion spike sample recovery | Form V, Part 2 except for GFAA; GFAA percent recovery documented on raw data. |
| | Duplicates | Form VI. |
| | Method blank spike (LCS) | Control chart. |
| | Standard addition | Form VIII. |

| QA LEVEL | METHOD REQUIREMENT | DELIVERABLES |
|---|---|---|
| Level C Metals (Continued) | Holding times | Form X (or XIV, as appropriate). |
| Level C Miscellaneous Inorganics | Case comments | As per Level D. |
| | Method blank spike | Control charts plus LIMS report, Section D (see Figure 14-7). |
| | Method blank | LIMS report, Section E. |
| | Duplicate/matrix spike, 1 in 20 per matrix | LIMS report, Section F (see Figure 14-8). |
| | Calibration verification (initial and continuing) | LIMS report, Section E - comments section (report %D). |
| | Dates of preparation and analysis | LIMS report, Section B (see Figure 14-9). |
| Level E All Parameters | Case comments | As per Level D. |
| | Sample results | LIMS report. |
| | Surrogates | LIMS report, Section C. |
| | Method blank spike | Control charts plus LIMS report, Section D. |

**FIGURE 14-1**

Date:
Report No.:
Section A Page 1

LABORATORY ANALYSIS REPORT

CLIENT NAME:
ADDRESS:

ATTENTION:

SAMPLE ID:
HALLIBURTON NUS SAMPLE NO.:
P.O. NO.:

HALLIBURTON NUS CLIENT NO.:
WORK ORDER NO.:
VENDOR NO.:

DATE SAMPLED:
DATE RECEIVED:
APPROVED BY:

| LN | TEST CODE | DETERMINATION | RESULT | UNIT |
|---|---|---|---|---|

COMMENTS:

**FIGURE 14-2**

Date:
Report No.:
Section C Page 1

QUALITY CONTROL REPORT
SURROGATE STANDARD RECOVERY

| LN | TEST CODE | SURROGATE COMPOUND | PERCENT RECOVERY | ACCEPTANCE LIMITS | REF LN |
|---|---|---|---|---|---|

SAMPLE ID: HALLIBURTON NUS SAMPLE NO.:

**FIGURE 14-3**

Date:
Report No.:
Section H Page 1

QUALITY CONTROL REPORT
MATRIX SPIKE AND MATRIX SPIKE DUPLICATE DATA

---

ANLS BATCH: HALLIBURTON NUS SAMPLE NO.:

| Test | Determination | MS Result | MSD Result | Units | RPD | MS PCT Recovery | MSD PCT Recovery |
|---|---|---|---|---|---|---|---|

**FIGURE 14-4**

Date:
Report No.:
Section E Page 1

QUALITY CONTROL REPORT
METHOD BLANK DATA

| Test Code | Determination | Result | Units |
|---|---|---|---|
| Batch: | Sample ID: Method Blank | HALLIBURTON NUS Sample No.: | |
| Batch: | Sample ID: Method Blank | HALLIBURTON NUS Sample No.: | |
| Batch: | Sample ID: Method Blank | HALLIBURTON NUS Sample No.: | |

# FIGURE 14-5
# INITIAL CALIBRATION DATA

DATE:_____ INSTRUMENT:_____

ANALYST:_____ COLUMN:_____

| COMPOUND | STD. ID. NO. | STD. CONC. | RESPONSE | RESPONSE FACTOR(RF) | $\bar{X}_{RF}$ | $S_{RF}$ | RSD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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| | | | | | | | |

* IF RSD $\leq$ 10%, USE $\bar{X}_{RF}$ TO CALCULATE SAMPLE RESULTS. IF RSD > 10%, DRAW A CALIBRATION CURVE AND CALCULATE SAMPLE RESULTS FROM THE CURVE.

REVIEWED BY_____

DATE_____

# FIGURE 14-6
# CONTINUING CALIBRATION VERIFICATION

CONTINUING CALIBRATION CURVE UPDATE

FRACTION _____ ANALYST _____

DATE OF ORIGINAL CURVE _____ STANDARD I.D.# _____

DATE OF CURVE UPDATE _____ BOOK/PAGE _____

INSTRUMENT _____ RUN # _____

| COMPOUND | THEO. RESULT ( ) | ACTUAL RESULT ( ) | % DIFFERENCE |
|---|---|---|---|
| | | | |
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| | | | |

COMMENTS _____

_____

% DIFFERENCE MUST BE $\leq$ 15 % CHECKED BY _____

**FIGURE 14-7**

Date:
Report No.:
Section D Page 1

QUALITY CONTROL REPORT
LABORATORY CONTROL SAMPLE RECOVERY

| Test Code | Determination | Percent Recovery | Acceptance Limits |
|---|---|---|---|

Batch: Sample ID: Lab Control Sample HALLIBURTON NUS Sample No.:

**FIGURE 14-8**

Date:
Report No.:
Section F Page 1

QUALITY CONTROL REPORT
DUPLICATE AND MATRIX SPIKE DATA

---

Prep Batch: HALLIBURTON NUS Sample No.:

| Test | Determination | Original Result | Duplicate Result | Units | Range/ RPD | Units | MS Result | MS % Rcvry |
|---|---|---|---|---|---|---|---|---|

**FIGURE 14-9**

Date:
Report No.:
Section B Page 2

QUALITY CONTROL REPORT
SUPPLEMENTAL INFORMATION

| | | | ------Sample Preparation---------- | | | ----------Sample Analysis---------- | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LN | Test Code | Batch | LR-Method | Date/Time | Analyst | LR-Method | Date/Time | Analyst | Anls Batch | Instrument |

Sample ID: HALLIBURTON NUS Sample No.:

LR Method Literature Reference

## 14.3 MONTHLY PROGRESS REPORTS

A monthly progress report (MPR) will be prepared for each CLEAN project throughout the duration of the contract, regardless if samples are received during a particular month. The LSG Project Manager at each facility will prepare MPRs for the work performed at their facility. If a project is split, the lead facility's Project Manager will prepare the MPR for the project.

Each MPR will be specific to one CLEAN project and will contain the following information.

a) Cover letter identifying the CLEAN project, contract number and task number (obtained from the Contracting Officer) and report period.

b) For samples received during the month:

- Identification of CLEAN samples by sample number, laboratory number, matrix, date sampled, date received, and analysis required.
- Identification of samples sent to other laboratories or facilities.
- Copies of signed field chain-of-custody forms.

c) For data packages delivered during the month:

- Copies of pertinent control charts.
- Summary of out-of-control incidents and corrective actions taken from the case narratives.
- Summary tables for all samples showing dates of extraction and analysis, or a tabular presentation of dates of extraction and analysis.

d) Description of and justification for any significant changes in QA/QC related to CLEAN samples.

e) Identification of any new methods or changes to old methods.

f) Description of changes in QA or other key personnel along with resumes.

g) Significant changes to the laboratory (e.g., new instrumentation, laboratory expansion).

Monthly reports are delivered to the Martin Marietta Analytical Quality Control Specialist for the project on or before the 15th of the following month. A copy of the cover letter is also delivered to the CLEAN Project Manager and the Martin Marietta Quality Assurance Manager.

# 15.0 INTERNAL AUDITS AND APPROVALS

## 15.1 PERFORMANCE AUDITS

Blind and double-blind quality control samples are submitted for analysis on a scheduled basis by the LSG Quality Assurance Department. Acceptance limits are based on the limits published by EPA for its QC samples or on LSG's internal quality control limits for in-house standards. If acceptance limits are not met, the analysis is repeated. If results remain out of control, corrective action, such as analyst retraining, is required.

## 15.2 SYSTEM AUDITS

LSG's program for conducting internal audits and the corrective action process applied to audit findings is described in Appendix L. In addition, LSG is audited regularly by several laboratory certification agencies and by private clients. Findings from these external audits undergo the same corrective action process as internal audit findings.

## 15.3 FEDERAL AND STATE APPROVALS

LSG also participates in a number of performance evaluation studies for various laboratory certification/approval programs, which are listed below. The results of the studies are available upon request.

- California Department of Health Services - Hazardous waste certification (Pittsburgh and Houston)
- Florida Department of Health and Rehabilitative Services - Wastewater certification program (Houston)
- New York State Department of Health - Wastewater and solid wastes certification programs (Pittsburgh)
- North Carolina Department of Natural Resources and Community Development - Wastewater (Pittsburgh and Houston)
- Nuclear Regulatory Commission - Class B Broad Scope materials license (Pittsburgh)

- Oklahoma Water Resources Board - Wastewater certification program (Houston)
- Pennsylvania Department of Environmental Resources - Drinking water certification program (Pittsburgh)
- State of New Jersey, Department of Environmental Protection - Wastewater and drinking water certification programs (Pittsburgh)
- Texas Water Commission - Wastewater analyses approval (Houston)
- South Carolina Department of Health and Environmental Control - Hazardous waste and wastewater certification program (Pittsburgh and Houston)
- Hazardous Waste Remedial Action Program (HAZWRAP) - Approval (Houston and Pittsburgh)
- Tennessee Department of Conservation - Approval for underground stroage tank analyses (Houston and Pittsburgh)

# 16.0 QA OBJECTIVES FOR MEASUREMENT DATA

The EPA defines data quality in terms of its representativeness, accuracy, precision, completeness, and comparability to previous sets of data. HALLIBURTON NUS' approach to each component of data quality is discussed below.

16.1 **Representativeness** describes the degree to which analytical data accurately and precisely represent the material or waste stream being measured. Several elements throughout the sampling and sample handling process must be controlled to maximize the representativeness of analytical data. They include sample collection, sample preservation, the time lapse between sampling and analysis, and subsampling for analysis. Sample preservation, and storage are discussed in Section 6.0 of this document. To ensure that sample aliquots taken for analysis are representative, samples will be homogenized by removing non-representative materials (e.g., sticks and stones), then stirring, shaking, crushing, and/or blending the sample as appropriate to the matrix. If a sample cannot be homogenized adequately by these means, as with multiphase samples for example, HALLIBURTON NUS will contact Baker to establish a means of handling the sample acceptable to both parties.

16.2 **Accuracy** describes the difference between experimental results and true values known or assumed). Accuracy is expressed as the percent recovery of standards and matrix spikes. Standards measure the bias of the analytical system - reagents, equipment, instrumentation, and analyst technique. Matrix spikes and surrogate standards measure sample matrix effects as well as the analytical system bias. In general, therefore, daily standards are used to monitor and control the analytical system, while matrix spikes are used to screen for matrix effects.

Acceptance criteria for accuracy are established as described in Appendix H, Section 3.2.

Blank analyses also monitor and control the basis of the analytical system by measuring trace levels of contamination. In general, blanks containing the target analyte(s) at levels at or above the detection limit are considered out of control, and sample results from the detection limit to ten times the level of blank contamination are rejected. An exception to this is taken from the USEPA Contract Laboratory Program protocols: common laboratory solvents or phthalates may be present in a blank at levels up to five times the detection limit of the compound before data is rejected.

16.3 **Precision** describes the reproducibility of measurements of a sample for the same parameter under the same or similar conditions. Precision is expressed as range (the difference between two values) or as relative difference (the range relative to the mean expressed as percent). Acceptance criteria for precision are established as described in Appendix H, section 3.2.

16.4 **Completeness** describes the amount of data generated that meets the objectives for representativeness, accuracy, and precision versus the amount of data expected to be obtained. For relatively clean, homogeneous matrices, HALLIBURTON NUS expects 100 percent completeness. As matrix complexity and heterogeneity of the sample matrix increases, completeness may decrease.

16.5 **The comparability** of HALLIBURTON NUS' data to previously generated data will be maximized by the use of approved, standardized methodologies whenever they are available. HALLIBURTON NUS will also express data in units commonly used for environmental measurements. Levels D and C results are expressed on a dry-weight basis along with a percent-moisture value so that they can be converted to wet-weight concentrations. Level E results are reported on a wet-weight (as received) basis along with percent moisture so that the results can be converted to dry-weight concentrations, if desired.

# 17.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality assurance reports to management are described in LSG Procedure QA-16 (Appendix M).

# ATTACHMENT B

# LABORATORY QUALITY ASSURANCE PLAN

# HALLIBURTON NUS ENVIRONMENTAL CORPORATION

## LABORATORY SERVICES GROUP

## GENERAL QUALITY ASSURANCE PLAN

## VOLUME II

## APPENDICES

HALLIBURTON NUS
*Environmental Corporation*

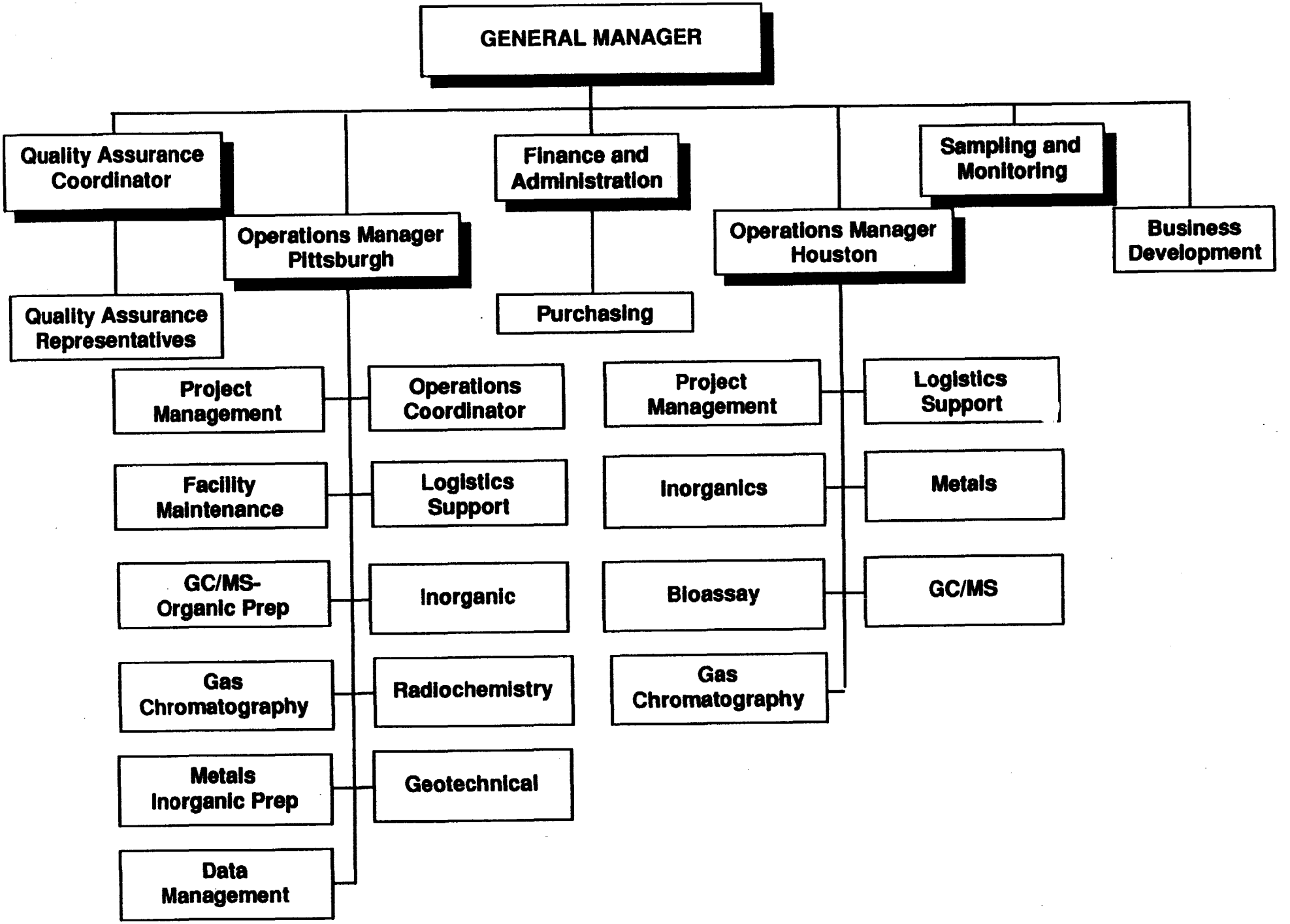
## APPENDICES

| | |
|---|---|
| A | LSG Organizational Structure |
| B | Professional Resumes |
| C | LSG Procedure, QA-17, Training Program |
| D | LSG Procedure QA-7, Laboratory Sample Tracking |
| E | LSG Procedure QA-19, Materials and Facility Control |
| F | LSG Procedure LWD-1, Laboratory Waste Disposal |
| G | LSG Procedure QA-13, Preventive Maintenance, and Appendix J to the LSG General Quality Assurance Plan |
| H | LSG Procedure QA-8, Laboratory Quality Control |
| I | LSG Procedure QA-15, Corrective Action |
| J | LSG Procedure QA-20, Quality Assurance Records |
| K | LSG Procedure QA-10, Data Handling |
| L | LSG Procedure QA-11, Systems Audits |
| M | LSG Procedure QA-16, Quality Assurance Reports to Management |

# APPENDIX A

# LSG ORGANIZATIONAL STRUCTURE

# HALLIBURTON NUS - LABORATORY SERVICES GROUP



# APPENDIX B

# PROFESSIONAL RESUMES

Anders, K.
Beyer, L.
Capp, R.
Chen, S.
Clepper, J.
Colbert, T.
Elkin, D.
Green, S.
Hearne, M.
Howbert, B.
Kieda, C.
Kohl, D.
Komm, R.
Kovach, C.
Kuhn, J.
Lehman, J.
Lin, S.
Lynch, P.
MacGregor, R.
Malzone, G.
Manning, L.
Mayo, S.
Meyer, D.
Mikus, J.
Miller, J.
Motley, E.
Papenmeier, P.
Perrigo, J.
Rieseck, M.
Rose, D.
Samchuck, J.
Saracena, P.
Scoullos, E.
Simanic, J.
Sommers, E.
Taylor, R.
Whartenby, R.

# KEVIN L. ANDERS

## QUALITY ASSURANCE REPRESENTATIVE

## EDUCATION

Houston Community College,
A.A.S., Medical Laboratory Technology, 1985
University of Houston,
Chemistry major, 1976-1980

Houston Community College,
Course in Audio Engineering, 1990
Course in Organic Chemistry, 1986

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1991-Present
Mobay Synthetics Corporation, 1986-1991
Roche Biomedical Laboratories, 1985-1986
Marshall Field & Company, 1983-1985

Serves as quality assurance representative. Responsible for routine quality control data review to isolate potential analytical problems. Performs program monitoring to ensure that procedures are followed correctly and meet quality assurance/quality control (QA/QC) requirements. Assists with external audits.

## RELATED EXPERIENCE

As a research assistant, helped ensure compliance with customer requirements for synthetic rubber, performed full physical testing on new developing products, kept detailed records and generated reports using spreadsheet and word processing software, and developed a new test method for measuring crystallization rate of synthetic rubber.

As a medical laboratory technician, ran radioimmunoassays for specific hormones and enzymes and assays for glycosylated hemoglobin.

H05281

# LANA J. BEYER

## GROUP LEADER, ATOMIC ABSORPTION

## EDUCATION

University of Houston,
M.S., Environmental Management, 1979
University of Delaware,
M.A., American Economic History, 1974
University of Delaware,
B.A., History, 1963

Fred Pryor Seminar,
Basic Supervision, 1985
Perkin-Elmer Corporation,
Inductively Coupled Plasma Atomic Emission Training Course, 1985
San Jacinto Junior College,
Introduction to Personal Computers, 1988
Chemistry courses, 1982

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1984-Present
PSI/Shilstone, 1983-1984
HALLIBURTON NUS Environmental Corporation, 1980-1983

Serves as group leader for the metals laboratory, supervising and training chemical analysts engaged in the performance of metals determinations. Specializes in the chemical analysis of environmental and industrial hygiene samples for metals by atomic absorption spectrophotometry (AA) and inductively coupled plasma spectrometry (ICP) using Instrumentation Laboratories' 151 and 251 dedicated flame atomic absorption units, an Instrumentation Laboratories' 655, and a Perkin-Elmer atomic absorption/inductively coupled plasma 5500 with HGA 500 graphite furnace.

## RELATED EXPERIENCE

Served as group leader of the inorganic laboratory. Assigned work and supervised analysts in the performance of all water quality analyses including total organic carbon and total organic halogens; bacteriological analyses including standard plate count, total coliform, fecal coliform, and sulfate reduction; oil analyses including ashing, PCBs, oxygen bomb preparation, sulfate, chloride, and viscosity; soil, sludge, and sediment analyses including total organic carbon, total organic halogen and all physical tests; mercury analysis by cold vapor technique; cyanide analysis; and analysis of samples for Resource Conservation and Recovery Act (RCRA) hazardous waste characteristics including corrosivity, ignitability, reactivity, and EP toxicity.

Served as part of a collaboration of analysts brought together by the EPA to decide the ramifications of the new toxic characteristic leaching procedure (TCLP) which replaced the EP toxicity test for RCRA characteristics. This procedure changes the requirements for compliance to RCRA regulations. Attended collaborative meetings held by the EPA in San Diego, California, and Washington, D.C. Works extensively with clients in interpreting the new requirements for conformance to RCRA regulations. Trains and supervises analysts in the performance of this new procedure.

Extensively involved in the development of special sample preparation techniques for inorganic analyses. Some of these sample preparation techniques are expected to be adapted for the preparation of samples for organic analyses.

- Performed inorganic chemical analyses of environmental samples by colorimetric, gravimetric, and volumetric methods of analysis and has used UV-visible spectrophotometers, atomic absorption (AA) spectrophotometers, organic carbon analyzers, and organic halide analyzers. Has extensive experience in the use of flame and graphite furnace AA as well as inductively coupled argon plasma (ICP).

- Implemented and maintains quality control measures in the inorganic and metals laboratories.

- Meets with clients to aid them in understanding and interpreting various government regulations.

- Orchestrated the analyses of special requests parameters by evaluating the best available methods for sample preparation and analysis and supervising the performance of that analysis.

## MEMBERSHIPS

Water and Wastewater Analysts Association

H04251

# RICHARD J. CAPP

## GROUP LEADER, GAS CHROMATOGRAPHY

## EDUCATION

West Virginia University
B.A., Chemistry (Pre-Medicine), 1972
University of Maryland, Baltimore County
Graduate Studies, 1975-1978

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1991-Present
Calgon Corporation, Research Chemist, 1981-1991
City of Baltimore, Maryland, Organic Lab Supervisor, 1978-1981

As the group leader of the gas chromatography section, is responsible for the supervision of personnel in the analysis of water, wastewater, and sediments for the presence of pesticides, herbicides, PCBs, volatiles, and gases using gas chromatography (GC) and high performance liquid chromatography (HPLC) techniques. Oversees the entire process involved in the sample analysis including analysis by gas chromatography and reporting of results. Responsibilities include the training of laboratory personnel, the implementation of the quality control program, the review of data generated in the laboratory, the routine maintenance of the instruments as well as the development of new procedures, and the analyses of samples for nonroutine parameters.

Experience with U.S. Contract Laboratory Program (CLP) protocols includes a working knowledge of 2/88 SOW.

## RELATED EXPERIENCE

As supervisor of an analytical laboratory for 3 years had complete responsibility for all activity including:

- Training technical employees on the operation of the GC/MS complex, GC, HPLC, and extraction procedures.
- Educating staff in analytical procedures necessary to produce a definitive GC and/or GC/MS result (screening, confirming, and quantitative procedures).
- Coordinating all routine and emergency laboratory activity.
- Acting as primary technical supervisor and reviewing all GC and GC/MS work.

- Performing organic extractions.
- Performing GC analysis of organics utilizing several detectors.

**MEMBERSHIP**

American Chemical Society
Spectroscopy Society of Pittsburgh
Society of Analytical Chemists of Pittsburgh

P04291

# SIOK HONG CHEN

## GROUP LEADER

## EDUCATION

University of Houston,
Chemistry, 1986-1987
Texas A & M University,
B.S., Marine Biology, 1984
Cottey College,
Associate of Arts, Biology, 1982

Finnigan MAT Institute,
Formaster training course, 1991
Mass Spectra Interpretation, 1987
Hewlett Packard,
Gas Chromatography, 1986

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
Texas A & M University, 1982-1984

Reviews data acquired by the gas chromatography/mass spectrometry laboratory. Verifies target compound identification and quantification for sample results on both CLP and routine samples. Identifies and quantifies unknown compounds via NIST library search utilizing USEPA CLP protocols.

## RELATED EXPERIENCE

As a chemist in the gas chromatography/mass spectrometry (GC/MS) laboratory, performed analyses for organic contaminants on a wide range of matrices including waters, medium and low-level concentration soils, sediments, sludges, and air. Performed routine instrument maintenance and troubleshooting.

H07221

# JAMES W. CLEPPER

## INSTRUMENT SERVICE ENGINEER

## EDUCATION

University of Houston,
School of Technology, Studies in Machine Drafting
and Electrical Engineering, 1952 - 1955

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1981 - Present
Finnigan Instruments, 1974-1981
Northrup Services, Inc., NASA-Johnson Space Center, 1965-1974
Schlumberger Well Surveying Corporation, 1947-1965
U. S. Navy, Submarine Service, 1941-1947

Serves as the Instrument Service Engineer for the HALLIBURTON NUS laboratory. Responsibilities include maintaining, calibrating, and repairing major laboratory instrumentation. These instruments include gas chromatograph/mass spectrometers (GC/MS) and accompanying data systems; gas chromatographs (GC); flame and graphite furnace atomic absorption (AA) spectrometers; UV-visible spectrophotometers; total organic halogen, infrared, and total organic carbon analyzers; pH/mv meters; chart recorders; turbidimeters; GC data systems; and conductivity meters.

## RELATED EXPERIENCE

- Served as Quality Assurance Coordinator for the HALLIBURTON NUS Houston Laboratory. Responsibilities included ensuring implementation of the quality assurance/quality control (QA/QC) program; reviewing QC data and performing statistical analyses on the data; and submitting performance evaluation samples for analysis to determine method, instrument, and analyst performance.

- Served as a service supervisor for a major analytical instrument manufacturer in a seven state area of the Southwestern United States. Responsibilities included assigning work to five service engineers and preparing personnel reviews, annual budgets, and monthly status reports on equipment installations, product problems, and customer relations. Was also responsible for providing technical support and training of service engineers and customers as well as installing, calibrating, troubleshooting, and repairing instrumentation.

- Was a systems specialist for a space environment simulation laboratory. Responsible for schedule planning and supervising three lead technicians and 10-30 additional technicians invc...d in the installation, maintenance, calibration, and operation of all thermal vacuum instrumentation, quadrupole residual gas analyzers, leak detectors, and magnetic mass spectrometers. These instruments were used as part of a thermal vacuum test conducted in the simulation laboratory chambers.

- Served as a laboratory technician with an oil well surveying firm. Compiled neutron log departure data used to plot curves and assisted in the construction of American Petroleum Institute neutron log calibration pits.

- Designed and constructed a hot cell used for protection from gamma and neutron sources.

## MEMBERSHIPS

Water and Wastewater Analysts Association

H06251

# TRACEY L. COLBERT

## GROUP LEADER, WET CHEMISTRY

## EDUCATION

University of Pittsburgh,
B.S., Chemistry, 1990
Community College of Allegheny County,
A.S., Chemistry, 1986

Pennsylvania State University
Applying Aquatic Chemistry to Concepts of Environmental Engineering, 1986
LaRoche College,
Courses in natural science, 1980-1981
Radio Shack, Inc.
Basic Operating Theory and Programming for the Radio Shack TRS-80 Computer, 1982
Parkway West Area Vocational Technical School,
Certificate of completion as research laboratory assistant, 1977

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1977 - Present

As group leader of the wet chemistry laboratory, is responsible for the general supervision and training of analysts, scheduling analyses to meet holding times and project requirements, review of laboratory data, and implementation of the quality control program, including routine instrument maintenance.

Additional capabilities include the following:

- Extensive experience in wet chemistry analyses, including colorimetric, titrimetric, gravimetric, and distillation procedures. Also experienced in the use of specific ion electrodes to perform ammonia, total Kjeldahl nitrogen, fluoride, and nitrate analyses and oxidation-reduction potential. Performs cyanide analyses using USEPA Contract Laboratory Program protocols.

- Experience in instrumentation, including the use of UV-visible and infrared (IR) spectrophotometers, pH/mv meters, infrared-oxidation-type total organic carbon analyzers, total organic halogen analyzers, and gas chromatographs. Experience in mercury analyses using a flameless-cold vapor atomic absorption technique and oil and grease analyses using an infrared spectrophotometer.

- Chemical tests on fly ash to determine specifications.
- Analysis of charcoal for iodine number and sieve distribution.
- Bacteriological analyses, including total plate count, total coliform, fecal coliform, and fecal streptococcus, on water samples.

## MEMBERSHIPS

Society for Analytical Chemists of Pittsburgh
American Chemical Society

P04291

# DAVID M. ELKIN

## TECHNICIAN, WET CHEMISTRY

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1987-Present

As a technician in the inorganics laboratory, is experienced in a variety of wet chemistry techniques including colimetric, gravimetric, titrimetric, and distillation procedures. Specific analyses include sulfite, surfactants, thiocyanate, thiosulfate, TOC, phenolics, cyanide, ammonia, nitrogen, TOX, Langlier Saturation Index, TKN, Soxhlet extractions, hexavalent chromium, and more. Experience with USEPA Contract Laboratory Program (CLP) protocols includes 2 years for percent moisture and 2 years for pH for organic extraction.

Microbiological tests include standard plate count, total coliform, fecal coliform, fecal streptococcus, and sulfate reducing bacteria.

### RELATED EXPERIENCE

Performed mercury determinations by the cold vapor technique.

# SANDRA L. GREEN

## GROUP LEADER
## DATA MANAGEMENT GROUP

## EDUCATION

University of Houston at Clear Lake,
Post-graduate chemistry courses, 1980-1982
Post-graduate course on database processing, 1987
Austin College,
B.A., Biology, 1976
University of Houston, Central Campus,
Summer courses toward B.A. degree, 1972 and 1974

Mardis and Associates,
Time Management Seminar, 1988
Pittsburgh Conference and Exposition, Alan-Braithwaite of
Trent Polytechnic, U.K.,
Mini-Course on LIMS, 1987
Success Builders,
Successful Collection Techniques, 1987
The Business Woman's Training Institute,
Communications and Image Skills Seminar, 1987
Women in Supervision, 1985
Finnigan School,
GC/MS Seminar Series, 1983-84
INCOS Operator Course, 1981
GC/MS Priority Pollutant Course, 1980
J. T. Baker Chemical Co.,
The Hazardous Chemical Safety Seminar, 1981
Varian Instruments,
Gas Chromatography Course, 1978

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1978-Present
Metabolic, Inc., 1976-1977
Gulf Coast Waste Disposal Authority (Bayport Plant),
Summer 1974

Oversees all data management in support of laboratory management as follows: preparation and review of HAZWRAP, CLP, and other special project data packages; delivery of project packages per deadlines; maintenance of project records; thorough knowledge and application

of Finnigan Formaster software, Telecations Enviroforms software, as well as other required software; client interfacing as needed; training and supervision of data management personnel.

## RELATED EXPERIENCE

- Served as Administrative Operations Group Leader responsible for all activities in Central Receiving (Logistics) as follows: accounting, financial, and management reports; purchasing; computerized LIMS data entry, report/invoice generation, final approval, and delivery; clerical services, office automation, recordkeeping; delivery and pick-up services, truck maintenance; shipping, receiving, and bottle preparation; sample custody, storage, and disposal; CLP packages; client interfacing; and personnel training.

- Served as second shift supervisor of laboratory operations. In this capacity, interfaced with clients, received samples, and made decisions on laboratory operations during the second shift.

- Performed organic extractions, gas chromatography analyses, gas chromatography/mass spectrometry analyses, and wet chemical and instrumental procedures.

- Maintained an animal testing laboratory. Observed laboratory animals for pyrogenic reactions to serum-related products; injected mice, rabbits, and guinea pigs; and kept records. Contributed to invitro analyses and autopsies of laboratory specimens for research of rubella and mumps.

## MEMBERSHIPS

Water and Wastewater Analysts Association (Secretary, 1980-1981 term)
Texas Water Utilities Association
National Association of Female Executives (NAFE)

H06201

# BRUCE D. HOWBERT

## GROUP LEADER, INORGANIC LABORATORY

### EDUCATION

Western State College,
B.A., Business, 1983

Ward Scientific,
CLP Software Training Seminar, 1990

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1991 - Present
Analytica Inc., 1987 - 1991
Enseco, Inc., 1985 - 1987
Cone Geochemical, 1983 - 1985
Amax Exploration, 1976 - 1978

As group leader of the wet chemistry laboratory, responsible for general supervision and training of analysts, scheduling of analyses in order to meet holding times and project requirements, and review of laboratory data. Responsibilities also include implementation of the quality control program and routine instrument maintenance.

### RELATED EXPERIENCE

- Laboratory manager of a commercial laboratory responsible for all operational aspects of a 50-person full-service environmental laboratory.
- Supervisor of the trace metals area of a commercial laboratory.
- Six years of experience using CLP inorganic methods.
- Experienced in all aspects of metals analysis including ICP emission spectroscopy, flame atomic and cold vapor spectroscopy, and sample preparation techniques.

H10081

# MATTHEW S. HEARNE

## GROUP LEADER, GAS CHROMATOGRAPHY/MASS SPECTROMETRY

## EDUCATION

Texas A & M University,
B.S., Marine Biology, 1981

Dun and Bradstreet,
The Supervisor's Workshop, 1991
Finnigan MAT
Advanced Procedure Writing, 1986
Mass Spectral Interpretation, 1985

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1982-Present

As group leader, manages the GC/MS laboratory, interviews prospective employees, and answers client questions. Also coordinates analyses and checks computer data for validity. Oversees sample analyses for volatile organic compounds, base-neutral and acid extractable compounds, and confirmational analyses of polychlorinated biphenyls by GC/MS/DS. Responsible for preventative maintenance and troubleshooting.

## RELATED EXPERIENCE

- Proficient with performing GC/MS analysis of a variety of sample matrices for priority pollutant compounds.

- Proficient in the analysis of inorganic parameters including the following: nitrate, Kjeldahl Nitrogen, cyanide, phenol, COD, TOC, and TOX.

## MEMBERSHIPS

Water and Wastewater Analysis Association

H04251

# CHARLES A. KIEDA

## GROUP LEADER
## GAS CHROMATOGRAPHY/MASS SPECTROMETRY

## EDUCATION

University of Pittsburgh,
B.S., Chemistry, 1971
Duquesne University,
Coursework towards Masters Degree in Chemistry, 1980-1985 (27 credits completed)

American Chemical Society,
Quality assurance of chemical measurements, 1984
Capillary gas chromatography, 1977
Gas chromatography-theory and practice, 1973
Finnigan Institute,
Incos quantitation, 1980
Incos applications programming, 1979
4000 GC/MS operator's training course, 1978
3200/3300 GC/MS operator's training course, 1975
University of Pittsburgh,
Digital electronics and computer interfacing, 1976
Mass spectrometry of organic compounds, (45 hours of classroom lecture),1975
Sadtler Research Laboratories,
Infrared interpretation course part I, 1975
The practice of UV/VIS spectroscopy, 1974
Department of Energy/NUS Corporation
Survey Procedures/Environmental Regulations, 1986
Environmental Sampling and Analysis, 1986
Radiation Principles, 1986
Health & Safety, 1986
Department of Energy
Environmental Survey Course, 1986
U.S. Environmental Protection Agency/NUS Corporation
Health & Safety, 1985

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
Calgon Corporation, 1971-1985

Serves as group leader of the gas chromatography/mass spectrometry (GC/MS) laboratory. Responsible for training of GC/MS chemists, review of GC/MS data, implementation of the quality assurance/quality control program in the GC/MS lab, and instrument maintenance and troubleshooting. Also involved in method development and direct supervision of other chemists.

Experienced in the review, interpretation, and validation of analytical data, especially for GC and GC/MS analyses. Prior to HALLIBURTON NUS, served as a Chemist and later as a Senior Research Chemist with a leading environmental/specialty chemical company. Specialized in measuring organic compounds in water , soil, sediment, and activated carbon using GC and GC/MS techniques. Applied analytical expertise to a wide range of applications both independently and as a member of an integrated team. Provided timely, cost-effective, and state-of-the art services.

Representative professional experience includes:

- Initiated and developed capillary column GC techniques for analyzing environmental samples and specialty chemicals.

- Developed and coordinated an analytical program for monitoring organic-containing influents to activated carbon adsorption systems.

- Tracked the quality assurance/quality control of GC/MS measurements by using stable, isotopically-labeled, surrogate standards added to environmental samples, prior to widespread use by EPA.

- Conducted an on-going discussion group for the professional staff on the interpretation of organic mass spectra.

- Introduced the routine use of flame ionization and electron capture detection gas chromatography as analytical techniques for measuring organic compounds in water during the early 1970's.

- Established the benefits of using specific gas chromatographic detectors for measuring environmental contaminants.

- Maintained and operated Finnigan Model 3200 and Model 4000 computerized GC/MS systems for trace organic analyses and organic characterization of specialty chemicals.

- Performed routine wet chemical analyses of water for organic and inorganic contaminants.

- Maintained and operated Technicon Auto Analyzer systems for routine measurements of water contaminants.

- Analyzed commercial water treatment chemical products by wet chemical and spectroscopic techniques.

## MEMBERSHIPS

American Chemical Society
Society for Analytical Chemists of Pittsburgh

## PUBLICATIONS

Nowicki, H.G., C.A. Kieda, and D.O. Bassett, "Quantitative Evaluation of Priority Pollutant Polycyclic Aromatic Hydrocarbons at One Part per Billion Using EPA Recommended Priority Pollutant Protocol," Polynuclear Aromatic Hydrocarbons: Chemistry and Biological Effects, A. Bjorseth and A.J. Dennis, Eds. Battelle Press, 1980, pp. 75-87.

Sauter, A.D., C.A. Kieda, R.F. Devine, and H.G. Nowicki, "Quantitative Determination of Priority Pollutants-Gas Chromatography/Mass Spectrometry Response Factor Variation," Measurement of Organic Pollutants in Water and Wastewater, ASTM STP 686, C.E. Van Hall, Ed., American Society for Testing and Materials, 1979, pp. 221-233.

Nowicki, H.G., R.F. Devine, and C.A. Kieda, "Application of Deuterated Organics as Internal Standards in Volatile Organic Analysis from Drinking Water and Wastewater by Computerized Gas Chromatography-Mass Spectrometry," Measurement of Organic Pollutants in Water and Wastewater, ASTM STP 686, C.E. Van Hall, Ed., American Society for Testing and Materials, 1979, pp. 130- 151.

Nowicki, H.G., C.A. Kieda, R.F. Devine, V. Current, and T.H. Schaefers, "Identification of Organic Compounds Solvent Extracted from Paper and Glass Soxhlet Thimbles," Analytical Letters, 12 (A7), 1979, pp. 769-776.

Gleditsch, S.D., R.F. Devine, and C.A. Kieda, "An Approach to the Characterization of Industrial Wastewater," Pollution Engineering, 1975.

# DAVID S. KOHL

## GROUP LEADER, RADIOCHEMISTRY

## EDUCATION

Allegheny College,
B.S., Chemistry, 1983

Harvard School of Public Health,
"Occupational and Environmental Radiation Protection," 1987
HALLIBURTON NUS Environmental Corporation Training Division,
"Radiochemistry Principles and Applications," 1987

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
A.L. Williams Corporation, 1984-1985
TLC Company, 1984

Supervises all radiochemistry analyses of water, soil, and bioassay samples. Responsible for data review, scheduling work assignments, training laboratory personnel, and method development. Performs radiochemistry analyses including gross alpha, gross beta, total uranium, radium-226 and -228. In addition, performs isotopic analyses using alpha and gamma spectroscopy. Screens potentially radioactively-contaminated samples upon receipt at the laboratory. Controls the amount of contaminated samples released to the laboratory staff for analysis. Trains new analysts in laboratory methods and quality assurance/quality control (QA/QC) procedures. Responsible for the operation and calibration of laboratory equipment including gas proportional counters, alpha spectrometers, coincidence counting systems, and radiation survey meters. Coordinates disposal of radioactive wastes.

## RELATED EXPERIENCE

- Serves on the laboratory safety committee. This committee is responsible for monitoring all laboratory areas for conformance to safety requirements. Isolates potential problems and recommends appropriate corrective action procedures.

- Prepared samples for organic analyses of perticides, herbicides, and base-neutral and acid extractables.

- Experienced with specific ion electrodes, UV-visible spectrophotometers, distillations, and titrations for routine wet chemistry analyses.

- Analyzed water, wastewater, and soils for biochemical oxygen demand (BOD), chemical oxygen demand (COD), fluoride, and hexavalent chromium.

# RICHARD M. KOMM

## GROUP LEADER, GAS CHROMATOGRAPHY

## EDUCATION

University of Houston,
B.S., Chemistry, 1982

Finnigan Institute,
INCOS 50 Operations Course, 1989
Varian Training School,
Autosampler Maintenance Course, 1989

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1988-Present
Dixie Services, 1982-1988
Thiokol Corporation, 1979-1982

Serves as Group Leader for the gas chromatography laboratory, supervising chemists and analysts engaged in the analysis of environmental samples (water, air, soil, and waste) for pesticides, herbicides, PCBs, and volatile and semivolatile organics. Supervises and approves chemical analyses, schedules work, and troubleshoots analytical problems.

Previously worked as a GC/MS operator responsible for analyzing environmental samples for volatile and semivolatile organic compounds using gas chromatography/mass spectrometry techniques.

## RELATED EXPERIENCE

Performed ASTM analyses on petroleum and petroleum products by classical and instrumental methods. Trained technicians and chemists to perform ASTM analyses.

Performed analyses on oil field products and operated pilot plants, including analytical support on oil field related projects.

H06121

# CHARLES F. KOVACH

## GROUP LEADER, ATOMIC ABSORPTION

## EDUCATION

Youngstown State University,
M.S., Chemistry, 1985
Master's thesis, "Analysis of Acid Copper Electrodeposition Solutions Using Inductively Coupled Plasma (ICP) Emission Spectroscopy," Youngstown State University, Youngstown, Ohio, 1985. (Studied ICP technique one-on-one with graduate thesis advisor for a period of 1-1/2 years)
Youngstown State University,
B.A., Chemistry and German, 1983
University of Constance,
Constance, Germany, 1981-1982

Society for Analytical Chemists of Pittsburgh,
"Hazardous Waste Management Seminar"
Leeman Labs,
ICP Training Course, 1988

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
Youngstown State University, 1979-1985

Supervises and trains a staff of nineteen chemists and technicians in the atomic absorption laboratory. Schedules work to meet holding times and project requirements, and reviews laboratory data. Implements the quality control program in the atomic absorption laboratory, and oversees routine instrument maintenance. Has 3 years' experience performing metals analyses according to USEPA-approved protocols including Contract Laboratory Program, NYSDEC, HAZWRAP, and Air Force IRP protocols.

Performed analyses of waters, low-level concentration soils, sludges, and hazardous wastes for organic contaminants using gas chromatography/mass spectrometry techniques. Analyzed for volatile organic compounds, base-neutral, and acid extractable compounds, and performed confirmation analyses for polychlorinated biphenyls (PCBs) by GC/MS/DS. Used EPA purge and trap technique 624 for analysis of VOAs and EPA Method 625 to analyze for base-neutral compounds. Has 2 years' experience performing GC/MS analyses according to Contract Laboratory Program protocols.

## RELATED EXPERIENCE

- Taught IC ˜ ˜heory and techniques to undergraduates and taught general chemistry and organic chemistry. Also taught elementary German classes.
- Worked on method development for VOA analysis of air bag samples as well as various EPA cases.
- Performed extractions for base-neutral and acid extractable compounds, PCBs, pesticides, and herbicides.
- Performed analysis of PCBs in oil by gas chromatography.
- Performs full data package preparation for CLP work.
- Presented a seminar entitled, "Degradation of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin," while attending Youngstown State University Graduate School.

## MASTER'S THESIS

"Analysis of Acid Copper Electrodeposition Solutions Using Inductively Coupled Plasma Emission Spectroscopy," Youngstown State University, Youngstown, Ohio, 1985.

## MEMBERSHIPS

American Chemical Society
Society for Analytical Chemists of Pittsburgh

P04101

# JOSEPH C. KUHN, P.E.

## INSTRUMENT SERVICE ENGINEER

## EDUCATION

Point Park College,
B.S., Electrical Engineering, 1977
Minor, Business Management

U.S. Air Force,
21 courses in electronics and related fields
Pennsylvania State University,
Engineering review courses
Finnigan MAT Institute,
4500 series GC/MS system maintenance course, 1987
Pittsburgh Conference and Exposition,
Laboratory Information Management Systems mini-course, 1987

## CERTIFICATIONS

Licensed Professional Engineer No. PE-0355756-E

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1986-Present
Pennsylvania Air National Guard, 1972-1986
Community College of Allegheny County, 1981-Present
Westinghouse Transportation Division, 1972

Serves as computer design and instrument repair engineer for HALLIBURTON NUS laboratories located in Pittsburgh, Pennsylvania, and Houston, Texas. Responsible for laboratory automation and the design of computer network systems as well as maintaining, calibrating, and repairing major laboratory instrumentation including gas chromatograph/mass spectrometers (GC/MS) and accompanying data systems; gas chromatographs (GC); flame and graphite furnace atomic absorption (AA) spectrophotometers; UV-visible spectrophotometers; total organic halogen, infrared, and total organic carbon analyzers; pH/mv meters; chart recorders; turbidimeters; and conductivity meters.

## RELATED EXPERIENCE

- As an adjunct professor at Allegheny Community College, instructs several engineering courses on a part time basis. Teaches courses on robotics; the design of DC and AC circuits in steady state as well as transition; accounting for the effects of power, energy, magnetism, and resonance through the use of network design theorems, graphical

analysis, and Fourier Series; and the design of semiconductor circuits, electromechanical converters, single phase and polyphase motors, magnetic starters, control relay transformers, and associated circuits.

- Maintained and inspected computers, navigational systems, head-up displays, and forward-looking radar using precision test equipment.
- Made quality verification inspections and wrote material deficiency reports for avionic systems.
- Developed the procedures for an avionics shop operation.
- Designed and supervised the installation of a three phase, 400 cycle, 440v to 115v power distribution system.
- Investigated design deficiencies on aircraft.
- Maintained and modified a radar and infrared weapons control system.
- Calibrated precision test equipment.
- Designed a solid state timer for an oxygen enricher machine. This entailed interfacing a low voltage CMDS logic to 110/220v inductive loads, interfacing the circuit as well as the circuit card layout to comply with U/L and VDE standards.
- Modified and maintained quality of printed circuit boards.

P07101

# JOHN C. LEHMAN

## GROUP LEADER
## GEOTECHNICAL/RCRA LABS

## EDUCATION

Institute of Computer Management,
Computer Programming Diploma, 1970

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
Michael Baker, Jr., Inc., 1974-1985
L. Robert Kimball, Inc., 1972-1974

Performs physical tests on soils, sludges, and coal refuse samples. Also responsible for the supervision and training of other analysts in these laboratories as well as for data review and method development. Experienced in all types of soils testing including Atterberg Limits, grain size distributions, moisture content, specific gravity, permeability, unconfined compressions, density, leachability, direct shear, and California Bearing Ratio tests. Also performs such tests as flashpoint, % water by Karl Fisher, specific gravity, viscosity, British Thermal Units (BTU), and elemental analysis by x-ray diffraction.

Responsibilities also include the preparation of samples of a wide variety of matrices for hazardous waste characterizations and EP Toxicity according to the Resource Conservation and Recovery Act (RCRA) regulations.

## RELATED EXPERIENCE

- Participation in numerous waste solidification projects. Responsibilities include the physical testing of the solidified samples. These physical tests include unconfined compressions to determine the strength of the solidified waste; static leach procedures to determine if any hazardous substances will leach out of the waste; and falling head permeabilities which are used to determine the flow rate of water through the samples.

- Analyzed ground blast furnace slag and lime products using standard and accelerated cube tests, Blaine fitness tests, and for available lime content.

- Inspected construction materials for conformance to specifications.

- Collected soil and well water samples.

# SIMON H. LIN

## ORGANIC SUPERVISOR

## EDUCATION

University of North Texas,
M.S., Analytical Chemistry, 1978
Feng Chia University, Taichung, Taiwan,
B.S., Chemical Engineering, 1975

Finnigan Institute,
INCOS Data System: Training Course, 1980
INCOS Data System: Application Programming Course, 1980
INCOS Data System: Quantitation Course, 1981
INCOS Data System: Maintenance Course, 1981
Capillary GC/MS, 1981
Super INCOS Data System: Target Compound Analysis, 1984

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1978-Present
Institute of Applied Sciences, University of North Texas, 1976-1978
University of North Texas, 1975-1976
Feng Chia University, 1975

Operates and maintains the computerized GC/MS data systems, develops and updates in-house software, develops analytical methods, and trains and evaluates personnel. Supervises GC/MS analyses on water, soils, wastes, air, and various other sample matrices for priority pollutant volatile and acid and base-neutral extractable compounds.

Modifies sample preparation and analytical techniques tailoring analyses to specific client needs. Often works with unusual sample matrices and analyzes for non-routine parameters. Educates clients about analytical requirements and works with them in interpreting various regulations. Also performs emergency hardware repair.

Provides complete analysis of all the proposed Appendix IX constituents.

## RELATED EXPERIENCE

- As a graduate student, was one of the early chemists applying GC/MS technology. Also was one of the first chemists to apply GC/MS to the analysis of environmental samples.

- Was a member of the group of chemists who first used GC/MS for analysis of the priority pollutant compounds in the 1970s.
- Initiated the use of GC/MS in the Houston laboratory in 1978. Has trained analysts and supervised this capability since 1978.
- Developed analytical methods for trace organic analyses in water using GC and GC/MS instrumentation.

## MEMBERSHIPS

American Chemical Society
Water and Wastewater Analysts Association

## PUBLICATIONS

Glaze, W. H., G. R. Peyton, S. H. Lin, R. Y. Huang, and J. L. Burleson, "Destruction of Pollutants in Water with Ozone in Combination with Ultraviolet Radiation. 2. Natural Trihalomethane Precursors," Environmental Science & Technology, Vol. 16, No. 8, August 1982.

Lin, S. H., "The Effect of Ozonation in Reducing Trihalomethane Formation Potential," presented at the annual meeting of the Water and Wastewater Analysts Association, Houston, Texas, May 1981.

Lin, S. H., "The Effect of Ozonation in Reducing Trihalomethane Formation Potential," Master of Science Thesis, University of North Texas, Denton, Texas, January 1981.

Glaze, W. H., R. Rawley, and S. H. Lin, "Ozone/Chlorine Dioxide Oxidation Products of Organic Materials," R. G. Rice, and J. A. Cortruvo, editors, Ozone Press International, International Ozone Institute, Inc., Cleveland, Ohio, p. 321 (1978).

Glaze, W. H., R. Rawley, and S. H. Lin, "By-products of Organic Compounds in the Presence of Ozone and Ultraviolet Light: Preliminary Results," presented in the International Ozone Institute, Inc., Cincinnati, Ohio, January 1977.

Glaze, W. H., R. Rawley, and S. H. Lin, "Photolytic Oxidation by Ozone/UV in Drinking Water Supply," presented in the Second Joint CIS/ACS Conference, Montreal, Canada, May 1977.

# PATRICIA WISE LYNCH

## PROJECT MANAGER

## EDUCATION

Juniata College,
B.S., Biology, 1970

University of Pittsburgh,
Studies toward a Certificate in Marketing
Improving Customer Service Performance, 1988
Fundamentals of Personal Computers for Managers, 1986
Dale Carnegie & Associates, Inc.
Effective Speaking and Human Relations, 1987
Radio Shack, Inc.,
Basic Operating Theory and Programming for the
Radio Shack TR8-80 Computer, 1982
National Bureau of Standards,
Quality Assurance of Chemical Measurement, 1981
J. T. Baker Chemical Company,
Hazardous chemical safety seminar, 1980
Instrumentation Laboratory Seminar,
Atomic absorption spectrometry, 1978
SACP-Sponsored Seminars,
Priority pollutant analysis, specific ion electrodes

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1970-Present
Juniata College, 1969-1970
Gwin Engineers, Inc., Summer, 1967

Serves as project manager for major projects performed by HALLIBURTON NUS laboratories. In this capacity, communicates special requirements to laboratory personnel involved in sample processing, data review, and report and invoice preparation. Also notifies clients of unusual conditions such as exceeded holding times, receipt of broken sample containers, and chain-of-custody discrepancies. Ensures that deliverables comply with project requirements prior to shipment to the client, arranges bottle orders and sample receipt, and oversees the entire project. Also performs special project training of laboratory staff and monitors the flow of work to ensure timely delivery of analytical results. In addition, conducts training seminars to assist clients in understanding analytical requirements and planning laboratory projects.

Manages projects of > $50,000 value and those projects with customized deliverables, special or complex contractural requirements, or high visibility, including work with the DOE, DOD, or USEPA.

Has managed projects with value in excess of $1M annually including all work for the Hazardous Waste Remedial Actions Program (HAZWRAP).

Serves as the project manager for the Brooks Air Force Base Installation Restoration Program (IRP).

Also was project manager for work with the USEPA Contract Laboratory Program (CLP).

## RELATED EXPERIENCE

- Served as an account executive and as Manager of Contracts with the Laboratory Services Group. Responsibilities included the preparation of cost and technical proposals, project management, forecasting work schedules, preparation of work plans, and data and report review. Served as the primary contact for all client inquiries.

- Served as proposal manager for the Laboratory Services Group. Managed a staff responsible for writing and coordinating cost and technical proposals. This group was also involved in writing and updating laboratory qualifications and resumes. Assisted in areas of business development and served as the primary laboratory contact for price quotations for other HALLIBURTON NUS divisions.

- Served as the Quality Assurance Coordinator for the Laboratory Services Division. Played a major role in the development and implementation of the laboratories' QA program. Duties included the monitoring of routine quality control data so that potential analytical problems could be isolated and corrected. In addition, was responsible for regularly reviewing all aspects of the laboratories' quality assurance program, the development and writing of quality assurance procedures and laboratory methods, and the training of all laboratory personnel in quality assurance procedures. Through routine monitoring activities, checked for compliance with approved procedures and reported any nonconformances to management so that corrective action could be initiated. Was also responsible for conducting nonconformance investigations and ensuring that isolated problems were resolved.

- In addition to the quality assurance responsibilities, served as the coordinator of the laboratory safety program. Responsible for performing routine laboratory safety inspections and reporting findings to management for remedial actions as well as for conducting safety training sessions and developing and writing safety procedures.

- Served as project manager for a method comparability study to demonstrate the equivalency of a procedure for determining nitrate-nitrogen using a specific ion electrode to an EPA-approved procedure for the same parameter. The comparability study involved both the analytical testing and the statistical review of the data.

- Performed qualitative and quantitative chemical analyses of water, wastewater, sediments, and sludge for inorganic components.

- Has considerable experience with most wet chemical procedures, especially in the areas of cyanide and nutrient methodology. Instrumental experience includes the use of atomic absorption and emission spectrometers as well as UV-visible spectrophotometers and combustion-type total organic carbon analyzers.

- Involved in special projects including cyanide method development and participation in various ASTM round robins for cyanide, bromide, and iodide. One of these projects involved testing the effectiveness of specific ion electrodes for measuring cyanide amenable to chlorination.

- Involved in the analyses of ion exchange resins to determine their physical conditions, exchange capacity, density, moisture content, and mesh size distributions.

- Has extensive experience in the use of specific ion electrodes both for method development activities and routine analyses.

- Established the current laboratory procedure for measuring total organic halogens (TOX) using instrumentation equipped to measure trace levels of TOX by microcoulometric titration.

- Involved in the training of other laboratory personnel in many areas of inorganic chemistry.

- Performed routine bacteriological analyses on drinking water and wastewater samples.

- At Juniata College, served as laboratory instructor for microbiology. Responsibilities included the preparation of materials for use in laboratory projects and instructional assistance in the laboratory.

## MEMBERSHIPS

American Chemical Society
Society of Analytical Chemists of Pittsburgh

## PUBLICATIONS

Gonter, C. E. and P. L. Wise, "Specific Ion Electrodes for the Direct Determination of Cyanide Amenable to Chlorination," presentation for Division of Environmental Chemistry, American Chemical Society, New Orleans, Louisiana, March 1977.

P06251

# ROBERT MacGREGOR, III

## SUPERVISOR, AQUATIC TOXICOLOGY/BIOASSAY
## HOUSTON LABORATORY

## EDUCATION

Louisiana State University,
Ph.D., Physiology, 1975
Louisiana State University,
M.S., Physiology, 1971
University of Texas at Austin,
B.A., Zoology, 1968

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1988 - Present
Espey, Huston and Associates, Inc., 1982 - 1988
University of Alabama in Birmingham, 1974 - 1982

Serves as supervisor of aquatic toxicology for the HALLIBURTON NUS Laboratory Services Group. Responsibilities include managing a staff of several biologists and technicians, reviewing technical data, providing technical consultation to clients, and expanding bioassay laboratory capabilities.

## RELATED EXPERIENCE

- As director of a bioassay laboratory, managed a staff of biologists and technicians in the performance of NPDES bioassay studies. Studied the effects of wastewaters, drilling fluids, dredge materials, and refined chemicals on various aquatic organisms. Responsibilities included market development, expanding lab capabilities, and managing and developing facilities.

- As assistant professor and member of the graduate faculty at UAB, taught, provided guidance for research programs, wrote grants for research funding, and published works in peer-reviewed journals. Principle research efforts were directed toward quantitative analyses of blood steroids using radio-immunoassay as the indicator of reproduction in a variety of fish.

  Studies involved grants from the following agencies: Alabama Department of Conservation and Resources, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the National Science Foundation.

## MEMBERSHIPS

American Fisheries Society
American Society for Testing and Materials
Society of Environmental Toxicology and Chemistry
Texas Water Utilities Association
Water Pollution Control Federation (Texas)
Waster and Wastewater Analysts Association

## PUBLICATIONS

Meier, A. H. (Assisted by Robert MacGregor). 1969. Antigonadal Effects of Prolactin in the White-throated Sparrow, Zonotrichia albicolis. Gen. Comp. Endocrinol. 13: 222-225.

Meier, A. H., D. D. Martin and R. MacGregor, III. 1971. Temporal Synergism of Corticosterone and Prolactin Controlling Gonadal Growth in Sparrows. Science 173: 1240-1242.

Meier, A.H., T.H. Trobec, H.C. Haymer, R. MacGregor III, and A. C. Russo. 1973. Daily Variation in the Effects of Handling on Fat Storage and Testicular Weights in Several Vertebrates. J. Exp. Zool. 184: 281-288.

MacGregor, R. III. 1974. Avian Reproductive Systems: Daily Variation in Responses to Hormones. In L. E. Scheving, R. Halberg and J. E. Pauley (ed.), Chronobiology: Proceedings of the Inter. Society for the Study of Biological Rhythms, Little Rock, Arkansas, Igaku Shoin Ltd., Tokyo.

Francis, K.T., and R. MacGregor, Effect of Exercise in the Heat on Plasma Renin and Aldosterone with Either Water or a Potassium-rich Electrolyte Solution. Aviat. Space Environ. Med. 49 (3): 461-465, 1978.

Dindo, J. J. and R. MacGregor III (1981). Annual Cycle of Serum Gonadal Steroids and Serum Lipids in Striped Mullet. Transactions Amer. Fish Soc. 110: 403-409.

MacGregor, R. III, J. J. Dindo, and J. Finucane. (1981). Changes in Serum Androgens and Estrogens During Spawning in Bluefish, Pomatomus saltatrix, and King Mackerel, Scomberomorus cavalla. Can. J. Zool. 59.

MacGregor, R. III, M. S. Greeley, P. Pagel and M. C. Reddington. (in prep.). Diel Variation of Plasma: Androgens and Estrogen in Gulf Killifish, Fundulus grandis. Gen. Comp. Endocrinol.

David, K. B., MacGregor, R. III, C. Goudie, W. Simco, N. Parker. (In Preparation). Effects of Blinding and Pinealectomy on Seasonal Changes of Plasma Testosterone. Estrogens and Gonadal Weights in Channel Catfish.

MacGregor, R. III, M. S. Greeley, W. C. Trimble, and W. M. Tatus. (In Prep.). A Comparison of the Annual Cycle of Reproduction in Fundulus grandis from a Natural Estuary and Mariculture Ponds. Northeast Gulf Science.

MacGregor, R. (In Preparation). Seasonal and Diel Fluctuations of Gonadal Steroids in Teleost Fish. IXth International Symposium on Comparative Endocrinology, Hong Kong, 1981. (December)

In preparation:

Greeley, M. S., Jr., R. MacGregor, III, and K. R. Marion. "Semilunar Reproductive Cycles and Associated Spawning Behavior of Fundulus similis". In final stages of preparation for submission to Canadian Journal of Zoology.

_____. "Annual and Semilunar Variation in Plasma Androstenedione, Testosterone and Ketotestosterone in Male Fundulus grandis."

_____. "Annual and Semilunar Variations in Plasma Androgens, Estrogens and Progesterone in Female Fundulus grandis."

_____. "Ovarian Changes Associated with the Annual and Semilunar Reproductive Cycles of the Gulf Killifish, Fundulus grandis."

_____. "Changes in the Testes of Fundulus grandis During Annual and Semilunar Reproductive Cycles.

# GREGORY A. MALZONE

## QUALITY ASSURANCE REPRESENTATIVE

## EDUCATION

University of Pittsburgh,
B.S., Biochemistry, Chemistry minor, 1979

37th Annual Bioassay Conference,
Quality Assurance Requirements for Radiochemistry, 1990
American Chemical Society,
Quality Assurance of Chemical Measurements, 1989
National Career Workshops Seminar,
How to Supervise People, 1987

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1988-Present
N. S. Marketing, Inc., 1987-1988
Neville Chemical Company, 1985-1987

Serves as quality assurance representative for the inorganic, organic, and radiochemistry laboratories at the Pittsburgh, Pennsylvania, facility. Responsible for routine quality control data review to isolate potential analytical problems. Updates control limits semi-annually. Coordinates performance evaluation studies for external certification/accreditation programs. Assists with program monitoring, which is a system to ensure that procedures are followed correctly and meet quality assurance/quality control (QA/QC) requirements. Conducts QA/QC training sessions for new employees, annual QA training for laboratory staff, and monthly QC meetings in which the status of corrective actions is discussed.

## RELATED EXPERIENCE

- Established an onsite quality control laboratory and system for QC record keeping. Involved in method development and implementation.

- Researched and compared oil well production and maintenance products for product development and improvement processes.

- Evaluated hydrocarbon resins, resin solutions, and chlorinated paraffins against customer specifications.

- Analyzed wastewater samples for pH and phenol.

- Analyzed raw materials and samples throughout the production process to determine product quality.

P05281

# LISA A. MANNING

## QUALITY ASSURANCE COORDINATOR

### EDUCATION

Thiel College,
B.A., Environmental Studies, 1979

American Association for Laboratory Accreditation
and Center for Energy and Environmental Management,
Laboratory Quality Control and Assessment for Environmental Testing, 1987
Executive Enterprises, Inc.
Comprehensive RCRA Briefing, 1987
Environmental Regulation Course, 1986
Perkin-Elmer Corporation,
Atomic absorption spectrophotometry seminar, 1981
Graphite furnace applications seminar, 1980

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1979-Present
U.S. Steel, Environmental Health Laboratory, 1978-1979 (summers)

Currently serves as the quality assurance coordinator for the Laboratory Services Group. In this capacity, is responsible for the overall management of the laboratory's quality assurance program and the quality assurance staff. Duties include regular review of all aspects of the laboratory's quality assurance program, the preparation of QA procedures and laboratory methods, and training laboratory personnel in QA procedures. Responsible for monitoring LSG compliance with approved procedures. Completes internal audits and nonconformance investigations in order to ensure that isolated problems are resolved. Provides support during client and government audits. Coordinates activities related to obtaining and maintaining laboratory certifications and approvals.

### RELATED EXPERIENCE

- Extensive experience in atomic absorption spectrophotometry, including the use of the graphite furnace.

- As past group leader in the atomic absorption laboratory, responsible for training of analysts, review of analytical data, routine instrument maintenance, and implementation of the quality control program as well as the development of new procedures and the analyses of samples of unusual or nonroutine matrices.

- Experience in the operation and routine maintenance of infrared-type and FID organic carbon analyzers.

- Experience in the analysis of water, wastewater, sediments, and sludges for inorganic components using traditional wet chemistry techniques, as well as the analysis of samples for total and coliform bacteria.

- Performed a variety of industrial hygiene analyses employing GC, fluorimetry, and gravimetry, and atomic absorption.

## PUBLICATIONS

Manning, L. A., "Quality Control in the Wastewater Analytical Laboratory," Water Pollution Control Association of Pennsylvania Magazine, September- October, 1980, pp. 32-34.

## MEMBERSHIPS

Society for Analytical Chemists of Pittsburgh

P06211

# R. SCOTT MAYO

## LABORATORY MANAGER, HOUSTON

## EDUCATION

University of Phoenix,
M.A., Business Administration, 1986
Texas A&M University,
B.S., Microbiology, 1978
Minor, Chemistry, 1978

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1989-Present
Core Laboratories, 1979-1989
Chromaspec Labs Inc., 1978-1979

As manager of the Houston laboratory, oversees daily operations, maintains the laboratory schedule, and coordinates special projects. Provides technical assistance to clerical personnel to ensure that samples processed through the laboratory are checked in and out properly. Reviews data processed through the laboratory computer system and provides technical assistance to clients. As a project manager, prepares work plans to ensure that all project requirements are met.

## RELATED EXPERIENCE

Served as district manager of a large earth sciences company, responsible for five commercial testing labs providing environmental testing and sampling services in Texas and Louisiana.

Served as manager of a laboratory located in Houston, Texas, that provides testing services to the petroleum, petrochemical, and chemical industries, as well as government agencies and environmental consultants. Services offered included organics by GC and GC/MS, NPDES, RCRA, and a variety of inorganic analyses.

Established and served as manager of a commercial testing lab located in Long Beach, California. Responsibilities included staffing, purchasing, sales, and budgeting.

Served as an assistant manager for two years, responsible for management of the GC, GC/MS, mass spectrometry, and elemental analysis laboratories.

Served as supervisor of an elemental analysis laboratory for two years.

Experience includes various analytical techniques including atomic absorption spectrophotometry, gas chromatography, and mass spectrometry.

## MEMBERSHIPS

American Society of Testing and Materials
American Chemical Society
American Petroleum Institute

H05091

# DIANE M. MEYER

## PROJECT MANAGER

## EDUCATION

Massachusetts Institute of Technology,
M.S., Inorganic and Physical Chemistry, 1965
University of California at Berkeley,
B.S., Chemistry, 1963

University of Houston,
Post-graduate course in gas chromatography, 1988
Post-graduate course in gas chromatography/mass spectrometry, 1981
Instrumentation Laboratory, Atomic absorption training course, 1980

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1974-Present
Grossmont Junior College, 1966-1968
Massachusetts Institute of Technology, 1963-1965
Lawrence Radiation Laboratory, 1962-1963
Convair Aircraft Corporation, 1961

Serves as project manager for major projects performed by HALLIBURTON NUS laboratories. In this capacity communicates special requirements to laboratory personnel involved in sample processing, data review, and report and invoice preparation. Also notifies clients of unusual conditions such as exceeded holding times, receipt of broken sample containers, and chain-of-custody discrepancies. Ensures that deliverables comply with project requirements prior to shipment to the client, arranges bottle orders and sample receipt, and oversees the entire project. Also performs special project training of laboratory staff and monitors the flow of work to ensure timely delivery of analytical results. In addition, conducts training seminars to assist clients in understanding analytical requirements and planning laboratory projects.

## RELATED EXPERIENCE

As group leader in the gas chromatography laboratory, supervised analyses and trained new personnel. Performed analyses on a variety of matrices for polychlorinated biphenyls (PCBs), pesticides, herbicides, and volatile and gaseous compounds using GC techniques. Performed organic extractions including Soxhlet extractions, separatory funnel, and sonication techniques.

Served as assistant laboratory manager for the HALLIBURTON NUS laboratory in Houston, Texas. Responsible for the overall daily operation of the laboratory. Duties included

coordinating work assignments; reviewing analytical data; supervising a staff of chemists, biologists, technicians, and administrative personnel; and providing technical assistance to clients.

Has significant experience in all areas of laboratory operations, including wet chemistry, atomic absorption spectrophotometry, bacteriology, and organic sample preparation and analysis. Has used a wide variety of instrumentation, including gas chromatograph/mass spectrometers (GC/MS), gas chromatographs (GC), total organic halogen (TOX) and total organic carbon (TOC) analyzers, atomic absorption (AA) spectrophotometers, UV-visible spectrophotometers, and infrared (IR) spectrometers.

Other experience includes:

- Research studies on rare earth elements
- Quality control analyses on resins
- Preparation of NMR spectra
- Teaching of college-level general chemistry courses

## MEMBERSHIPS

American Chemical Society
Water and Wastewater Analysts Association

## PUBLICATIONS

Redlich, Otto, and Meyer, Diane M., "Molal Volumes of Electrolytes," Chemical Review 64, No. 3, May 28, 1964.

H04261

# JOHN B. MIKUS

## SENIOR CHEMIST, GAS CHROMATOGRAPHY

## EDUCATION

University of Pittsburgh,
B. S., Chemistry, 1968
Columbia University,
Chemistry, 1954-1955

ACS Short Course,
Introduction to GC/MS, 1987
Beckman Instruments,
Operation of Plasma Emission Spectrometer, 1986
HALLIBURTON NUS Environmental Corporation,
Handling of Hazardous Waste Materials, 40-hour course
in compliance with OHSA Standard 29 CFR 1910.120, 1985
U. S. Steel Corporation,
Managing for Motivation, 1979

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1984-Present
Vandenberg Air Force Base, 1984
U. S. Steel Corporation, 1960-1983

Provides GC analyses and supervision for on-site analytical projects. Working from mobile laboratories and permanent on-site facilities, performs GC analysis of water, soil, and air samples for volatile organic compounds.

Analyzes samples of various matrices using GC direct injection and purge and trap methods. Analyses performed include polychlorinated biphenyls, pesticides, herbicides, and volatile organics. Many of the pesticide and PCB analyses involve the use of Contract Laboratory Program (CLP) protocols.

## RELATED EXPERIENCE

Provided expertise to the team of the Environmental Emergency Response Unit (EERU) training specialists in the area of analytical field chemistry. Technical expertise includes the following:

- Experienced in the operation of gas and liquid chromatography for the analysis of PCBs, pesticides, purgeable hydrocarbons, and polynuclear aromatic hydrocarbons in water and solids.

- Knowledgeable in EPA methods of extractions and analysis and EPA QA/QC procedures.

- Experienced in operation of plasma emission spectrometer for the analysis of priority pollutant metals.

Served as field and clean room chemist on site at an Air Force base. Was responsible for the analysis of solutions used in cleaning piping systems for the Air Force Space Shuttle Launch Complex. Supervised field chemists and clean room technicians. Performed in accordance with NASA QA/QC procedures.

As a Research Project Engineer for a steel-manufacturing corporation, worked in the research and development of raw materials processing from laboratory through pilot-plant to commercial plant operation. Has trained technicians in new laboratory procedures and supervised technical personnel during project work. Specific project-related experience includes the following:

- Served as research representative on two sinter-plant quality improvement teams that significantly improved the chemical and physical properties of the product.

- Member of task force that observed and evaluated sintering technology in Europe and Japan for a proposed sinter plant.

- Evaluated a new flux material in a commercial-plant test that improved sinter production and quality and was subsequently incorporated in the product mix. Supervised a staff of 10 technical personnel during the test.

- Evaluated the addition of chemical additives in a commercial-plant test that resulted in a 15 percent increase in productivity. System approved for installation in the plant.

- Responsible for the bench and pilot-plant studies of a fluid-bed direct-reduction technology.

- Member of a start-up team that began operation of a commercial fluid-bed direct-reduction plant in Venezuela.

- Operated a fluid-bed direct-reduction pilot plant with a staff of 35 technical personnel that successfully solved start-up problems of the commercial fluid-bed plant.

- Experienced in the measurement of the physical properties of materials: surface areas by nitrogen adsorption and permeability, size distributions, porosity, thermogravimetric analysis, moisture saturation, and heat transfer.

## MEMBERSHIPS

American Chemical Society, 1986-Present
Iron and Steel Society, AIME, 1976-1983
Process Technology Session, AIME, Program Co-chairman, "Modeling of Raw Materials," 1982

## PUBLICATION

"Analysis of Priority Pollutant Metals for the Environmental Emergency Response Unit (EERU) by D. C. Plasma Emission Spectrometry" (co-author), paper presented at the Eleventh National Conference of Spectrochemical Excitation and Analysis, September 1986.

P06191

# JAMES J. MILLER

## ASSISTANT GROUP LEADER, WET CHEMISTRY

## EDUCATION

University of Pittsburgh,
B.S., Chemistry, 1982

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1987-Present

As assistant group leader in the wet chemistry laboratory, responsible for the general supervision and training of other analysts. Has experience with a wide variety of analytical techniques including colorimetric, titrimetric, and distillation procedures. Specific experience includes reactive cyanide and reactive sulfide, bromide, iodide, boron, turbidity, conductance, chlorides, nitrate, water hardness, boron fusion, hexavalent chromium, carbon, EDTA, fluoride, total organic halogens, phosphorus, and many automated procedures using the ALPKEM automatic analyzer. Experience with USEPA Contract Laboratory Program (CLP) protocols includes 2 years for pH for organic extractions and 3 years for cyanide.

Experienced in the use of instrumentation including UV-visible spectrophotometers, pH and mv meters, infrared-oxidation-type total organic carbon analyzers, total organic halogen analyzers, and the ALPKEM automatic analyzer.

## MEMBERSHIPS

American Chemical Society
Society of Analytical Chemists of Pittsburgh

P05081

# ELIZABETH A. MOTLEY

## SENIOR CHEMIST, ATOMIC ABSORPTION SPECIALIST

## EDUCATION

Ohio State University,
M.A., Analytical Chemistry, 1967
Southern Illinois University,
B.A., Chemistry, 1964

Instrumentation Laboratory,
Atomic absorption spectrometry seminar, 1978
Jarrell-Ash,
Atomic absorption course, 1967

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1971-Present
Gulf Research & Development, 1967-1971

As a senior chemist in the metals laboratory, is primarily responsible for the operation and maintenance of atomic absorption (AA) instrumentation. Routinely performs metals determinations using conventional flame and graphite furnace AA as well as cold vapor, hydride generation, and inductively coupled plasma (ICP) techniques. Has 3 years' experience analyzing aqueous and solid samples using USEPA Control Laboratory Program (CLP) and routine quality assurance/quality control (QA/QC) protocols. Trains new analysts in the operation and maintenance of instrumentation used for metals determinations. Experienced in preparation of samples that have unusual matrices or are radioactive. Considerable experience with nonroutine procedures including special sample preparations, extractions into organic solvents for AA analyses, and work with organic matrices. Familiar with sample preparations for radiochemical analyses including isotopic alpha spectroscopy and isotopic uranium in urine. Extensive experience in routine and nonroutine wet chemistry techniques. Instrumental experience includes infrared and UV-visible spectrophotometers and x-ray diffraction and fluorescence spectrometers.

## RELATED EXPERIENCE

- Analysis of lead in gasoline by AA
- A rapid AA method for determination of cobalt in organic matrices
- Analysis of lithium in lubricating oil by AA

## MEMBERSHIPS

Society for Analytical Chemists of Pittsburgh

# PAMELA A. PAPENMEIER

## ASSISTANT GROUP LEADER
## GAS CHROMATOGRAPHY/MASS SPECTROMETRY

## EDUCATION

Seton Hill College,
B. A., Chemistry, 1980

HALLIBURTON NUS Environmental Corporation Quality Program,
Facilitator training course, 1988
University of Pittsburgh,
Mass Spectrometry: Interpretation and Analysis
Fall 1987 - Spring 1988 (60 hours of classroom lecture)
Finnigan Training,
Incos 50, 1988, Interpretation of Mass Spectra
Carnegie Mellon University,
Analytical Quantitative Gas Chromatography
National Institute of Occupational Safety and Health,
Courses in laboratory quality control

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1986-Present
IT Corporation, 1984-1985
Mellon Institute, 1980-1984
Seton Hill College, 1976-1979

Assistant group leader in charge of GC/MS data evaluation and interpretation and quantitative verification of GC/MS data from 6 GC/MS systems. Also responsible for QA compliance and verification and coordinating data files to be suitable for processing.

Served as the assistant group leader in the VOA subgroup. In this capacity, was responsible for scheduling analyses, coordinating personnel and equipment to meet project requirements, and training new analysts. Provided technical advice to other staff members, reported analytical data, and performed routine instrument maintenance and troubleshooting.

Experienced in performing analyses on water, wastewater, soil, sediment, and sludge samples for volatile and semivolatile organic compounds. Uses EPA purge and trap and direct injection methods. For 2-1/2 years performed analyses using USEPA Contract Laboratory Program (CLP) protocols. Responsible for data reduction and case preparation for analyses associated with the USEPA CLP using FORMASTER software.

## RELATED EXPERIENCE

- Prepared water and waste samples for analysis using ASTM, EPA, and NIOSH procedures.
- Conducted free silica and kidney stone analyses utilizing x-ray diffraction and scanning electron microscope techniques.
- Assisted in research studying the molecular movements of polymers.
- Taught basic laboratory techniques and use of routine instrumentation.

## OTHER EXPERIENCE

- Serves as a facilitator for the quality improvement program at HALLIBURTON NUS.

P05081

# JAMES B. PERRIGO

## SHIFT LEADER, GAS CHROMATOGRAPHY/MASS SPECTROMETRY

## EDUCATION

Texas A & M University,
B.S., Marine Biology, 1981

Graduate Courses in Wildlife and Fisheries Science, 1983

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1981-Present
Red Ewald Enterprises, 1984
Texas A & M University, Texas Engineering Experiment Station, 1983
Texas A & M University at Galveston, 1983

As shift leader in the Houston facility's GC/MS laboratory, oversees analysts and performs analyses on a variety of matrices including: water, low-level concentration water, soils, sludges, and hazardous wastes. Analyzes samples for volatile organic compounds and base-neutral acid extractable compounds, and performs confirmational analyses of polychlorinated biphenyls (PCBs) by GC/MS/DS. Performs special identification of unknown compounds using mass spectral libraries, maintains mass spectrometers, and communicates with other shift leaders. Experienced in the use of Finnigan Models 3200, 4000, and 4500 GC/MS and INCOS and Data General data systems.

## RELATED EXPERIENCE

- Extracted samples for GC and GC/MS analysis for semivolatile compounds, herbicides, pesticides, and PCBs.
- Performed GC analysis for herbicides, pesticides, and PCBs using FID and ECD detectors.
- Performed TOX analysis using Dohrman instruments.
- Collected background samples for radiological studies.
- Collected air emissions samples for laboratory analysis.
- Collected and cultured marine and freshwater organisms for the purpose of bioassay testing.

- Offshore collection, laboratory analysis, and identification of marine nekton samples.
- Maintained marine and freshwater fish in raceway recovery systems for mariculture purposes. This involved the construction and maintenance of fiberglass tanks and accessories. Also involved the inducement of spawning, hatching, and care of fingerlings.
- Monitored and constructed apparatus which was used for bioassay tests.
- Served as teaching assistant in field ichthyology.

H06261

# MEREDITH L. RIESECK

## ASSISTANT GROUP LEADER
## GAS CHROMATOGRAPHY

## EDUCATION

Gannon University
B.S., Chemistry, 1986
Teacher Certification, 1986
Geneva College,
Post Graduate Studies, 1986
Pennsylvania State University
Post Graduate Studies, 1986

HALLIBURTON NUS School of Laboratory Practices,
Advanced Gas Chromatography, 1989
Graphite Furnace, 1988
Fisher Scientific Seminar, 1988
HALLIBURTON NUS Environmental Corporation,
Quality Education, 1988
HALLIBURTON NUS Environmental Corporation,
40-hour Health and Safety Hazardous Material Handling
Course in compliance with OSHA 29 CFR 1910.120, 1989

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1987 - present
Vulcan Materials Company, 1987
Beaver Valley School District, 1986

Works from mobile laboratories and permanent onsite facilities to perform GC analyses of water, soil, and air samples. Analyzes samples using gas chromatography direct injection and purge and trap techniques and high performance liquid chromatography (HPLC). Works with a variety of sample matrices including soil, waters, oils, Soxhlet extracts, and wipes. Specific analyses include polychlorinated biphenyls (PCBs), herbicides, pesticides, phenols, naphthalenes, cresols, alcohols, volatile organics, and miscellaneous organic analysis. Responsible for GC training, scheduling, and data validation and entry.

## RELATED EXPERIENCE

- Performed inorganic analyses on water, wastewater, sediment, and sludge samples using a variety of titrimetric, colorimetric, and gravimetric bench chemistry procedures.

Performed cyanide analyses using USEPA Contract Laboratory Program (CLP) protocols. Is familiar with the use of total organic carbon analyzers, total organic halogen analyzers, pH/specific ion meters, UV-visible spectrophotometers, and infrared spectrometers. Trained new analysts in basic wet chemistry procedures.

- Qualitative and quantitative analysis of tin plate scrap and tin chemicals.

**MEMBERSHIPS**

American Chemical Society

P05021

# DAVID ROSE

## ASSISTANT GROUP LEADER, ATOMIC ABSORPTION

## EDUCATION

Sam Houston State University,
B.S., Chemistry, 1986

Perkin-Elmer Training Seminars,
Graphite Furnace, 1987
Inductively Coupled Plasma (ICP) Spectrometer, 1987

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1987 - Present

As an assistant group leader in the metals laboratory, supervises personnel in the completion of proper project requirements, schedules analyses to meet holding times, reviews laboratory data, and trains new personnel. Assists in implementing the quality assurance program.

Is experienced in performing metals analyses on water, wastewater, soil, sludge, and sediment samples using flame, graphite furnace, and cold vapor atomic absorption (AA) techniques. Is experienced in the use of the ICP analytical technique.

## RELATED EXPERIENCE

- Performed wet chemistry analyses on a variety of water quality parameters which include cyanide, phenol, nitrate, Kjeldahl nitrogen, bromide, surfactants, total organic carbon, total organic halogens, etc.

- Experienced in the use and maintenance of pH/mv meters, UV-visible spectrophotometers, total organic carbon analyzers, total organic halogen analyzers, sonication instruments, etc.

## MEMBERSHIP

Water and Wastewater Analysts Association

LH09288
B

# JOSEPH A. SAMCHUCK

## ASSISTANT GROUP LEADER, GAS CHROMATOGRAPHY/MASS SPECTROMETRY

## EDUCATION

Gannon University,
B.S., Chemistry, 1983
Finnigan Institute,
Course in Spectral Interpretation, 1986

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1983-Present

Oversees the entire operation of the gas chromatography/mass spectrometry laboratory. Responsible for scheduling the staff and equipment to meet project completion dates. Provides technical assistance to the other staff members. Performs analyses on a range of unusual sample matrices such as paints, solvents, cloths, and fish and fish-tissue for organic contaminants. Experienced in analyses using specialized techniques including selective ion monitoring (SIM).

Experienced in the operation and calibration of gas chromatograph/mass spectrometers (GC/MS) and accompanying data systems for the analysis of water, wastewater, soils, sediments, and sludges for organic contaminants. Performs volatile organic analyses (VOAs) and base-neutral and acid extractable analyses by GC/MS using EPA-approved procedures, including 5 years' experience using Contract Laboratory Program (CLP) protocols for samples from suspected or known hazardous waste sites. Assists in GC/MS data review, training of other GC/MS chemists, routine instrument maintenance, scheduling of routine analyses, and review and assembly of sample data packages for EPA Superfund CLP projects.

## RELATED EXPERIENCE

- Analysis of samples of various matrices for priority pollutant pesticides, polychlorinated biphenyls (PCBs), volatile organics, and herbicides using gas chromatography (GC).

- Organic analysis sample preparations, including herbicide extractions, pesticide and PCB extractions, and base-neutral and acid extractions.

## MEMBERSHIPS

American Chemical Society

# PAUL J. SARACENA

## ASSISTANT GROUP LEADER, SAMPLE PREPARATION, CONTROL, AND WASTE MANAGEMENT

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1986-Present

As assistant group leader, trains and supervises the work of technicians and chemists in the organic extraction laboratory.

Prepares sample extracts from water and soil matrices for the analysis of priority pollutant, hazardous substance list (HSL), and miscellaneous parameters by gas chromatography and gas chromatography/mass spectrometry (GC/MS). Assists in method development of sample extraction procedures. For 3 years has performed low-level water and low- and medium-level soil sample extractions for pesticides, PCBs, and semi-volatiles using EPA Contract Laboratory Program (CLP) protocols. The procedures include various sample cleanups such as alumina and Florisil™ column cleanups. He also performs extractions using EPA-approved procedures for wastewater and drinking water samples for priority pollutant pesticides/PCBs and drinking water pesticides and herbicides.

## RELATED EXPERIENCE

- Developed and established a systematic ordering system that is currently being implemented in all the laboratories at the Pittsburgh facility, including the inorganics, organics, and radiochemistry laboratories.

- Oversaw waste disposal in the laboratories. Was responsible for separating all wastes according to identity and concentration of hazardous material content.

- Assisted the head of the Industrial Hygiene section on numerous special projects by performing Soxhlet extractions and other sample preparations.

- Served as laboratory assistant in all laboratories at the Pittsburgh facility.

LP09268
B

# EVA A. SCOULLOS

## DATA MANAGEMENT GROUP LEADER

## EDUCATION

Youngstown State University,
M.S., Chemistry, 1984
Ohio University
B.S., Microbiology, 1979

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1985-Present
Youngstown State University, 1982-1984
Bellaire City Hospital, 1980-1982

As group leader of the data management group, is responsible for the processing, assembly, and review of all data packages (organic and inorganic). This is accomplished through the use of personal computer and Formaster/Ward software packages. Final review includes checking dates for completeness, correctness, and compliance with the various protocols such as the EPA Superfund CLP requirements.

## RELATED EXPERIENCE

- Performs analyses on water, wastewater, soils, sediments, sludges, and hazardous waste for organic contaminants. Instrumental experience includes the use of gas chromatograph/mass spectrometers (GC/MS) to perform volatile organic analyses by the purge and trap method and semi-volatile analyses according to EPA guidelines. Also responsible for routine instrument maintenance of the GC/MS units and accompanying data systems. Performs specialized analyses on gas and air samples.

- Performs analyses using EPA Methods 624 and 625 for industrial wastewaters. Has 3 years' experience performing EPA Contract Laboratory Program (CLP) protocols for samples collected from known or suspected hazardous waste sites.

- Reporting and spectral interpretation and identification of GC/MS data.

- Teaching of university laboratory chemistry courses.

- Clinical chemistry, microbiology, and hematology analyses.

## HONORS

Cum Laude Graduate of Ohio University

## MEMBERSHIPS

American Chemical Society

# JOANNE C. SIMANIC

## LABORATORY MANAGER
## PITTSBURGH LABORATORY

## EDUCATION

East Stroudsburg State College,
B.A., Chemistry, 1972

West Chester State College,
Graduate studies in chemistry, 1974

## EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1977 - Present
Chester County Health Department, 1973 -1977

As manager of the Pittsburgh laboratory, oversees daily laboratory operations, maintains the laboratory schedule, and coordinates special projects. Provides technical assistance to clerical personnel to ensure that samples processed through the laboratory are checked in and out of the laboratory properly. Reviews data processed through the laboratory computer system and provides technical assistance to clients. Functions as a project manager by preparing work plans and organizing and directing special project work to ensure that all project requirements are met.

## RELATED EXPERIENCE

- As a group leader in the inorganic chemistry laboratory, was responsible for the daily operations of the laboratory, including the scheduling of work assignments, the reviewing of analytical methods, the reviewing of data generated in the laboratory, and the supervision of other laboratory personnel. Also performed various administrative functions, including the supervision of sample check-in and sample check-out processes.

- Past duties included the routine analysis of water and wastewater for both inorganic components and bacteria. Experienced in most general wet chemistry procedures. Was involved in the training of other laboratory personnel.

- Special projects included round robin testing for such parameters as phenol, boron, and cyanide and the development of sample preparation procedures for those samples requiring special handling or having unusual matrices. Also developed a method for analyzing chloride in nuclear wastewater by ion chromatography. This method will be incorporated into a system for post- accident testing at nuclear generating stations.

- Performed chemical and microbiological testing of water and wastewater, especially of samples related to health problems or to the enforcement of local and state pollution laws.

- Participated in the planning and execution of stream surveys. Involved in the teaching and supervision of student interns. Instrumental experience includes the Technicon Auto Analyzer II and atomic absorption spectrometry.

**MEMBERSHIPS**

American Chemical Society
Society for Analytical Chemists of Pittsburgh

LP09238
B

# ELESSA G. SOMMERS

## SPECIAL PROJECT CHEMIST

### EDUCATION

Abilene Christian University,
M.S., Management and Human Relations, 1980
Abilene Christian University,
B.A., Chemistry, 1976

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1986-Present
ACS Laboratories, 1984-1986
PPI/Key Laboratory, 1980-1984
Pride Refining, 1978-1979
Zoecon Industries, 1976-1978

Primary responsibilities are performing technical data checks for inorganic CLP projects (primarily metals), providing training as needed for metals and inorganics labs, special projects, and evaluating new instruments and/or methods as needed.

Specializes in the chemical analysis of environmental and industrial hygiene samples for metals by atomic absorption spectrophotometry (AA) and inductively coupled plasma spectrometry (ICP) using Instrumentation Laboratories' 151 and 251 decicated flame atomic absorption units, an Instrumentation Laboratories' 655, and a Perkin-Elmer atomic absorption/inductively coupled plasma 5500 with HGA 500 graphite furnace.

### RELATED EXPERIENCE

- Supervised a group of chemists who performed metals analyses on water, catalysts, alloys, and waste samples using ICP, DCP, and ICP/MS instrumentation.

- Supervised a group of chemists and technicians engaged in the chemical analysis of water, wastewater, brines, crude oil, and petroleum products by EPA, ASTM, and Standard Methods procedures. Responsible for customer problems and requests, data reporting, and invoicing.

- Supervised the analysis of non-routine sample matrices by modifying sample preparation techniques and methods of analysis.

- Worked with clients to determine unique analytical needs in satisfying a range of government regulations and industry-specific requirements.

- Performed quality control analyses of petroleum products, gasoline, diesel, and jet fuels. Used gas chromatographs, distillation apparatus, flashpoint apparatus, and spectrophotometers.

- Performed quality control analyses of pesticides and pest controls using gas chromatographs as well as infrared and ultraviolet spectrophotometers. Worked on methods development and special projects.

## MEMBERSHIPS

American Chemical Society
Water and Wastewater Analysts Association

H06261

# RONALD J. TAYLOR

## CHEMIST, GAS CHROMATOGRAPHY/MASS SPECTROMETRY

### EDUCATION

University of Houston,
B.S., Biological Sciences, 1980
Alvin Community College,
A.S., Math/Science, 1977

San Jacinto College,
Organic Chemistry, 1978

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1981-Present

As a chemist in the gas chromatography/mass spectrometry (GC/MS) laboratory, performs analyses for organic contaminants on a wide range of matrices including waters, medium and low-level concentration soils, sediments, sludges, and air. Performs routine instrument maintenance and troubleshooting.

### RELATED EXPERIENCE

- Performed metals analysis on a range of sample matrices using flame, graphite furnace, and cold vapor atomic absorption (AA) techniques.
- Performed metals analyses using inductively coupled plasma (ICP) spectrometry.
- Prepared samples for organics and metals analysis.
- Performed a variety of wet chemistry procedures for parameters including total organic carbons, total organic halogens, cyanide, ammonia, and hexavalent chromium.
- Experienced in the use and maintenance of the following instruments: pH/mv meters, UV-visible spectrophotometers, TOC analyzers, TOX analyzers, and sonication instruments.

### MEMBERSHIPS

Water and Wastewater Analysts Association

H06271

# RICHARD A. WHARTENBY

## ASSISTANT GROUP LEADER,
## RCRA LABORATORY AND METALS PREPARATION

### EDUCATION

LaRoche College,
B.S., Chemistry, 1987

### EXPERIENCE

HALLIBURTON NUS ENVIRONMENTAL CORPORATION, 1989-Present
ACM Compliance, 1989

Analyzes samples for hazardous waste characteristics including corrosivity and flashpoint. Prepares samples for analysis using EP toxicity, toxic characteristic leaching procedure (TCLP), and ASTM leach procedures. Performs metals digestions for soils and waters according to Contract Laboratory Program (CLP) protocols.

### RELATED EXPERIENCE

Experience includes the physical testing of soils, preparation of samples for organic analyses, collection and analysis of air samples for asbestos, and the analysis of soil and water digestions for metals by flame AA.

P05201

# TRAINING PROGRAM

## 1.0 PURPOSE AND APPLICABILITY

This procedure describes the LSG plan for the conduct of training in areas affecting quality. It specifically applies to the training of laboratory personnel in the following areas: LSG quality assurance program, analytical methods, and project-specific requirements. The procedure also addresses training in safety and waste handling procedures.

## 2.0 RESPONSIBILITIES

### 2.1 LABORATORY OPERATIONS MANAGERS AND GROUP LEADERS

The Laboratory Operations Managers and Group Leaders assure that all LSG personnel receive the training necessary to perform their designated tasks, whether by attendance at the School of Laboratory Practices, by method-specific training, by relevant experience acquired prior to employment at NUS, or a combination of these.

Group Leaders are also responsible for ensuring that safety practices are discussed during method-specific training.

Group Leaders are responsible for providing project-specific training to their staffs initially, and to new hires for ongoing projects.

### 2.2 QUALITY ASSURANCE DEPARTMENT

The Quality Assurance Department (QAD) conducts quality assurance training in conformance with the requirements of this procedure.

### 2.3 CUSTOMER SERVICES DEPARTMENT (CSD) AND LSG PROJECT MANAGERS

CSD (for production-managed jobs) and the LSG Project Manager (for project-managed jobs) conduct project-specific training for key LSG personnel and/or delegate a qualified person to provide this training in accordance with this procedure.

CSD or the LSG Project Manager are further responsible for conduct of project-specific safety training.

## 2.4 SAFETY COORDINATOR

The facility Safety Coordinator is responsible for conducting safety training as defined in this procedure for all LSG personnel. He/she is responsible for ensuring that this training is provided, but the actual training ma_ be delegated to any person designated by the Safety Committee.

## 2.5 SCHOOL OF LABORATORY PRACTICES DIRECTOR

School of Laboratory Practices (SLP) instructors provide lecture and "hands-on" laboratory training sufficient to qualify personnel who successfully complete a course to perform generic analyses in the discipline taught in that course.

# 3.0 PROCEDURE

## 3.1 QUALITY ASSURANCE TRAINING

3.1.1 Training in the overall quality assurance program and quality assurance procedures is conducted annually, at a minimum. Annual refresher training in the quality assurance program is mandatory for all LSG staff.

3.1.2 Interim training is provided to new personnel, as appropriate to their respective work assignments, and to all key personnel when major revisions are made in specific quality assurance procedures.

3.1.3 The QAD determines the personnel who require training in a specific area on a need-to-know basis.

3.1.4 Attendance records indicating the training received are maintained in the quality assurance files.

## 3.2 SAFETY TRAINING

3.2.1 Training in the safety program is conducted annually, at a minimum. Annual refresher training in the safety program is mandatory for all LSG staff. Training in emergency procedures such as fire and evacuation drills is conducted on a regular basis with at least one annual emergency drill scheduled for each facility.

3.2.2 All LSG personnel receive site-specific safety training at the point of hire as appropriate to their respective work

assignments, as specified by the "Right-To-Know" or HazCom requirements, and as specified in the Safety Manual. The format and contents of the training course offered is at the discretion of the site Safety Committee or Safety Director except that the following elements shall be included and documented:

- An explanation or summary of the OSHA Hazard Communication Standard as it applies to the specific site.
- OSHA mandated list of hazardous chemicals and the work area and work place lists of hazardous chemicals.
- LSG hazard evaluation program for that facility.
- Training in the use of Material Safety Data Sheets and in internal labeling requirements for any materials in original containers when removed from their containers or when disposed in accordance with the waste disposal procedures for that site.
- Training in the use of personal protective equipment required or recommended for the job assignment.
- Training in hazards associated with the work environment with specific emphasis on hazards associated with the specific area to which the employee will be assigned.
- Training in emergency procedures.
- Delineation of policies and procedures, such as requirements for safety glasses and other personal protective wear and the policies for enforcement and potential penalties for violation of these policies.
- Training in the waste disposal policies specific to the site.

3.2.3 Safety training specific to analytical methodology shall be conducted as follows:

- Group Leaders or their designees are responsible for ensuring that analytical personnel receive training in potential hazards associated with a lab method which go beyond the scope of the safety training delineated above.

- Account Executives or the LSG Project Manager or their designees are responsible for ensuring that all personnel handling samples from a project site where samples are known or expected to pose a hazard receive safety training appropriate to that site, and that all sample handling personnel receive training in safe sample handling and disposal as appropriate to their assigned job functions.

- All persons attending the courses sponsored by the School of Laboratory Practices shall receive general training in the safety precautions and requirements specific to the analytical discipline being taught.

3.2.4 Attendance records shall be maintained in the safety files as evidence of training.

## 3.3 ANALYTICAL METHOD TRAINING

Analytical method training is prerequisite to sample analysis by an analyst who is not under the direct supervision of an experienced analyst. Analytical method training may take one of three forms, or a combination thereof, at the discretion of the Laboratory Operations Manager: (1) generic training at the School of Laboratory Practices, (2) method-specific training by an experienced analyst, and (3) method-specific self-training. Documentation of training is maintained by the Laboratory Group Leader.

### 3.3.1 School of Laboratory Practices (SLP)

- The SLP provides off-line generic method training or instruction in the theory and skills required to perform laboratory analyses ranging from basic skills such as measurements and labware cleaning to advanced class work in sophisticated, state-of-the-art techniques such as GC and metals analyses.

- The Laboratory Operations Managers works with the Director of the SLP to schedule attendance at the appropriate SLP courses. To the extent practical, hiring and transfers between laboratory groups should be performed so that SLP classes can be formed consisting of several individuals receiving concurrent training.

- SLP courses are structured for both in-house and commercial training. The SLP class work involves both classroom lectures and "hands-on" laboratory practice. Attendees are

provided with a course syllabus and supplementary texts where necessary. Laboratory personnel work closely with the SLP Director to make instrumentation and necessary specialized expertise available for training purposes so that all personnel attending the SLP will have had experience in performing the techniques taught in the course.

- Evidence of training is maintained in the SLP files for all personnel who have completed the requirements for an SLP training course(s). This evidence consists of the following:

  - Daily training attendance records for both the class and the laboratory sessions.

  - Certificates of course completion issued by the SLP attesting that the individual has completed all course requirements.

  Persons who fail to meet all course requirements will not have a certificate of completion issued, but may at a later date have such a certificate issued after completing any unfinished course requirements.

- The Director of the SLP provides a copy of the certificates of the LSG personnel who have successfully completed each course to the Laboratory Group Leader for inclusion in the training files after all course requirements have been completed.

3.3.2 <u>Method-Specific Training by an Experienced Analyst</u>

- Method-specific training is conducted on a one-on-one or small group basis by a trainer, selected by the Group Leader, who is experienced in the procedure. During the training period the trainer closely supervises all work performed by the trainee and reviews the trainee's work at the end of each day. During training, both the trainer and the trainee sign-off jointly on the work performed. The trainee is identified by an encircled "T" on the analysis log.

- The trainee works from a controlled copy of the analytical method at all times during training. Training must agree with the approved written procedures.

The trainer explains and demonstrates the following during the course of training:

- Preparation of standards and reagents.
- Standardization procedures.
- Care and operation of equipment and instrumentation.
- Sample analysis.
- Data reduction.
- QC requirements and acceptance criteria.
- Special instructions for specific sample sources.
- Common interferences and corrective measures.
- Glassware cleaning requirements.

o The trainee analyzes standards initially whenever practical and shall not analyze samples until standard recoveries are within quality control limits. Analysis of the standards shall be documented in an analysis log.

o At the end of the training period, when the trainee has demonstrated mastery of the analytical method to the satisfaction of the trainer based on his/her understanding of the technique and on quality control results within acceptance limits, the trainer completes the analyst's training record form. The training record contains the following information, at a minimum:

1. The beginning and end dates of the training.
2. The name of the trainer and the trainee.
3. The test(s) which were learned.

3.3.3 Method-Specific Self-Training

o At the election of the Laboratory Operations Manager, an analyst may either develop a new analytical procedure (i.e., new to LSG) or may train himself/herself in analytical procedures or disciplines already established as routine functions for LSG by virtue of education, experience prior

to hire at LSG, or demonstrated competence by meeting any of the criteria specified in the following guidelines:

- Bachelor's degree in chemistry or related field with prior analytical chemistry experience, or a Master's or Ph.D. degree in chemistry, or

- More than 6 months' experience performing related analyses and demonstrated competence based on the Group Leader's evaluation of previous work experience and on the performance of the analyst in the current job assignment.

o A specific validation protocol is established by the Group Leader in conjunction with the Quality Assurance Coordinator (QAC) prior to the start of independent training. These established validation criteria must be met by the analyst prior to sample analysis.

For new analytical procedures, the validation protocol includes the following, at a minimum, as applicable to the test:

- A multiple point initial calibration demonstrating the linearity and working range of the procedure.

- A demonstration of proficiency based on the analysis of a minimum of four standards of the same concentration. The mean and standard deviation of the four results will be calculated and compared to similar values published for precision and accuracy in the method reference. If the method reference does not contain precision and accuracy information, the demonstration will be repeated and the agreement between the two sets of data will be used to judge whether or not the method is acceptable for use and whether the analyst is demonstrating proficiency.

- A detection limit study.

Validation studies are evaluated by the Laboratory Group Leader and QAC prior to sample analysis. The Group Leader documents the training on the training record form. When method precision and accuracy requirements have been met, where practical the QAD will submit a QC check sample to verify the continuing accuracy of the technique. Tests that will be performed on an ongoing basis will be included in the Blind QC Sample Program whenever practical.

For established analytical procedures, the analyst training himself/herself performs the demonstration of proficiency described above using one or more blind QC check samples where practical. The Laboratory Group Leader evaluates the analyst's data against LSC current control limits, the precision and accuracy listed in the method, or previous demonstrations of proficiency. When acceptable results are obtained, the Laboratory Group Leader documents training on the training record form.

3.4 PROJECT-SPECIFIC TRAINING

3.4.1 Key personnel assigned to projects of a long term duration, or complex or nonroutine nature receive project-specific training in the procedures required for that job before the inception of the project tasks. For the purposes of this procedure, key personnel are defined as personnel responsible for conducting the work under the project plan (including sample handling and disposal), appropriate supervisory personnel, and any personnel responsible for product review. Project-specific training will not be necessary in cases where LSG's routine approach will meet project requirements.

3.4.2 Training of Group Leaders and Assistant Group Leaders is performed by CSD (for production-managed jobs) or the Project Manager (for project managed jobs). Group Leaders are then responsible for conducting project training for staff members involved in the project.

3.4.3 Group Leaders also provide project-specific training for ongoing projects to new hires.

3.4.4 Attendance records are maintained in the quality assurance files as evidence of training.

## 4.0 RECORDS

The following records are maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records:

- o Records of quality assurance training.
- o Records of safety training.
- o Records of analytical method training.
- o Records of project-specific training.

# LABORATORY SAMPLE TRACKING

## 1.0 PURPOSE AND APPLICABILITY

This section of the General Quality Assurance Plan outlines procedures for receipt, log-in, storage, and tracking samples received for analysis at fixed-base laboratories.

## 2.0 RESPONSIBILITIES

### 2.1 LOGISTIC SUPPORT GROUP LEADER

The Logistic Support Group Leader shall supervise sample receipt and log-in personnel. The Logistic Support Group Leader also arranges for sample receipt during off-hours.

### 2.2 SAMPLE LOG-IN CLERK

The Sample Log-in Clerk shall receive samples during normal working hours and log in all samples in a timely manner. The Sample Log-in Clerk is also responsible for notifying Laboratory Group Leaders of the receipt of samples having limited holding times.

Identify radioactive samples at check-in using the criteria provided in section 3.5.1.

### 2.3 ACCOUNT EXECUTIVE (ALSO PROJECT MANAGER, BIOASSAY GROUP LEADER, INDUSTRIAL HYGIENE GROUP LEADER)

The Account Executive is responsible for reviewing sample log-in for completeness and accuracy with respect to parameters assigned, invoicing, and special instructions. If any anomalies are noted during log-in, the Account Executive contacts the client to resolve them. The Account Executive is also responsible for final review of deliverables.

NOTE: The Project Manager assumes these duties for project-managed jobs. The respective Laboratory Group Leaders assume these duties for bioassay and industrial hygiene jobs.

### 2.4 SAMPLE CUSTODIAN

The Sample Custodian is responsible for storage and retrieval of samples, for maintenance of the sample storage areas, for moving samples from primary to secondary storage, and, under the supervision of the Sample Preparation/Control and Waste Disposal Group Leader, for disposal of samples in accordance with LSG's waste handling procedures after the appropriate holding time has lapsed.

Identify radioactive samples using the uR meter screening procedure provided in section 3.5.2.

2.5 LABORATORY OPERATIONS COORDINATOR

The Laboratory Operations Coordinator is responsible for coordination of interfacility sample shipments.

2.6 RADIOCHEMISTRY GROUP LEADER

Provide log-in personnel with a list of cleints and projects for which radioactive samples may be submitted for analysis. Update the list as necessary.

2.7 RADIOCHEMISTRY PERSONNEL

Take custody of and store samples identified as radioactive materials.

2.8 RADIATION SAFETY OFFICER

Train sample custodians in the proper use of the uR meter to screen incoming samples for radioactivity above background.

3.0 PROCEDURE

NOTE: See Appendix M, Section 3.0 for NJDEP X-408 contract specifications regarding sample log-in and direct laboratory tracking.

3.1 SAMPLE RECEIPT AND LOG-IN DURING NORMAL WORKING HOURS

3.1.1 All samples are received into the laboratory through sample receiving. When samples are received during normal working hours, the Sample Log-in Clerk, Sample Custodian, or a member of the receiving department signs and dates the shipping manifest to acknowledge receipt of the shipping containers.

3.1.2 The Sample Log-in Clerk then examines the shipping containers and verifies that the correct number of shipping containers was received by signing and dating the air bill.

3.1.3 The Sample Log-in Clerk opens the shipping containers to remove the enclosed sample documents.

<u>CAUTION:</u> Samples may contain potentially hazardous materials at high levels. OPEN COOLERS WITH CAUTION. If fumes are apparent or sample containers are broken or

leaking, close the cooler immediately and reopen it under an operating fume hood.

EXERCISE EXTREME CAUTION WITH BROKEN OR LEAKING SAMPLES - THEY MAY CONTAIN HAZARDOUS MATERIALS. If sample tags or accompanying documentation are wet (i.e., possibly contaminated by leaking samples), seal them in a plastic bag.

3.1.4 The Sample Log-in Clerk removes the samples from the shipping container(s) and completes the laboratory sample log-in sheet (Figure 7-1 or equivalent). Analyses requested and sample bottles received are documented using test codes and bottle codes, respectively. (NOTE: In order to maintain consistency in the codes, new codes must be requested from the Quality Assurance Coordinator.)

Any anomalies with the sample containers, such as the following, are noted on the laboratory sample log-in sheet and a nonconformance/corrective action record. (See Figure 15-2.)

- o Broken or leaking sample container.
- o Improper sample container.
- o Improperly preserved sample (with respect to chemical or temperature preservation).
- o Air bubbles in a VOA vial or TOX bottle.

3.1.5 The Sample Log-in Clerk cross-checks the information on the chain-of-custody record, air bill, sample labels, sample tags, and traffic reports to determine if discrepancies exist. If so, it is noted on the laboratory sample log-in sheet and a nonconformance/corrective action record. When all of the information has been recorded and cross-checked, the Sample Log-in Clerk signs and dates the laboratory sample log-in sheet.

If log-in of any samples will be delayed until questions regarding the samples, analyses requested, etc., are resolved with the client, the samples are listed on an off-hours sample receipt log (Figure 7-2 or equivalent) and placed in the sample cooler so that they are not inadvertently misplaced or forgotten.

3.1.6 The Sample Log-in Clerk physically applies a laboratory sample number to each bottle. If sample tags are received with the samples, the laboratory sample number is also applied to these. Care must be taken to ensure that the sample number does not interfere with information recorded on the sample label.

The laboratory sample number consists of seven characters, as follows:

- o H999999 for samples received at the Houston laboratory
- o P999999 for samples received at the Pittsburgh laboratory

where "999999" is a six-digit number, which increases consecutively with each new sample number.

3.1.7 The Sample Log-in Clerk signs and dates the chain-of-custody record. If any anomalies with the samples or their accompanying documentation were noted during log-in, the problem is noted again in the "Remarks" box of the chain-of-custody record.

3.1.8 The Sample Log-in Clerk signs and dates the traffic reports (if received with the sample). The condition of the samples may be recorded on the first traffic report and referenced on the remainder of the reports.

3.1.9 The Sample Log-in Clerk completes the short holding time parameters worksheet (Figure 7-3 or equivalent) for parameters with holding times ≤48 hours. The Inorganics Laboratory Group Leader checks this form periodically throughout the day and assigns analysis of the samples manually for the short holding time parameters.

3.1.10 If direct laboratory tracking of sample custody is to be maintained, the Sample Log-in Clerk completes the top portion of a lab tracking record (Figure 7-4).

3.1.11 Using the information on the laboratory sample log-in sheet, the Sample Log-in Clerk completes sample log-in through the LIMS. This process is explained in the "LIMS User's Guide."

## 3.2 RECEIPT OF SAMPLES FOR ANALYSIS BY CLP PROTOCOLS

Log-in and storage of CLP samples proceeds as described in section 3.1 above, except that an auxiliary sample log-in sheet (Figure 7-5) and an immediate work sheet (Figure 7-6) or equivalent are prepared by the Sample Log-in Clerk. The auxiliary sample log-in sheet is routed with the sample log-in sheet. The immediate work sheet is distributed to the appropriate Group Leaders to inform them of the receipt of the samples. Following check-in review, the documents are filed in the case file.

## 3.3 RECEIPT OF FIRST PRIORITY (RUSH) SAMPLES

3.3.1 Account Executives must clear acceptance of samples for first priority analysis through the Laboratory Operations Manager or the Operations Coordinator, and inform the Logistics Support Manager of their anticipated arrival. The Account Executive then provides the Sample Log-in Clerk with the information necessary for sample log-in: client, job, analyses required, pricing, deliverables, and turnaround commitment.

3.3.2 Upon receipt of the samples, the Sample Log-in Clerk initiates log-in immediately in accordance with section 3.1 above. The Sample Custodian also performs the pH verification (see section 3.7 below) immediately. Once the laboratory tracking numbers have been applied to the sample bottles, the Sample Log-in Clerk distributes an immediate worksheet (Figure 7-6) or equivalent to the appropriate Group Leaders, and the Sample Custodian stores the samples.

## 3.4 RECEIPT OF INDUSTRIAL HYGIENE AND BIOASSAY SAMPLES

3.4.1 The Sample Log-in Clerk, Sample Custodian, or a member of the receiving department sign and date the shipping manifest to acknowledge receipt of the shipping containers. The number of shipping containers received is verified against the airbill, and the air bill is signed and dated. The shipping containers are then forwarded to the bioassay or industrial hygiene laboratory.

If the client prefers, he/she may deliver industrial hygiene samples directly to that laboratory.

3.4.2 Laboratory personnel inspect the shipping containers and samples, review the shipping documents, and complete the sample log-in sheet following LSG Procedure QA-7, sections 3.1.2 through 3.1.5, 3.1.7, and 3.1.10. Perishable samples are refrigerated if analysis will be delayed.

3.4.3 The log-in sheet and sample receipt documents are then forwarded to the Log-in Clerk who assigns sample numbers and completes sample log-in through the LIMS. A copy of the log-in sheet is returned to the Group Leader so that sample numbers can be applied to the sample containers.

## 3.5 RECEIPT OF RADIOACTIVE SAMPLES AND SAMPLES FOR RADIOCHEMISTRY ANALYSIS

This procedure is applicable at LSG facilities possesing a radioactive materials license and/or performing radiochemistry analyses.

3.5.1 <u>Sample Receiving Personnel</u>

a. Examine the documentation received with each sample shipment to determine whether the shipper has identified the samples as containing radioactive materials. If samples are identified as radioactive,

handle them as a radioactive material. (See 3.5.2c below.)

b. Check the client and oject name of each sample shipment against the list of clients/projects potentially shipping radioactive materials. (Note: This list is provided by the Radiochemistry Group Leader (RGL) and updated as necessary.)

c. Samples that are not identified by the shipper as radioactive and that have not been received from clients on the list described in step 3.5.1b above may be considered to be non-radioactive and handled as such.

3.5.2 Sample Custodians

a. If the samples are not identified as radioactive but have been received from a client on the list described in 3.5.1 above, survey the sample using the uR survey instrument maintained in the receiving area.

Note: Surveys are to be performed only by personnel trained by the Radiation Safety Officer (RSO) or his designee.

Also survey all sample containers submitted for radiochemistry analysis so that samples presenting a potential cross-contamination problem can be identified.

b. If the samples are greater than background based on the survey instrument reading, handle them as radioactive materials. (See step 3.5.2c.)

c. If it is determined by steps 3.5.1a or 3.5.2b that samples are radioactive, notify the RSO, RGL, or another member of the Radiochemistry Laboratory for transfer of the samples to a controlled area.

d. If radioactive samples are received after hours, or when no member of the Radiochemistry Laboratory is available, transfer the samples to the radioactive sample staging area designated by the RGL.

e. The RGL will determine the safe handling procedures appropriate to the radioactivity level of the samples as described in Appendix-N.

## 3.6 RECEIPT OF PERFORMANCE EVALUATION (PE) SAMPLES

3.6.1 Upon receipt, external PE samples are given to the local Quality Assura Representative (QAR) prior to log-in. (Note: Radiochemistry PE samples from EMSL-LV are radioactive and are handled in accordance with LSG Procedure RS-7.0, Handling and Shipment of Radioactive Materials.) The QAR completes the sample log-in sheet, identifying analytes and tests to be run on each sample. The due date for the completion of analysis is also defined, along with any special requirements. This information is identified on the work list.

3.6.2 The external PE samples are returned to the QAR following log-in. The QAR gives the samples to the Group Leaders along with the preparation instructions and a copy of the report form. Any special requirements are discussed at that time.

## 3.7 RECEIPT OF SAMPLES DURING OFF-HOURS

3.7.1 The Logistic Support Group Leader makes arrangements for an LSG staff member to receive samples after 5 p.m., on weekends, and on holidays.

3.7.2 Upon receipt of the samples, the assigned LSG staff member signs and dates the shipping manifest to acknowledge receipt of the samples. He/she then examines the shipping containers and verifies that the correct number of shipping containers was received by signing and dating the air bill.

If the chain-of-custody record and samples are not sealed in the shipping container, the LSG staff member also verifies that the correct number of sample containers was received and signs and dates the chain-of-custody record. Any discrepancies are noted in the "Remarks" box on the form. The shipping containers are then placed in refrigerated sample storage.

If a sealed cooler must be opened to perform rush or short holding time parameter analyses, the analyst does the following:

- Observe the custody seals on the sealed cooler; note whether or not they are intact.
- Open the cooler and obtain the chain-of-custody record.

- o Verify that the correct number of sample containers was received. Sign and date the chain-of-custody record. Note the condition of the custody seals at sample receipt (i.e., intact/broken) and any anomalies in the "Remarks" box on the form.

- o Place the cooler in locked, refrigerated storage. Note this on the chain-of-custody form also.

3.7.3 An entry is made on the off-hours sample receipt log (Figure 7-2 or equivalent), which is posted outside refrigerated sample storage. The documents received with the samples are placed on the Sample Log-in Clerk's desk.

3.7.4 The Sample Log-in Clerk checks the off-hours sample receipt log each morning. If unlogged samples have been received, the Sample Log-in Clerk logs them in, starting with paragraph 3.1.3 above.

## 3.8 BIOASSAY AND INDUSTRIAL HYGIENE SAMPLES RECEIVED DURING OFF-HOURS

Follow the procedure described above. Bioassay samples are stored in the locked cooler. Industrial hygiene samples are taken to the Asbestos Laboratory. The shipping documents are placed in the "NOTICE" box on the bioassay laboratory door for bioassay samples or on the Industrial Hygiene Group Leader's desk for asbestos samples.

The following working day, bioassay or industrial hygiene personnel inspect the shipping containers and samples, review the shipping documents, and complete the sample log-in sheet following LSG Procedure QA-7, sections 3.1.2 through 3.1.5, 3.1.7, and 3.1.10.

The log-in sheet and shipping documents are then forwarded to the Log-in Clerk who assigns sample numbers and completes sample log-in through the LIMS. A copy of the log-in sheet is returned to the Group Leader so that sample numbers can be applied to the sample containers.

## 3.9 SAMPLE STORAGE

3.9.1 As soon as possible after the sample log-in sheet is completed and prior to sample storage, the Sample Custodian verifies the pH of chemically preserved, aqueous samples (except VOA and TOX samples) using broad-range pH paper. The

pH check is recorded in a laboratory notebook. If pH adjustment is required, it is performed and documented in the notebook and on the laboratory sample log-in sheet.

3.9.2 The Sample Custodian places the samples in the appropriate storage area. Samples for volatile organics analysis are segregated from other samples to minimize the opportunity for cross-contamination. Samples requiring preservation at 4°C are stored in refrigerated storage units. Samples requiring direct laboratory tracking are maintained in locked storage units.

3.9.3 Samples are retained in primary storage until work is completed. Samples are retrieved and stored by Sample Custodians or analysts. Following generation of the report, the Sample Custodian moves the samples to secondary storage. Thirty days thereafter, unless otherwise specified, the samples are disposed of in accordance with LSG's waste handling procedures.

NOTE: See Appendix M, Section 3.0 for NJDEP X-408 contract specifications regarding sample storage.

## 3.10 REVIEW OF SAMPLE LOG-IN

3.10.1 Following sample log-in, the laboratory sample log-in sheets, the documents received with each set of samples, and a printout from the LIMS of the information entered at sample log-in are routed to the Account Executives for review of the following.

- Are the correct preparation and analysis methods assigned?
- Is all of the chain-of-custody information in agreement? Has laboratory receipt been documented on the field chain-of-custody record and the air bill?
- Is all sample log-in documentation accounted for?
- Are there any anomalies with sample containers, preservation, or sample identification that the client should be informed of? If any anomalies were noted on the laboratory sample log-in sheet, the Account Executive contacts the client to discuss resolution of the problem. The Account Executive then notes the action to be taken on the nonconformance/corrective action record, which is maintained in the client file, and directs efforts as necessary to carry out the resolution.

- o Is pricing correct?
- o Are quality control, deliverables, and lab tracking designations correct?

If any of the information entered into the LIMS is incorrect, the Account Executive notes the appropriate changes on a speed letter (Figure 7-7) or equivalent. When the changes have been completed, the Account Executive signs and dates the laboratory sample log-in sheet.

3.10.2 After each Account Executive has reviewed the log-in documents, the laboratory sample log-in sheets, speed letters containing corrections, documents received with the samples, and LIMS printout are forwarded to the Manager of Laboratory Operations. The Laboratory Operations Manager reviews any changes that are critical with the Laboratory Group Leaders. The LIMS sample receipt and log-in documents are then forwarded to the Sample Log-in Clerk who makes the corrections. Completed corrections are noted on the speed letter and a copy of the speed letter is returned to the Account Executive. The laboratory sample receipt and log-in documents are maintained in the active jobs file.

## 3.11 SAMPLE ANALYSIS AND DATA ENTRY

3.11.1 Periodically, the Group Leader prints a work list from the LIMS. The work list shows the sample number, date received, preparation method, analytical method, analyte, and client for the selected test(s) and samples. As soon as sample log-in is completed, the analyses are available for inclusion on the work list.

3.11.2 Working from the work list, immediate work sheet, or short holding time parameters work sheet, the analyst requests the appropriate samples from the Sample Custodian. If the analyst is working during a weekend or evening when a Sample Custodian is not available, the analyst will retrieve the samples.

3.11.3 Sample preparation and analysis is documented in laboratory notebooks and on preprinted worksheets. In addition, instrument output (chromatograms, quantitation reports, etc.) are printed and retained in files in the laboratory. (See also LSG Procedure QA-10, section 3.1.1.)

3.11.4 During data entry, the book and page number of the analysis log record is entered into the LIMS along with the results so that the raw data are easily retrievable. The process of data entry is outlined in Appendix K, "The LIMS User's Guide."

## 3.12 REPORT PREPARATION

NOTE: See Appendix M, Section 4.0 for NJDEP X-408 contract specifications regarding deliverables.

3.12.1 Following review and approval of the data at the Laboratory Group Leader and Operations Manager levels, the project deliverables are assembled. LSG's standard lab analysis report, which is generated through the LIMS, is shown in Figure 7-8. This report may be supplemented by a quality control report, which contains the following supplementary information, as applicable to the analytes in the report.

- o Sample preparation method, batch number, date, time, and analyst.
- o Sample analysis method, batch number (if not previously assigned during sample preparation), date, time, analyst, and instrument.
- o Surrogate standard recovery for organic parameters, by fraction.
- o Laboratory control sample recovery for parameters for which surrogate standards are not feasible.
- o Method blank results.
- o Duplicate and matrix spike or duplicate matrix spike results.

The original copy of the field chain-of-custody record is also delivered with the report, unless it has been previously returned to the client.

The lab analysis report and quality control report may be supplemented with additional information, such as initial and continuing calibration data or raw data, at the client's request. This information must be assembled manually.

LSG will also prepare full USEPA CLP deliverables for work performed according to CLP protocols.

3.12.2 As each portion of the deliverables is assembled, it is given to the Account Executive. The Account Executive assembles the deliverables package, and authorizes delivery of the package to the client. A copy of all deliverables, the laboratory sample log-in sheet, and documents received with the samples are retained in the client or project files.

## 3.13 BIOASSAY REPORT PREPARATION

3.13.1 Upon completion of analysis, the analyst, date and time of analysis, results, and book and page number are entered into the LIMS.

3.13.2 Bioassay personnel prepare the laboratory analysis report containing the information listed in Table 7-1.

3.13.3 The report is reviewed and approved (signed) by the Bioassay Group Leader and a Quality Assurance Representative prior to its delivery to the client.

## 3.14 CLIENT AND PROJECT FILES

The client files contain the following for each job. (Note: All records will not be applicable to all jobs.)

- o Bill of lading/air bill
- o Field chain-of-custody records
- o Traffic reports
- o Sample log-in sheet (and auxiliary sheet and immediate worksheet when generated)
- o Sample tags
- o All project-related correspondence (internal and external)
- o Laboratory tracking records
- o A complete set of the deliverables
- o Holding blank data

For CLP projects, these records plus a document inventory (see Figure 7-9) and all raw data (i.e., laboratory notebook pages, preprinted work sheets, and instrument printouts) will be retained in separate project-specific files. The Document Custodian will maintain a document inventory for each project file.

## 3.15 SAMPLE TRACKING

### 3.15.1 Indirect Tracking

The handling of all samples may be tr c-d indirectly through the following documents:

- o Field chain-of-custody record (when supplied by the client) showing custody of samples from the time of collection through their receipt at the laboratory.
- o Sample traffic reports (when supplied by the client).
- o Sample log-in sheet correlating each sample with a unique laboratory tracking number and identifying any anomalies with the samples.
- o Analysis logs documenting the date and time of sample preparation and/or analysis, the analyst, the method used, the instruments used, etc. Each result reported is traceable to an analysis log entry. Whenever practical, the logs are supplemented by instrument output, such as quantitation reports, chromatograms, etc..
- o The laboratory analysis report, which lists results for the samples. This may be supplemented by a quality control report, which provides the additional information listed above, or it may be replaced by a CLP data package.

### 3.15.2 Direct Tracking

NOTE: See Appendix M, Section 3.0 for NJDEP X-408 contract specifications regarding direct sample tracking.

The National Enforcement Investigations Center (NEIC) of the EPA defines custody of evidence in the following ways:

- o It is in your actual possession, or
- o It is in your view after being in your physical possession, or
- o It is in your possession and then you locked or sealed it to prevent tampering, or
- o It is in a secure area.

LSG will maintain direct sample tracking showing the transfer of samples from secure, locked sample storage to the secure laboratory area and back to locked storage when requested to do so by the client.

To maintain chain of custody within the laboratory, samples, sample extractions, and sample digestions are stored in locked areas when not in use for sample preparation or analysis. Keys to the locked storage areas are controlled by the Sample Custodian or designated laboratory personnel. The following LSG personnel are authorized to access samples in locked storage.

- Account Executives
- Drivers
- Laboratory Analysts
- Laboratory Assistants
- Laboratory Group Leaders and Assistant Group Leaders
- Laboratory Operations Managers
- Logistic Support Group Leaders
- Quality Assurance Coordinator
- Quality Assurance Representatives
- Sample Custodians
- Sample Log-in Clerks

The following steps are taken to document the location of the samples at all times.

- When a sample is to be placed in locked storage following check-in, or a sample extract or a sample digestion is to be placed in storage following sample preparation, the Sample Custodian, Log-in Clerk or analyst obtains a key to the locked storage area and signs the lab tracking record (Figure 7-4). The storage area is unlocked, and the sample or sample preparation is placed in the designated area. The storage unit is locked immediately, and the key is returned.

- When a sample (or its extract or digestion) is to be removed from storage, the Sample Custodian or analyst obtains a key to the storage area, signs the lab tracking record, and unlocks the storage area to permit removal of the sample. The storage area is locked immediately after the removal of the sample, and the key is returned. The analyst is now responsible for the custody of sample.

- When a sample (or its extract or digestion) is to be returned to locked storage, the Sample Custodian or analyst obtains a key to the storage area, signs the lab tracking record, and unlocks the storage area to permit return of the sample. The storage area is locked immediately after return of the sample, and the key is returned.

The laboratory tracking record is placed in the client file or project file following review by data management personnel.

## 3.16 INTERFACILITY SAMPLE SHIPMENTS

In order to use its analytical resources most efficiently and maximize sample throughput, LSG may ship samples from one facility to another for analysis as contractual and regulatory restrictions permit. Since both fixed-base laboratories operate under this General Quality Assurance Plan, the results obtained and level of services rendered at either facility are comparable.

### 3.16.1 Decision Making

The Operations Coordinator at the originating facility (or the Logistic Support Group Leader in his/her absence), in conjunction with the Group Leaders and Project Managers, selects possible samples that might be processed more efficiently at the sister facility because of additional laboratory capacity. Note: Where contractual or regulatory restrictions require that samples be analyzed at the originating facility, interfacility shipments will not be considered.

The Operations Coordinator at the originating laboratory contacts the Operations Coordinator at the receiving laboratory to discuss the feasibility of forwarding the selected samples for analysis. If samples from a project-managed job are involved, the Project Manager at the receiving laboratory is also consulted. The analyses required, sample matrices, any restrictions on the analytical method employed, any anticipated sample matrix-related problems, and quality control, deliverables, and turnaround requirements are also discussed. If the Operations Coordinators are unable to agree on the interfacility sample shipment, the Operations Managers are consulted. If they are unable to reach an agreement, the Assistant General Manager will make the decision.

### 3.16.2 Sample Shipment

The Operations Coordinator at the originating facility identifies the appropriate sample container for the parameter(s) of interest (e.g., wet chemistry bottle, organics bottle, cyanide bottle) and the necessary sample volume. The entire sample, an extract, and/or a digestate may be sent, or an aliquot of of a sample, extract, or digestate may be sent, depending on the work to be done at the originating laboratory. The Operations Coordinator completes an interfacility sample shipment form (Figure 7-10).

The Interfacility Sample Shipment Form is then forwarded to the the Logistic Support Group Leader, who assembles the samples for shipment. (This task may be delegated to a Sample Custodian as long as explicit instructions are provided.) When extracts or digestates are included in a shipment, their related quality control checks (e.g., method blanks, lab control standards, duplicates, matrix spikes, MS/MSDs) must also be sent in the shipment for analysis by the receiving laboratory.

Once the samples have been assembled, the Operations Coordinator verifies that all of the requested samples (and associated quality control check samples for extracts and digestates) have been assembled. A Sample Custodian then packs the samples in a manner that will prevent leaking or breakage, and retain temperature control if required for any of the analytes. The mode of transportation and transfer of custody to the carrier are listed on the Interfacility Sample Shipment Form and a copy of the form is put into a plastic bag and placed in the shipping container. The shipping container is then sealed with custody seals such that the seals will break should the container be opened. A copy of the Interfacility Sample Shipment Form is also forwarded to the Operations Coordinator at the originating laboratory.

3.16.3 Sample Receipt

Upon receipt of the sample shipment, the samples are logged-in according to standard procedure. The Operations Coordinator at the receiving facility functions as the Account Executive for interfacility work, reviewing log-in, deliverables, and invoices, and resolving any anomalies or problems encountered with the Operations Coordinator at the originating facility.

Following log-in review, the receiving laboratory's Operations Coordinator returns a copy of the completed chain-of-custody record and sample shipment form to the originating laboratory's Operations Coordinator, and to the Project Manager if project-managed samples were included in the shipment.

3.16.4 Reporting

Following report preparation, the Operations Coordinator at the receiving facility forwards the deliverables to the Operations Coordinator at the originating laboratory. Deliverables are passed on to the Project Manager for project-managed jobs.

Note: Prior to receipt of the receiving laboratory's laboratory analysis report, the originating laboratory may report data from the receiving laboratory, available from the LIMS, that has passed independent data review. Then, upon receipt of the receiving

laboratory's laboratory analysis report, the Operations Coordinator at the originating laboratory must verify that the data reported initially agree with the results on the laboratory analysis report. Should a discrepancy exist, the originating laboratory must issue a revised report to the client.

## 4.0 RECORDS

The contents of the client and project files will be retained in the client file or case file in support of this procedure, in accordance with LSG Procedure QA-20 of this General QA Plan.

Figure 7-1
Sample Log-in Sheet

SAMPLE LOG-IN SHEET
NUS CORPORATION LABORAOTRY SERVICES GROUP

Page _____ of _____

Client: _____
Report Address: _____
Attention: _____
CC: _____
Phone: _____

☐ Check if new Client

Project: _____
Invoice Address: _____
Attention: _____
Phone: _____

Date/Time Sample Receipt: _____
Air Bill No.: _____
No. Coolers Received: _____
Custody Seals: Yes/No Intact Yes/No
Chain of Custody Record: Yes/No
Sample Tags: Yes/No
Traffic Report: Yes/No

| Log-In Date: | Client No.: | Job No. | SIC | Price Date: | ___ Discount (%) ___ List ___ Premium (%) | PO No: | Vendor No: | Work Order No.: | Project No/ PMS Code: |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

Condition of Samples Upon Receipt:
Ice: Yes/No Ice Packs: Yes/No
Containers Intact: Yes/No
Other: _____

Anomalies: _____

Change Order: Yes/No
Deletions: _____
Additions: _____

Proposal No: _____

| Task No. | Lab Sample Number | Matrix | Sample Identification | Date Sampled | Test Codes (AM/PM) | Bottles |
|---|---|---|---|---|---|---|
| | | | | | | |

Special Instructions: _____

Special Requirements:
___ CLP (1)
___ Lab Tracking
___ Labor
___ MSIS
___ Add Deliverables
___ QC Report
(1) Complete Auxiliary Sheet

Account Executive: _____
Written up by: _____
Logged-In by: _____
Reviewed by: _____

Figure 7-2
Off-Hours Sample Receipt Log

OFF-HOURS SAMPLE RECEIPT LOG
NUS CORPORATION LABORATORY SERVICES GROUP

| DATE REC'D | TIME REC'D | CLIENT | RECEIVED BY | LOCATION OF SAMPLES | # SXs/ # COOLERS | FIELD CHAIN OF CUSTODY RECORD | ADDITIONAL PAPERWORK | LOGGED IN BY/DATE |
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Figure 7-3
Short Holding Time Parameters Work Sheet

**SHORT HOLDING TIME PARAMETERS WORKSHEET**
**NUS CORPORATION LABORATORY SERVICES**

Date/Time Received _____ SAMPLE NUMBERS
Sample No.

| Parameters | Holding Time | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOD | 48 Hrs. | | | | | | | | | | | | | | | |
| Chlorine, Free Residual | Immed. | | | | | | | | | | | | | | | |
| Chlorine, Total Residual | Immed. | | | | | | | | | | | | | | | |
| Chromium, Hexavalent | 24 Hrs. | | | | | | | | | | | | | | | |
| Coliform, Fecal | 30 Hrs. | | | | | | | | | | | | | | | |
| Coliform Total | 30 Hrs. | | | | | | | | | | | | | | | |
| Color | 48 Hrs. | | | | | | | | | | | | | | | |
| Iodide | 24 Hrs. | | | | | | | | | | | | | | | |
| Iron, Ferrous | Immed. | | | | | | | | | | | | | | | |
| MBAS | 48 Hrs. | | | | | | | | | | | | | | | |
| Nitrate (unpres.) | 48 Hrs. | | | | | | | | | | | | | | | |
| Nitrite | 48 Hrs. | | | | | | | | | | | | | | | |
| Odor | 24 Hrs. | | | | | | | | | | | | | | | |
| Orthophosphate | 48 Hrs. | | | | | | | | | | | | | | | |
| Oxygen, Dissolved | Immed. | | | | | | | | | | | | | | | |
| pH | Immed. | | | | | | | | | | | | | | | |
| pH HSL | | | | | | | | | | | | | | | | |
| Phosphorous, Hydrolyzable | 48 Hrs. | | | | | | | | | | | | | | | |
| Phosphorous, Total Dissolved | 24 Hrs. | | | | | | | | | | | | | | | |
| Solids, Total Dissolved | 48 Hrs. | | | | | | | | | | | | | | | |
| Solids, Setteable | 48 Hrs. | | | | | | | | | | | | | | | |
| Sulfite | Immed. | | | | | | | | | | | | | | | |
| Turbidity | 48 Hrs. | | | | | | | | | | | | | | | |

Figure 7-4
Laboratory Tracking Record

LABORATORY TRACKING RECORD
NUS CORPORATION LABORATORY SERVICES GROUP

Page ____ of ____

Case No./Project Name: _____

Location: _____

| Sample Numbers | Date Received | Airbill Number | Containers Received |
|---|---|---|---|
| | | | |

| Container/ Fraction | Sample Numbers (Include blank, MS/MSD, duplicate, etc.) | Removed from Storage | | | Returned to Storage | | |
|---|---|---|---|---|---|---|---|
| | | By | Date | Time* | By | Date | Time* |
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* Military time (e.g., 13:00 = 1 p.m.)

Page ____ of ____

AUXILARY SAMPLE LOG-IN SHEET
FOR CLP PROJECTS

Case No./Project Name _____

Date/Time Sample Receipt _____

| Sample Identification on Bottle | COC Record No. | Sample Tag No. | Lab Sample No. | Does all COC Information agree? |
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NUS CORPORATION LABORATORY SERVICES GROUP

Figure 7-5
Auxiliary Sample Log-in Sheet

Figure 7-6
Immediate Work Sheet

IMMEDIATE WORKSHEET
NUS CORPORATION LABORATORY SERVICES GROUP

DATE/TIME RECEIVED _____ CASE/PROJECT NAME _____

| NUS Sample No. | EPA/Client Sample No. | Matrix | Analyses | Special Instructions |
|---|---|---|---|---|
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DISTRIBUTION:

Figure 7-7
Speed Letter

Speed Letter. 44-902 GrayLine

Speed Letter.

To _____ From _____

Subject _____

MESSAGE

Date _____ Signed _____

REPLY

Date _____ Signed _____

WilsonJones

RECIPIENT—RETAIN WHITE COPY, RETURN PINK COPY

SENDER—DETACH AND RETAIN YELLOW COPY. SEND WHITE AND PINK COPIES WITH CARBON INTACT.

Figure 7-8
Lab Analysis Report

NUS CORPORATION

Laboratory Services Group
5350 Campbells Run Road
Pittsburgh, PA 15205
412-788-1080

REMIT TO:
Park West Two
Cliff Mine Road
Pittsburgh, PA 15275

1.

LABORATORY ANALYSIS REPORT

CLIENT NAME: NUS CORPORATION
ADDRESS: 5350 CAMPBELLS RUN ROAD
PITTSBURGH, PA 15205-0000

NUS CLIENT NO: 0157 0002
VENDOR NO:
WORK ORDER NO: 55830

REPORT DATE: 02/07/89

ATTENTION: MS. LISA MANNING

SAMPLE IDENTIFICATION: LEACHATE BLANK - BATCH 357
NUS SAMPLE NO: P0108244
DATE SAMPLED :
DATE RECEIVED: 19-JAN-89
APPROVED BY: Joanne C. Sieanic

| TEST | DETERMINATION | RESULT | UNIT |
|---|---|---|---|
| OVZHE | VOLATILES - ZHE - PART 261 | | |
| | 1,1,1,2-Tetrachloroethane | <5 | ug/L |
| | 1,1,1-Trichloroethane | <5 | ug/L |
| | 1,1,2,2-Tetrachloroethane | <5 | ug/L |
| | 1,1,2-trichloroethane | <5 | ug/L |
| | 1,1-Dichloroethylene | <5 | ug/L |
| | 1,2-Dichloroethane | <5 | ug/L |
| | 2-Butanone (MEK) | <10 | ug/L |
| | Acrylonitrile | <100 | ug/L |
| | Benzene | <5 | ug/L |
| | Carbon Tetrachloride | <5 | ug/L |
| | Carbondisulfide | <5 | ug/L |
| | Chlorobenzene | <5 | ug/L |
| | Chloroform | <5 | ug/L |
| | Methylene Chloride | <5 | ug/L |
| | Tetrachloroethylene (Perchlors) | <5 | ug/L |
| | Toluene | <5 | ug/L |
| | Trichloroethylene | <5 | ug/L |
| | Vinyl Chloride | <10 | ug/L |
| | i-Butanol | * | ug/L |

COMMENTS: "*" indicates that the compound was undetected after a library search for ions chacteristic for this compound.

Figure 7-9
Document Inventory

(NOTE: XXXXX = Case Number)

RETURN TO:

NUS CORPORATION
5350 Campbells Run Road
Pittsburgh, PA 15205

Attn:

## DOCUMENT RECEIPT ACKNOWLEDGEMENT

The following documents were received from the NUS Corporation, Laboratory Services Division.

Received By: _____
Signature

_____
Title

_____
Date

| DOCUMENT CONTROL NUMBER | DOCUMENT(S) | NUMBER OF PAGES |
|---|---|---|
| XXXXX-3-0001 | Document Inventory | 1 |
| XXXXX-3-0002 | Bill of Lading | 2 |
| XXXXX-3-0003 | Chain of Custody Record | 4 |
| XXXXX-3-0004 | SMO Traffic Report | 1 |
| XXXXX-3-0005 | Sample Tags (37 Tags) | 1 (envelope) |
| XXXXX-3-0006 | Sample Log-In Sheet | 1 |
| XXXXX-3-0007 | Auxiliary Sheet | 1 |
| XXXXX-3-0008 | Immediate Work Sheet | 1 |
| XXXXX-3-0009 | SDG Cover Sheet | 1 |
| XXXXX-3-0010 | Correspondence | 1 |
| XXXXX-3-0011 | CCS Report/Response | 47 |
| XXXXX-3-0012 | Laboratory Analysis Report | 60 |
| XXXXX-3-0013 | Laboratory Tracing Record | 6 |
| XXXXX-3-0014 | Holding Blank Data | 12 |
| XXXXX-3-0015 | Sample Preparation Notebook Page | 4 |
| XXXXX-3-0016 | Injection Log Notebook Pages | 11 |
| XXXXX-3-0017 | Original GC Chromatograms | 21 |
| XXXXX-3-0018 | Data Package | 318 |

Figure 7-10
Interfacility Sample Shipment Form

INTERFACILITY SAMPLE SHIPMENT AND CHAIN-OF-CUSTODY RECORD
NUS CORPORATION LABORATORY SERVICES GROUP

Receiving Lab: _____

Originating Lab: _____

Shipment Approved by: _____

Attention: _____

Date Shipped: _____ Carrier: _____

Total Number of Bottles in Shipment: _____

QC Requirments: _____ Standard; _____ Other: _____
Deliverables: _____ Standard; _____ Other: _____

NOTE: Reference our client number and name for each sample on our 5583 report.

| Orig. Lab Number/ Field ID | Rec. Lab Number | Client | Client No. | Pricing | Charge No. | Date Sampled | Bottles | Tests | Due Date |
|---|---|---|---|---|---|---|---|---|---|
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| Relinquished by: Date/Time | Received by: Date/Time |
|---|---|
| Air Bill No. | |

Page _____ of _____

Additional Instructions: _____

1/91

**TABLE 7-1**
**Content of Bioassay Laboroatry Analysis Reports**

Introduction

1. Permit number
2. Toxicity testing requirement of permit
3. Plant location
4. Name of rceiving body of water
5. NUS Corporation laboratory name, address, and phone number

Source of Effluent and Dilution Water

1. Effluent Samples

   - o Sampling point
   - o Collection dates and times
   - o Sample collection method
   - o Physical and chemical data

2. Surface Water Samples (if used as test sample)

   - o Sampling point
   - o Collection of dates and times
   - o Sample collection method
   - o Physical and chemical data

3. Dilution Water Samples

   - o Source
   - o Collection date and time
   - o Pretreatment
   - o Physical and chemical characteristics

Test Methods

1. Toxicity test method used
2. End point(s) of test
3. Deviation(s) from reference method, if any, and the reason
4. Date and time test started
5. Date and time test terminated
6. Type of test chambers
7. Volume of solution used per chamber
8. Number or organisms per test chamber
9. Number of replicate test chambers per treatment
10. Acclimation of test organisms (temperature and salinity mean and range)
11. Test temperature (mean and range)
12. Specify if aeration was needed

**TABLE 7-1**
**Content of Bioassay Laboroatry Analysis Reports**

Test Organisms

1. Scientific name
2. Age
3. Life stage
4. Source

Information on mean length and weight, diseases and treatments, and the taxonomic key used for species identification are documented and retained by LSG.

Quality Assurance

1. Standard toxicant used and its source
2. Date and time of most recent test
3. Dilution water used
4. Results (LC50 or, where applicable, NOEC and/or EC1)
5. Physical and chemical methods used

Results

1. Raw biological data in tabular form, including daily records of affected organisms in each concentration (including controls) and plots of toxicity data
2. Table of LC50's, NOEC's, LOEC's, etc.
3. Statistical methods used to calculate end points
4. Summary table of physical and chemical data
5. Table of quality control data

# MATERIALS AND FACILITY CONTROL

## 1.0 PURPOSE AND APPLICABILITY

Th.- procedure defines the requirements for control of data quality through control of the raw materials and the environment in which analyses are conducted. Specifically, the procedure addresses procurement of the materials necessary to support the analysis process, inventory control, and security and environmental stability of the facility. The procedure is applicable to all fixed-base LSG facilities.

## 2.0 RESPONSIBILITIES

### 2.1 PROCUREMENT REPRESENTATIVE

The Procurement Representative places all orders for materials, goods, or services. This task may be delegated only to employees selected by the Corporate Manager of Purchasing. The Procurement Representative is also responsible for inspection of materials and goods upon receipt. This task may be delegated to other LSG personnel.

### 2.2 PERSONNEL COORDINATOR

The Personnel Coordinator, or a designee, assigns building keys and security codes to new employees as requested by the Laboratory Operations Manager, and obtains photo identification badges. He/she collects keys, security cards, and badges from employees upon termination.

### 2.3 LABORATORY OPERATIONS MANAGER

The Manager of Laboratory Operations reviews and approves all orders placed for materials, goods, and services. He/she also selects subcontractor laboratories and approves analytical subcontractor data prior to its delivery to LSG's client.

### 2.4 RECEPTIONIST

The receptionist ensures that all visitors complete the visitor registry and are issued a visitor's tag.

### 2.5 FACILITY AND INSTRUMENTATION MAINTENANCE MANAGER

The Facility and Instrumentation Maintenance Manager maintains the physical plant in a condition suitable for the performance of analytical chemistry analyses.

## 3.0 PROCEDURE

### 3.1 PROCUREMENT

#### 3.1.1 Procurement of Materials

o Ordering Materials

When materials are needed to support the analysis process, the analyst specifies the materials to be purchased on a purchase requisition (Figure 19-1, NUS form 379A 0788 or equivalent). Materials placed on order must meet the specifications of the reference method.

Twice weekly, at a minimum, the Procurement Representative contacts the vendor to obtain current prices, determine availability, and place the order pending approval by the Laboratory Operations Manager. A purchase order (Figure 19-2, NUS form 296 1188) is completed when required by the vendor. The date ordered and the expected date of receipt are entered on the purchase requisition.

The purchase requisitions and purchase orders are forwarded to the Laboratory Operations Manager for approval. The Laboratory Operations Manager either signs the form as evidence of approval or asks the Procurement Representative to cancel all or part of the order. (Note: The requester should be notified of any cancellations.)

o Receipt Inspection of Materials

Upon receipt, shipping and receiving personnel unpack the shipment and check the packing list against the contents of the shipment, noting any discrepancies on the packing list.

NOTE: Materials identified as being radioactive are not opened by shipping and receiving personnel, but are handled in accordance with LSG Procedure RS-6, Receipt and Identification of Radioactive Materials.

Analytical instruments and other delicate equipment are opened and unpacked by the Instrument Specialist and/or the Laboratory Group Leader.

Reagent chemicals and standards must be handled with care during unpacking and distribution to prevent spills or other safety hazards.

The date received is recorded on each bottle of reagent or standard material. The packing list is initialed and dated, and forwarded to the Procurement Representative. All items are retained in the receiving area until the Procurement Representative approves the shipment.

If the materials received conform to the approved purchase requisition, the Procurement Representative documents receipt acceptance on the purchase requisition. The shipping and receiving personnel are instructed to release the shipment, and the requisition sheet is updated to show receipt of the materials.

If the materials received do not conform to the approved purchase requisition, the nonconforming items are segregated and returned to the vendor. When replacements for the nonconforming items are received, the receipt inspection process is repeated.

The Procurement Representative retains a copy of the purchase requisitions, purchase orders, and invoices for a minimum of two full years. The purchase requisitions, packing slips, and a copy of the purchase order are forwarded for payment to the accounts payable department in Pittsburgh (Park West Two office) and all originals are finally kept in the accounts payable department in Gaithersburg, Maryland.

### 3.1.2 Procurement of Services

Procurement of services follows the procedures for procurement of materials with regard to the processing of purchase requisitions.

o Arranging for Analytical Services

When an analytical subcontractor must be used to supplement the LSG's analytical services, the subcontractor must provide the following deliverables for receipt inspection so that the data may be validated prior to its delivery to the client.

- A qualifications package including the following: the laboratory's quality assurance plan, resumes of key personnel, a list of major equipment, and a list of certifications. (Note: It is preferable to obtain this information prior to selection of the subcontractor. This information is required only once from each subcontractor. It is evaluated by the QA Department)

- Method references for each test performed.

- Analytical results.

- Supporting documentation including the following: raw data, and the quality control data and acceptance limits associated with the analysis of LSG's samples.

LSG reserves the right to audit the subcontractor to verify qualifications and ensure that the subcontractor meets industry standards.

NOTE: NPDWR compliance monitoring samples may be subcontracted to a laboratory certified to perform drinking water analysis for the parameter(s) in question solely by virtue of the subcontractor's certification. Since the certifying agency has reviewed and approved the laboratory's quality assurance plan, resumes of key personnel, and major equipment related to drinking water analyses, only a copy of the laboratory's certificate is required as qualification. Method references and supporting documentation must still be received from the subcontractor with each set of results.

o Receipt Inspection of Services

When the service performed is preventive maintenance, calibration, and/or repair of equipment or instrumentation, receipt inspection consists of approval of the service report by the person that requested the service.

When the service performed is sample analysis by an analytical subcontractor, receipt inspection consists of review and approval of the deliverables by the Laboratory Operations Manager. Suspect data will ' brought to the subcontractor's attention and must be substantiated to LSG's satisfaction prior to its delivery to the client.

## 3.2 INVENTORY CONTROL

3.2.1 Reagents are used on a "first-in first-out" basis. Only one reagent container should be opened at a time.

3.2.2 Each manufacturer's lot of a solvent used in organic extractions is screened for contamination prior to use in sample analysis. If a positive result is obtained (i.e., a result at or above the reporting limit), the screen is repeated side-by-side with a blank extracted using the solvent lot currently in use. If a second positive result is obtained for the new solvent while a negative result is obtained for the old solvent, the new lot of solvent cannot be used for the extraction method. The solvent is returned to the vendor, or each container of the solvent is labeled to indicate that it is not suitable for the particular extraction method. (Note: If the lot of solvent in question passes the screen for another extraction method, it may be used for that method.)

3.2.3 Standards exceeding the manufacturer's expiration date cannot be used as calibration standards. They may be used as calibration checks, however, until such time as degradation is apparent. At that point, they must be disposed of in accordance with LSG's waste handling procedures.

Reagents exceeding the manufacturer's expiration date may be used until such time as degradation is apparent and/or quality control problems arise. At that point, they must be disposed of in accordance with LSG's waste handling procedures.

## 3.3 GLASSWARE CONTROL

### 3.3.1 Volumetric Glassware

All volumetric glassware must be Class A. Volumetric glassware must not be subjected to high temperatures, as this may deform the glassware and alter its volume.

### 3.3.2 Glassware Cleaning Procedures

The proper procedures for the care and cleaning of laboratory glassware are determined by several factors. These include: the substances to be removed, the analyses to be performed, and the composition of the vessel to be cleaned.

a. **Glassware Used for Trace Metals Analyses**

- Wash with warm soapy water and, if necessary, Nochromix acid solution.
- Rinse with tap water.
- Rinse with 1:1 nitric acid and water mixture.
- Rinse with tap water.
- Rinse with 1:1 hydrochloric acid and water mixture.
- Rinse with tap water and successive portions of reagent water.
- Store in a clean environment.
- Alternatively, following the soapy water wash and the first tap water rinse, glassware may be soaked in 1:1 $HNO_3$ overnight, then rinsed with successive portions of reagent water.

b. **Glassware Used for Bacteriology**

- Wash with phosphate-free detergent that has acceptable inhibitory residue test results.
- Rinse with hot water followed by successive reagent water rinses.
- Autoclave at 120° for 15 minutes to sterilize.
- Store in a clean environment.

c. **Glassware Used for Trace Organic Analyses** (except for Total Organic Halogen Analyses)

- Rinse as soon as possible after use with acetone.
- Scrub with residueless soap.

- Rinse thoroughly with tap water.
- Rinse three times with reagent water.
- Treat non-volumetric glassware in a muffle furnace at 450°C for at least four hours.

- Rinse volumetric glassware and graduated cylinders with chromic acid solution, tap water, and successive portions of organic-free reagent water. Dry at 103°C.

- Store in a clean environment and rinse with solvent before use.

d. **Glassware Used for Total Organic Halogen (TOX) Analyses**

- Wash with hot, soapy water and rinse with warm tap water.

- Rinse with chromic acid cleaning solution.

- Rinse with tap water followed by successive rinsings with reagent water.

- Treat non-volumetric glassware in a muffle furnace at 400°C for at least 30 minutes

- Rinse volumetric glassware with successive portions of organic-free reagent water and air dry or dried at 103°C.

- Seal with aluminum foil in a clean environment immediately after cooling.

e. **Glassware Used for Phosphorus Analyses**

- Rinse with 1:1 hydrochloric acid and water mixture.

- Rinse with tap water and successive portions of reagent water.

- Store in a clean environment.

- Rinse glassware with 1:1 hydrochloric acid, tap water, then reagent water immediately before use.

f. **Oil and Grease Gravimetric Flasks**

- Rinse with acetone (and freon if necessary).

- Rinse with successive portions of tap water.

- Rinse with chromic acid cleaning solution.

- o Rinse with tap water and successive portions of reagent water.
- o Thoroughly rinse outside of flasks and dry with a paper towel.
- o Store in oven at 105°C until use.

g. **BOD Bottles**

- o Clean bottles and stoppers with a 2% Chlorox solution.
- o Rinse thoroughly with tap water and successive portions of reagent water.
- o Dry bottles in a 105°C oven for two hours or until dry.
- o Cap bottles with aluminun foil or store inverted.

h. **Spectrophotometric Absorption Cells**

- o Always start with reagent water for aqueous solutions or a suitable organic solvent for organic materials.
- o Clean the cell with a mild agent as soon as possible after each use.
- o For hard-to-remove deposits, use a solution of 50 percent 3N HCL and 50 percent Ethanol.
- o Nitric acid rinses are permissible, but dichromate solutions are not recommended because of the absorptive properties of dichromate on glass.
- o NEVER use any brush or instrument which might scratch the sides of the cell.
- o NEVER use alkali, abrasives, etching materials, or hot, concentrated acids to clean cells.
- o NEVER use ultrasonic devices to clean cells.
- o Rinsing and drying of cells with alcohol or acetone before storage is a preferred practice. Remember that if a reagent is not of spectrograde purity, it may leave a deposit on the cell window after evaporation.

- o NEVER blow the cell dry with air. It is better to speed evaporation of the solvent with the aid of vacuum.

- o DO NOT touch the optical surfaces of any absorption cell. Natural oils or perspiration on the hands will form smudges on the optical surfaces which will absorb or reflect light.

- o Wipe surfaces clean with lens paper or tissue.

i. **Radiochemistry Glassware Cleaning**

- o Wash with warm, soapy water and rinse with tap water.

- o Rinse with Nochromix acid solution.

- o Rinse thoroughly with tap water followed by successive rinsings with reagent water.

j. **General Glassware Cleaning**

- o Wash with warm, soapy water and, if necessary, chromic acid solution and/or appropriate solvent.

- o Rinse with tap water followed by successive rinsings with reagent water.

k. **Removal of Stopcock Grease or High Vacuum Grease**

- o Rinse glassware with a solvent and wipe with a paper towel. Clean with chromic acid cleaning solution. Clean as usual.

OR

- o Clean glassware in a solution of 10-15 mL of 50 percent KOH in 100 mL Ethanol. (Note: Prolonged exposure of glassware to this solution may etch the glass. Ten minutes is sufficient soaking time to remove all traces of grease.) Clean as usual.

## 3.4 FACILITY SECURITY

3.4.1 All entrances to the facility are locked on weekends and holidays, and during non-business hours on weekdays.

3.4.2 At the discretion of the Laboratory Operations Manager, LSG personnel are issued a key to the facility, a security system identification card containing a unique code, and a set of entry/exit procedures.

3.4.3 Building keys are numbered and are controlled by a designated administrative assistant. He/she conducts an occasional spot check of keys to ensure that keys have not been misplaced.

3.4.4 A photo identification badge is issued to each LSG employee. The badge is worn in a conspicuous place while in the facility.

3.4.5 Visitors are required to register at the front desk. The visitor's name, the company he/she represents, the time of arrival and departure, and the name of the employee whom he/she is visiting are recorded on the visitor registry. The visitor is issued a visitor's tag. An LSG employee will escort the visitor throughout the facility and ensure that he/she signs out upon departure.

NOTE: Visitors remaining in the reception area need not register. Service personnel who are familiar with the facility need not be escorted. They must register and wear a visitor's tag, however.

3.4.6 Upon termination of employment with LSG, security cards and keys are returned to the Personnel Coordinator.

## 3.5 LABORATORY ENVIRONMENTAL CONTROL

Since analytical chemistry techniques are sensitive to temperature and humidity, the laboratory environment must remain consistent with respect to these conditions. Stable sources of electrical power and reagent water are also essential to the production of valid data. Therefore, the following requirements have been established to control the laboratory environment.

- Changes in ambient temperature should not exceed 5°C in an 8-hour shift.
- Cold sample storage should be maintained at 2 - 6°C.
- Reagent water must have a resistance >1 Mohm.cm at 25°C.
- Surge suppression devices should be used on instrumentation that is sensitive to changes in current.

- o Equipment should be properly grounded.
- o Fume hoods should maintain a face velocity ≥100 ft/min (linear) with the sash fully open.

## 4.0 RECORDS

The following records will be maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

- o Purchase requisitions and purchase orders.
- o Requisition sheets.
- o Analytical subcontractor deliverables.
- o Service reports.
- o Solvent screening data.
- o Building key distribution list.
- o Visitor registry.
- o Refrigerated sample storage temperature logs.

Figure 19-1
Purchase Requisition

**NUS CORPORATION AND SUBSIDIARIES** — **PURCHASE REQUISITION**

SUPPLIER:

ATTENTION:

PHONE:

P.O. NO.:

DATE:

CHARGE NO.:

AFE NO.: (CAPITAL ITEM)

GOVERNMENT CONTRACT NO.:

☐ VENDOR REQUIRES TYPED COPY ☐ VENDOR ACKNOWLEDGMENT REQUIRED ☐ CONFIRMING ORDER

| ITEM NO. | QUANTITY | DETAILED DESCRIPTION | UNIT PRICE | TOTALS |
|---|---|---|---|---|
| | | | | |
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SHIP TO:

ATTENTION:

TOTAL

DATE NEEDED:

REQUESTED BY:

APPROVED BY:

Figure 19-2
Purchase Order

**PURCHASE ORDER**
FROM

NUS CORPORATION

Laboratory Services
5350 Campbells Run Road
Pittsburgh, PA 15205
(412) 747-2500

PURCHASE ORDER NO.:

DATE:

REQUESTED BY:

APPROVED BY:

ACCOUNT:

SHIP TO:

TO:

*PLEASE ENTER OUR ORDER FOR THE FOLLOWING, SUBJECT TO TERMS AND CONDITIONS STATED BELOW OR ATTACHED HERETO:*

NEED DELIVERY BY:

| ITEM | QUANTITY | DESCRIPTION | UNIT PRICE | TOTAL |
|---|---|---|---|---|
| | | | | |

PURCHASE AUTHORIZATION BY:

ORDER NUMBER MUST APPEAR ON ALL PACKAGES, SHIPPING PAPERS, AND INVOICES. PREPAY SHIPPING CHARGES, IF ANY, AND SHOW SEPARATELY ON YOUR INVOICES. TERMS: NET 30 DAYS UNLESS OTHERWISE STATED.

NUS 299 REVISED 1188

AN EQUAL OPPORTUNITY EMPLOYER

NUS CORPORATION

## 1.0 PURPOSE

As of August 5, 1985, small quantity waste generators are required under RCRA to label and dispose of hazardous waste by sending them to an EPA or state-approved waste handling facility. The purpose of this procedure is to delineate hazardous waste safe handling practices for the protection of laboratory personnel, and to ensure that each laboratory facility within LSG, as a small quantity waste generator, meets RCRA requirements.

## 2.0 APPLICABILITY

This procedure is intended to control all waste disposal practices within the Laboratory Services Group.

## 3.0 DEFINITIONS

3.1 Laboratory-Generated Waste - Reagent chemicals, solvents, and acid wastes classified as hazardous, and empty solvent or acid containers.

3.2 Sample Waste - Aqueous, sludge, organic/oil, and solid samples, subsequent extracts or digestates of samples, and sample containers.

3.3 Mixed Low-level Waste - Waste that is characterized as radioactive and having any of the following characteristics: Ignitability, Corrosivity, Reactivity, or Toxicity.

3.4 RCRA - Resource Conservation and Recovery Act.

## 4.0 REFERENCES

4.1 40 CFR 260-270, RCRA Guidelines for Identification and Disposal of Hazardous Wastes.

4.2 Department of Transportation Waste Transport Regulations

4.3 LSG Standard Operating Procedure RS-8.0, "Handling, Storage, and Shipment of Radioactive Waste".

## 5.0 DISCUSSION

Hazardous waste generators, transporters, and disposers are generally controlled by RCRA, DOT, and NRC regulations and guidelines, and state-specific requirements. Hazardous waste disposal is prescribed within RCRA and other applicable federal regulations for each category of waste. LSG wastes fall into two basic categories: (1) sample waste and (2) laboratory-generated waste. Each category requires specific controls on handling and disposal. LSG also receives a small number of noxious samples that require special controls on storage, handling, and disposal. A standard operating procedure is necessary to define the requirements for handling all categories of waste produced by LSG at its operating facilities, and to ensure that LSG meets all RCRA and DOT requirements for labeling and disposal of these hazardous wastes.

## 6.0 RESPONSIBILITIES

6.1 Each Laboratory Group Leader shall:

- o Post a list identifying proper disposal procedures for all solvents, acids, dry reagents, and standard materials used in the laboratory.
- o Post a copy of the Laboratory Waste Disposal Procedure near the waste storage area for each laboratory.
- o Ensure that analysts adhere to practices delineated in the posted waste handling documents.

6.2 The Hazardous Waste Coordinator (HWC) shall:

- o Ensure that all sample disposals are performed properly by segregating the samples prior to disposal in accordance with the requirements of this procedure.
- o Ensure that personnel handling hazardous materials are trained in LWD-1 upon hire and at least annually thereafter.
- o Ensure that Sample Custodians are trained in the requirements of this procedure. Specifically, their duties shall, at a minimum, include sample disposal and monitoring the waste storage area for cleanliness. Other duties may be assigned to Sample Custodians as needed in order to comply with the requirements of this procedure.

While sample disposal may be delegated to Sample Custodians, it is the ultimate responsibility of the HWC to ensure that all procedural requirements are met.

6.3 The Quality Assurance Department shall monitor compliance of all groups with this procedure annually, at a minimum.

## 7.0 PROCEDURE

### 7.1 Safety

For personal protection, all laboratory personnel must, at a minimum, wear gloves, safety glasses or goggles, and a laboratory jacket when handling waste of any type. In addition, the specific handling procedures for various categories of wastes delineated below must be followed.

#### 7.1.1 Laboratory-Generated Waste

- When disposing of chlorinated or nonchlorinated solvent waste into one-gallon or five-gallon containers located in the hood, be certain that the appropriate funnel and container are chosen for disposal and that the container is closed securely after use. When transferring solvent waste from one-gallon or five-gallon containers into appropriate waste drums, wear a mask fitted with a charcoal cartridge. Be certain that solvent container caps are secure during transport to waste drum, and that drum cap is closed after use.

  Do not mix chlorinated and nonchlorinated solvents.

- When disposing of Chromerge or COD waste into the drum located in the laboratory, or when transferring the drum to the waste storage area, it is strongly recommended that a face shield be worn. Be certain that drum cap is secure after use and when drum is being moved.

#### 7.1.2 Sample Waste

Prior to disposal, all samples must be segregated according to the disposal techniques delineated in Section 7.3 of this procedure.

- o Protective wear for disposing of any samples includes gloves, safety glasses or goggles, and a laboratory jacket, at a minimum.

- o A respirator may be required when handling samples containing asbestos, or when inhalation of a toxic substance could occur.

- o Samples designated as noxious are segregated from other samples and are stored in a hood located in a low traffic area or a cooler located in segregated hazardous waste storage area. These samples are handled in accordance with Section 7.4 of this procedure. Generally, noxious samples will be returned to the client for disposal, and should not require disposal by Sample Custodians.

- o Aqueous sample waste (see Section 7.3.1) that may be flushed into the municipal sewage system is disposed of in the cup sink of a designated hood.

7.1.3 General Waste Disposal Area Safety Requirements

- o In order to prevent laboratory personnel from being overcome by fumes, the waste storage area must always be well-ventilated.

- o On a weekly basis, Sample Custodians monitor the waste storage areas for cleanliness, signs of leakage from drums, and proper labeling of drums. This information is recorded on a log. **To ensure the safety of all laboratory personnel, Sample Custodians must notify the HWC and Laboratory Operations Manager immediately of spills or leakage discovered in this monitoring process.**

- o The HWC must take immediate action to clean up a spill or leak in the waste storage area in accordance with RCRA requirements and sound principles for the health and safety of employees. Any reportable released quantity of a hazardous substance as defined by RCRA, OSHA, or NRC must be reported and managed in accordance with the appropriate guidelines specified in the federal regulations in addition to any requirements specified in this procedure.

- o **NEVER PLACE CYANIDE OR SULFIDE-CONTAINING WASTE INTO A DRUM CONTAINING ACID.**

## 7.2 Disposal of Laboratory-Generated Waste

For the purposes of this procedure, laboratory-generated wastes can be broken down into the following categories. chlorinated solvents; nonchlorinated solvents; Chromerge and COD wastes (which includes wastes containing heavy metals and mineral acids); and miscellaneous reagent chemicals. Additionally, empty containers for acids, solvents, and other reagent chemicals have specific handling requirements. Wastes are segregated in the storage areas as follows:

- Acid
- Bases
- Oxidizers
- Flammables
- Halogenated Organics - ORMA
- Non-Halogenated Organics
- PCB Waste
- Asbestos Waste

The general disposal procedure for each category of waste is as follows:

### 7.2.1 Chlorinated Solvents

These compounds include laboratory solvents that contain fluorine, chlorine, bromine, or iodine as part of their chemical structure, such as chloroform, methylene chloride, and freon. Chlorinated solvent waste is collected in five-gallon containers located in a designated laboratory fume hood. When a container in the designated hood has been filled, it is emptied into the thirty-gallon drum designated for chlorinated solvents, located in the waste storage area.

### 7.2.2 Nonchlorinated Solvents

Nonchlorinated solvents are any category of laboratory solvent that does not have any halogen substitutions within its molecular structure. These include alcohols, ethers, alkanes (such as hexane), and aromatics (such as benzene or toluene). In addition, pyridine-containing wastes generated during cyanide analysis and other similar types of wastes are treated as nonchlorinated solvents.

Nonchlorinated solvent waste is collected in one-gallon or five-gallon containers located in the organic preparation laboratory fume hood or other designated hood. When a container in the designated hood has been filled, it is emptied into the thirty-gallon or fifty-five-gallon drum designated for **nonchlorinated** solvents located in the waste storage area.

7.2.3 Chromerge/COD/Sulfuric Acid Waste

This category of waste includes spent Chromerge; waste from COD analyses; and laboratory reagent wastes containing heavy metal salts, such as mercury-containing waste reagent from the UV-promoted TOC analyzer. These types of wastes are poured into a drum labeled for COD and Chromerge Waste. The drum must be constructed of polyethylene or lined with polyethylene.

**THIS DRUM MUST NEVER BE USED TO DISPOSE OF WASTES WHICH HAVE SALTS CONTAINING SULFIDE OR CYANIDE ANIONS**. Also, do not dispose of materials contining organic acids in this waste drum.

7.2.4 Miscellaneous Reagent Chemicals

In general, hazardous reagent chemicals are segregated by DOT hazard class and stored in the designated waste disposal area, awaiting transport to a disposal facility. Nonhazardous chemicals may be disposed of by mixing them with water and flushing them into the municipal sewage system.

When placing chemicals into storage for disposal as hazardous waste, the following procedure is used:

The Laboratory Group Leader ensures that the waste is clearly labeled with the material and strength (e.g., concentration, normality), and notifies the HWC of the waste. The HWC verifies that the waste requires disposal as hazardous waste, logs in the material, and stores it appropriately. Each entry on the log sheet must include the chemical, quantity, date, and person placing the chemical into storage.

7.2.5 Empty Reagent Containers

- Prior to disposal, solvent cans are triple rinsed, at a minimum, with water and made unfit for reuse by punchin_ holes in the sides and bottom of the container. Solvent containers and lids are then discarded separately into the dumpster. (In addition to possible toxicity, some solvents are flammable, and can be potentially explosive in closed containers.)

- Empty acid and nonhazardous reagent bottles are triple rinsed, at a minimum, thoroughly with water before placing them into the dumpster.

- All cans and bottles are double-bagged with plastic garbage bags before being placed into the dumpster.

7.3 Sample Waste Disposal

LSG's preferred means of disposal is to ship samples back to the client. However, whe a mutually acceptable agreement for return of the samples cannot be arranged, LSG disposes of sample waste as follows.

In general, samples that meet the laboratory criteria for disposal (elapse of 30 days from the time of report completion) are loaded onto laboratory carts for inspection prior to disposal. The HWC or other designated supervisory personnel must inspect ALL samples and determine appropriate handling procedures prior to disposal. The LIMS may be used to flag grossly contaminated waters (e.g., pickle liquors, aqueous samples with percent-level metals or organics) and all oils, sludges, and soils. Note, however, that this does not substitute for the HWC or other supervisory personnel inspecting each sample to determine appropriate handling. A three part procedure following Federal and applicable state regulations is used to determine disposition of the waste.

1) Is the waste excluded? Materials such as household waste, domestic sewage, and fly ash, which are not subject to PA or federal regulations.

2) Is the waste listed? 40 CFR 261 Sub part D lists waste names, EPA ID numbers, and indication of why waste is hazardous.

- o F-List HAZARDOUS WASTES FROM NON-SPECIFIC SOURCES e.g. "halogenzted solvents"

- o K-List HAZARDOUS WASTES FROM SPECIFIC SOURCES e.g. "still bottoms' from distillation of benzyl chloride"

- o P/U-Lists DISCARDED COMMERCIAL CHEMICALS, OFF-SPECIFICATION SPECIES, CONTAINER RESIDUES AND SPILL RESIDUES Thereof. The P-List conains acutely hazardous materials and the U-List contains all others.

3) Does the waste exhibit any characteristics of a hazardous waste? Waste may still be hazardous if it exhibits one or more of the following characteristics:

| | |
|---|---|
| o Ignitabilty | (flash point <140$^{o}$F) |
| o Corrosivity | (pH $\leq$2 $\geq$12.5) |
| o Reactivity | (Explosive; Water/S/CN reactive) |
| o EP Toxicity | (TCLP toxics) |

Samples found to be hazardous by any of these definitions are disposed of as hazardous waste. Samples are physically isolated from other samples and/or are labeled with a fluorescent organic label to distinguish them from other samples to assist the Sample Custodian in disposal.

Each sample bottle placed into storage for disposal as hazardous waste is listed on the appropriate log sheet. Each entry on the log sheet must include a brief description of the material, the quantity, date, and person placed the sample into storage for disposal on hazardous waste. Ultimately, each sample should be traceable to a specific waste shipment.

Qualified vendors are used to pack, ship, and dispose of these wastes. Waste samples shipments are prepared quarterly, at a minimum.

7.3.1 <u>Aqueous and/or Water-Miscible Samples</u>

Samples that are primarily aqueous and organic samples with a 3% or greater solubility in water that are not highly toxic or foul-smelling may be disposed of by flushing them into the municipal sewage system. Approval of the HWC or other authorized supervisory personnel is required before

disposing of samples in this manner. Samples in this category should be disposed of into the cup sink of a designated hood.

7.3.2 Oils, Tars, Sludges and Semisolid Sample Matrices

Samples of this nature are placed in storage for disposal as hazardous waste as follows or returned to the client. These sample matrices are not placed in the dumpster under any circumstances.

7.3.3 Soils

Soil samples that have not been determined to be hazardous may be disposed of in the dumpster. These samples are first double-bagged in plastic garbage bags before they are placed into the dumpster.

7.3.4 Asbestos Samples

All asbestos samples are triple-bagged in sealed plastic bags for disposal into drums used only for asbestos samples. The drum is labeled with information regarding the nature and potential hazards of the contents of the drum. Asbestos samples are stored in plastic trash cans with plastic liners during sample analysis and then moved to the asbestos disposal drums in the Waste Storage Area as necessary.

7.3.5 Empty Bottles and Inert Materials

Only empty bottles (including empty sample bottles) and inert materials are placed in the dumpster. No oils, sludges, water samples, or any materials that have been determined to be hazardous waste are placed in the dumpster. All containers are placed in double-lined plastic bags before they are discarded in the dumpster. No loose bottles are discarded into the dumpster.

7.3.6 PCB Sample Waste

PCB sample waste consists of oils, sludges, tars, soils, or other solids containing greater than 50 mg/kg of PCB. Any material with less than 50 mg/kg PCB may be disposed of as prescribed above for the appropriate matrix. All PCB waste samples are

identified by the analysts immediately upon completion of the analysis by attaching a "PCB Material" sticker to the sample container. Laboratory materials that become contaminated with high concentrations of PCBs during extraction may, at the discretion of the SPD Group Leader, be segregated for disposal as PCB waste.

7.3.7 Radioactive Samples, Materials, and Mixed Waste

Samples that are radioactive and laboratory materials that become contaminated during the course of analysis are handled for disposal according to the requirements of the Radiation Safety Procedure RS-8.0, "Handling, Storage, and Shipment of Radioactive Waste."

7.3.8 Sample Extracts and Digestates

- Metals digestates may be flushed into the municipal sewage system along with other aqueous sample waste except where a significant toxicity hazard is known to exist. As a guideline, digestates or distillates containing more than 0.1% of a hazardous material must be treated as hazardous waste.

- Distillates generated in the inorganics laboratory (e.g., cyanide and phenol) may be flushed into the municipal sewage system except where a significant toxicity hazard is known to exist. As a guideline, distillates and digestates containing more than 0.1% of a hazardous material must be treated as hazardous waste. **Do not flush COD waste into the municipal sewage system.** (See Section 7.2.3 of this procedure.)

- Vials containing organics extracts are packaged in groups according to the type of extract solvent (e.g., hexane, methylene chloride, carbon disulfide). These groups of vials are carefully packed in Ziplock bags, glass jars, or boxes so as to minimize the opportunity for leaking or breakage. The outside is labeled with the number of vials, the approximate capacities of the vials, and the solvent type. The bags are then given to the HWC who places them in the waste storage area.

## 7.4 Procedure for Storage and Handling of Noxious Samples

Samples identified by clients, laboratory personnel, or by their odors as being noxious, foul-smelling, or hazardous are isolated at the time of arrival at the laboratory. These samples are handled as follows:

- The Laboratory Operations Manager and the Account Executive (AE) are notified immediately about problem samples so that clients can be contacted to obtain additional information on the nature and potential hazards associated with the samples.

- Problem samples are not logged-in without approval of the Laboratory Operations Manager. If the decision is made to accept samples for analysis, they are plainly labeled on the bottles by sample log-in personnel as hazardous or noxious material. Where possible, the labels should indicate the nature of the hazard.

- Samples are sealed in wide-mouth glass jars, Ziplock bags or the equivalent, or plastic pails, and stored in a designated fume hood in a low-traffic area of the facility pending analysis or in coolers in segragated hazardous waste storage.

- Laboratory work lists **must** identify these samples as hazardous or noxious and requiring special handling. Analysts are also to be instructed on the work list to obtain handling instructions from their Group Leader before removing problem samples from the hood or starting analyses, so that isolation techniques can be applied as needed.

- Upon completion of analyses and check out of results for noxious samples, the client is contacted by the AE immediately to ascertain proper disposal of any remaining material. The normal 30 day holding period should be waived and the material in question either returned to the client or disposed of properly by laboratory personnel as instructed by the HWC.

- In some instances, work may have to be declined and samples returned to clients in order to protect the health of employees and the working environment of the laboratory.

## 7.5 Procedures for Preparation of Wastes for Off-Site Shipment

### 7.5.1 Inventory of Waste Drums

The SPD Group Leader first checks waste drum logs and waste drums in the waste storage area to determine which drums are ready for shipment. Following this determination, the contracted disposal service is requested to pick up any drums that are full and ready for off-site shipment.

### 7.5.2 Preparation of Manifest

The manifest is prepared either by the disposers or by the HWC. If the manifest is prepared by the disposers, the HWC verifies the contents of the manifest, paying particular attention to the codes used to identify hazardous materials. If the manifest is prepared by the HWC, the following information must be completed at a minimum: 1) generator name and mailing address; 2) generator telephone number; 3) the transporter identifying information; 4) EPA identification numbers for both the generator and the transporter; 5) DOT description of the waste being shipped; 6) additional descriptions of the waste (if required); and 7) any special handling instructions. Other specific information may also be required.

### 7.5.3 Reporting Requirements of State Agencies

Each state agency requires small quantity generators to file reports in accordance with the requirements specified in their waste permits. Examples of these reports include monthly shipment records, and periodic (normally annual) reports on hazardous waste minimization activities. Other records, such as lab pack tracking documents, may also be required.

### 7.5.4 Procurement of Waste Drums

Normally, replacement waste drums will be provided by the company contracted to transport the waste off-site. It is the responsibility of the HWC to ensure that new drums are received, properly labeled, and placed in the waste storage area for use by laboratory personnel.

## 8.0 RECORDS

The following records will be maintained permanently in support of this procedure:

- o Annual reports to regulatory agencies.
- o All shipment reports.
- o Logs of what is contained in waste drums, including drums that have been shipped off-site.
- o Logs or records of inspections of waste storage areas.
- o Original copies of generator permits and any revisions to the permits.
- o Radioactive Material License.

# PREVENTIVE MAINTENANCE

## 1.0 PURPOSE AND APPLICABILITY

These requirements have been established to ensure that instruments used for sample analysis function properly and reliably and to minimize prolonged instrument downtime so that regulatory holding times and other sample turnaround commitments can be met. These requirements apply to LSG's fixed-base and mobile laboratory operations.

## 2.0 RESPONSIBILITIES

### 2.1 GROUP LEADERS

The Group Leaders are responsible for the following:

- o Perform assigned preventive maintenance (PM) at required intervals. (These tasks may be delegated to analysts within the work group familiar with maintenance and operation of the instruments and equipment.)
- o Inform the Quality Assurance Department of changes in the status of analytical equipment, particularly with respect to acquisition of new equipment.

### 2.2 FACILITY AND INSTRUMENTATION MAINTENANCE MANAGER (Instrument Specialist)

The Facility and Instrument Maintenance Managers are responsible for the following:

- o Perform or supervise in-house preventive maintenance, troubleshooting, and corrective maintenance of major equipment.
- o Maintain equipment files.
- o Establish a preventive maintenance schedule for newly acquired equipment, providing any information and assistance necessary to integrate the new equipment into the PM reminder scheme.
- o Label equipment with calibration status stickers.
- o Perform or schedule calibration of test equipment.

2.3 QUALITY ASSURANCE DEPARTMENT (QAD)

The Quality Assurance Department is responsible for the following:

- o Revise equipment lists.
- o Review maintenance logs annually, at a minimum.
- o Distribute reminders for required preventive maintenance performed monthly or less frequently.

## 3.0 PROCEDURE

### 3.1 INSTRUMENT MAINTENANCE LOGS

3.1.1 The performance history of all major laboratory equipment is be documented in instrument maintenance logs. In-house preventive maintenance, trouble-shooting, and corrective maintenance is documented in the log by the LSG staff member performing the maintenance. When maintenance is performed by an outside vendor, the LSG staff member signing the service report shall also note the service performed in the maintenance log so that a chronological record is maintained in the log. The book and page number of the maintenance log entry is referenced on the service report, and the service report is forwarded to the Instrument Specialist for inclusion in the equipment file.

3.1.2 The QAD reviews instrument logs annually, at a minimum.

### 3.2 TEST EQUIPMENT CALIBRATION

The equipment used to calibrate analytical equipment is NIST certified and/or calibrated periodically against standards having known and valid traceability to recognized standards. Requirements are specified below. Calibration of test equipment is documented in the same fashion as analytical equipment calibrations. (See 3.3.3.)

3.2.1 mV standards and 5-1/2-digit voltmeters are calibrated by an outside vendor annually, at a minimum.

3.2.2 Glass/mercury thermometers are calibrated against an NIST-certified thermometer annually, at a minimum. A tag identifying the calibration date and correction factor are physically applied to the thermometers.

3.2.3 Thermocouples are calibrated against a mV standard and an ice bath annually, at a minimum.

3.2.4 Class ⁻ ··eights are used to verify weights maintained at the balances. They are calibrated annually against weights whose calibration is traceable to the NIST.

3.2.5 Weights maintained at the balances are calibrated against Class S weights annually, at a minimum.

3.2.6 Meters used to measure air uptake of exhaust and fume hood are calibrated annually, at a minimum, by an outside vendor.

## 3.3 PREVENTIVE MAINTENANCE OF ANALYTICAL EQUIPMENT

3.3.1 Preventive maintenance (PM) encompasses a variety of operations: specification checks, calibration, cleaning, lubrication, reconditioning, adjustments, and testing. The purpose of preventive maintenance is two-fold: (1) to minimize the occurrence and severity of catastrophic performance losses that result in prolonged equipment downtime, and (2) to detect and correct more subtle, noncatastrophic performance losses before they have a significant impact on data generation and/or quality.

The time frames specified for preventive maintenance activities are minimum requirements; checks/maintenance may be performed more frequently but not less frequently.

3.3.2 Preventive maintenance requirements for analytical equipment are tabulated in Appendix J to this QA Plan. The QAD issues reminders (Figure 13-1 or equivalent) for PM due monthly or less frequently. Reminders are issued to the Group Leader or the Instrument Specialist, as appropriate, approximately six weeks before the PM due date. This will allow sufficient time to schedule the maintenance so that it can be performed prior to the due date with minimal disruption to sample analysis. The Group Leader/Instrument Specialist is responsible for completion of the PM on or before the due date. Performance of the PM may be delegated, but responsibility for its completion rests with the Group Leader/Instrument Specialist.

If the required preventive maintenance cannot be performed on or before the due date, it is the responsibility of the Group Leader/Instrument Specialist to contact the QAD and reach a mutually agreed upon time frame for its completion.

Every effort should be made to keep the preventive maintenance program and supporting documentation current and complete, since failure to do so could result in equipment performance loss and/or the equipment becoming inactive.

3.3.3 The Group Leader or Instrument Specialist performing the preventive maintenance is responsible for documenting the activity in the maintenance log. Documentation includes the following:

- o Brief description of the PM activity.
- o Identification of any equipment used in calibration or verification by type, make, model, serial number, date of last calibration, and calibration due date.
- o Signature of the person performing the PM.
- o Date on which the PM was performed.

The Instrument Specialist labels equipment with a calibration sticker (Figure 13-2) following any calibration or calibration verification performed as part of the PM program.

3.3.4 Inactive equipment is labeled with an inactive sticker (Figure 13-3) and is segregated from active equipment whenever possible. Equipment that is not in conformance with preventive maintenance requirements may be made inactive at the discretion of the Quality Assurance Coordinator (QAC).

3.3.5 Any change in status, from active to inactive or inactive to active, should be recorded by the Group Leader on a Change of Status Record (CSR, Figure 13-4). The completed CSR should be forwarded to the QAD to update the equipment list, then to the equipment file.

## 3.4 REQUESTING IN-HOUSE SERVICE

3.4.1 While preventive maintenance reduces the number and severity of equipment malfunctions, it will not eliminate all malfunctions. Whenever the expertise of the Instrument Specialist is required to trouble-shoot and/or repair equipment, the Group Leader completes a Service Request Form (Figure 13-5). The form serves three purposes: (1) it informs the Instrument Specialist of problems, (2) it helps

the Instrument Specialist prioritize his/her work, and (3) it provides a history of the problems encountered by individual instruments and classes of instruments. (This form is also used to schedule in-house maintenance for the facility.)

3.4.2 The requester completes Part I of the form and notes the request for service in the instrument log. The requester should describe the problem on the form as completely as possible. This allows the Instrument Specialist to evaluate and correct the problem in the most efficient manner. Priority codes are as follows:

- o Priority 1 - Immediate repair required. Downtime will have a major impact on overall laboratory performance. Repair to be completed as soon as possible (i.e., within 1 working day or less if parts/service are available).

- o Priority 2 - Service to be performed within 1 to 5 working days. Limited impact on overall laboratory operations, but significant impact on 1 or more groups. Extended downtime may cause significant problems.

- o Priority 3 - Service to be performed on a scheduled basis. Order of service performed is based on order in which requests are received. Generally service will be performed within 10 to 30 working days. Priority 3 is appropriate when an operable backup system is available.

- o Priority 4 - Service to be performed on inactive equipment or low priority maintenance. Service should be performed within 90 days, even if an outside vendor must be used.

3.4.3 Following servicing, the Instrument Specialist completes Part II of the form. The original form is forwarded to the equipment file and a copy is forwarded to the requester.

3.5 MAJOR EQUIPMENT LIST

3.5.1 All major laboratory equipment is catalogued on a Major Equipment List. The list identifies equipment by type, make, model, and serial number. The list also identifies the year in which the equipment was obtained, the laboratory to which it is assigned, its calibration status, and the

frequency of calibration as applicable to the equipment type. The list is upated by the QAD as equipent is put into or taken out of service.

3.5.2 Equipment that contains radioactive isotopes is listed on the primary equipment list and on an auxiliary Radioactive Instrument/Article Inventory. The Radioactive Instrument/Article Inventory identifies the type of equipment, its make, model, and serial number, the nuclide and its activity, and the Group Leader responsible for the equipment.

3.5.3 Equipment cannot be moved, modified, or discarded without approval of the responsible Group Leader.

## 3.6 NEW EQUIPMENT

3.6.1 Newly acquired equipment must be integrated into the QA program prior to its use in sample analysis. In order to do this efficiently, the Instrument Specialist, Group Leader, and QAC must work together.

3.6.2 When new equipment has been received, the Group Leader works with the Instrument Specialist and QAC to develop a set of preventive maintenance checks and quality control checks for the equipment, if not already established. Additionally, the Group Leader and the QAC determines if any preliminary studies should be performed, such as a detection limit study and/or a demonstration of performance. It is important to include any preliminary studies and demonstrations of equipment performance, such as first chromatograms or raw data, etc., in the equipment file, as this will be valuable for later diagnostics.

NOTE: For new types of equipment, the choice of preventive maintenance and quality control checks is discussed with all fixed-base laboratories so that requirements are consistent between the facilities.

3.6.3 After successful calibration and completion of any required studies, the Group Leader completes a CSR, indicating that the equipment is active. The record lists the performance studies completed and references the location of the documentation of the studies. The equipment may then be used in sample analysis. The CSR is forwarded to the QAD, who updates the equipment list. The CSR is then forwarded to the equipment file.

3.6.4 Instrument manuals supplied by the manufacturer are maintained in the equipment file, a copy of pertinent sections of the manual maintained with the instrument.

## 3.7 CRITICAL SPARE PARTS LIST

Each laboratory retains a critical spare parts inventory and a spare parts inventory list. The spare parts listed are those which , in the best judgment of the Group Leader, Instrument Specialist and LSG management, can best decrease downtime and increase data acquisition efficiency most economically. A critical spare parts list is included in the equipment file and updated as necessary. A recommended critical spare parts list for each instrument group is included in the appendix to this procedure.

## 4.0 RECORDS

The following records are maintained in support of this procedure in accordance with Section 20 of this General QA Plan.

- o Instrument Maintenance Logs
- o Preventive Maintenance Reminders
- o Change of Status Records
- o Service Request Forms
- o Major Equipment List
- o Radioactive Instrument/Article Inventory
- o Instruction manuals supplied by equipment manufacturers
- o Critical spare parts list
- o Preliminary studies and demonstrations of equipment performance following installation and major repair

FIGURE 13-1

**PREVENTIVE MAINTENANCE REMINDER**

ISSUED TO: _____ DATE: _____

**SERVICE REQUIRED**

INSTRUMENT: _____
(Make/Model/Serial No.)

PM TO BE PERFORMED: _____

DUE DATE: _____

**SERVICE COMPLETED**

BY: _____

DATE: _____

DOCUMENTED: _____
(Maintenance Log Book and Page Number)

**RETURN COMPLETED REMINDER TO QAC**

FIGURE 13-2

NUS CORPORATION

CALIBRATED DATE: _____

VERIFIED DATE: _____

DUE DATE: _____

FIGURE 13-3

NUS CORPORATION

INACTIVE

CALIBRATE BEFORE USE

FIGURE 13-4

**CHANGE OF STATUS RECORD**

TYPE: _____ MODEL: _____

MANUFACTURER: _____ SERIAL NO.: _____

This piece of equipment became: _____ on _____
Active/Inactive Date

List the events leading to the change of status along with any other pertinent information below.

NAME: _____ DATE: _____

FIGURE 13-5

**SERVICE REQUEST FORM**

**PART I - SERVICE REQUIRED**

INSTRUMENT OR FACILITY SYSTEM: MAKE MODEL SERIAL NO.

DESCRIPTION OF PROBLEM (Include date and time first occurred):

PRIORITY CODE (1.4) (See back of form):

REQUESTER: _____ DATE: _____

**PART II - SERVICE PERFORMED**

FAULT CONDITION DIAGNOSIS:

CORRECTIVE ACTION:

SERVICED BY: _____ DATE: _____

DISTRIBUTION: Equipment file (original)
Requester

# LABORATORY QUALITY CONTROL

## 1.0 PURPOSE AND APPLICABILITY

This procedure provides an overview of the quality control (QC) measures used to assess and control analytical processes. Specific information on quality control checks for individual laboratory groups is provided in Appendices B through I of this General Quality Assurance Plan. The blind QC sample program and participation in interlaboratory performance evaluation studies are detailed in LSG Procedure QA-12, Performance Audits.

## 2.0 RESPONSIBILITIES

### 2.1 QUALITY ASSURANCE DEPARTMENT

The Quality Assurance Department (QAD) shall establish and publish acceptance limits for quality control checks and update variable limits semiannually, at a minimum.

### 2.2 LABORATORY ANALYSTS

Laboratory analysts shall compare the results of quality control checks to the published acceptance limits, and shall take appropriate corrective measures whenever acceptance limits are exceeded. Corrective measures shall be documented.

## 3.0 PROCEDURE

### 3.1 QUALITY CONTROL PROGRAMS

#### 3.1.1 Daily Quality Control Program

NOTE: The following discussion of the daily quality control program is general in nature. The test-specific requirements of Appendices B - I supercede these general requirements.

- The daily quality control program includes a variety of QC checks inserted into the analysis process by the analysts. These checks include instrument tuning or sensitivity checks, continuing calibration or calibration verification checks, lab control standards, and method blanks. Calibration verification standard, continuing calibration standard, and lab control standard results are calculated as percent recovery. Method blanks results are evaluated for the presence/absence of laboratory contaminants. These quality

control checks monitor the accuracy of the analytical procedure in the absence of matrix interferences. Decisions to accept or reject analytical results are based on these quality control results.

Acceptance limits for these checks are taken from EPA methods or are established by LSG from actual QC data. If these checks fail to meet acceptance limits, corrective action is required prior to continuation of analysis and/or reporting of the data. The corrective action taken for <u>each</u> out-of-control event must be described in the analysis log and approved by the data reviewer. In addition, when corrective action cannot be completed by the analyst within the same work shift, a nonconformance/corrective action record is completed. (See LSG Procedure QA-15, Corrective Action.)

- In addition to these checks, 1 in 10 samples (1 in 20 samples for GC/MS and physical testing analyses) of a similar matrix is analyzed in duplicate and as a matrix spike, or as duplicate matrix spikes, to evaluate matrix effects. Accuracy is calculated as percent recovery of the matrix spike. Precision is calculated as range or relative percent difference (RPD) of duplicates or matrix spike duplicates. Range is evaluated when one or both of the results are <5 times the method detection limit. RPD is calculated when the results are ≥5 times the method detection limit. Precision is not quantified when one or both results are less than values.

  Acceptance limits for these checks are also taken from the EPA methods or are established by LSG from actual sample data. If matrix spike recovery fails to meet acceptance limits and the analytical system yielded acceptable results for calibration standards, and lab control standards or surrogate standards, corrective action is not required. The associated sample results are qualified, however, to indicate the probable presence of a matrix interference. If precision acceptance criteria are exceeded, reanalysis of the duplicates and 25% of the positive samples in the batch is required, at a minimum. The corrective action taken is described in the analysis log and approved by the data reviewer. In addition, when corrective action cannot be completed by the analyst within the same work shift, a nonconformance/corrective action record is completed. (See LSG Procedure QA-15, Corrective Action.)

- o Specific information on daily quality control checks for individual laboratory groups is provided in Appendices B through I of this General Quality Assurance Plan.

### 3.1.2 Blind Quality Control Program

The blind quality control sample program includes QC samples inserted into the analysis process by the QA staff. These checks are used to evaluate data accuracy over time. The blind QC program is detailed in LSG Procedure QA-12, Performance Audits.

### 3.1.3 Interlaboratory Performance Evaluation Studies

LSG participates in a variety of Federal and state interlaboratory performance evaluation studies for drinking water, wastewater, hazardous waste, and industrial health programs. Participation in these programs allows LSG to evaluate its performance against the performance of many other laboratories. External performance evaluation studies are also discussed in LSG Procedure QA-12, Performance Audits.

## 3.2 ACCEPTANCE LIMITS

Acceptance limits for the daily QC program are taken from EPA methods or are established by LSG from actual QC data as described in this section. Acceptance limits are calculated and summarized semi-annually, at a minimum, and distributed to laboratory operations personnel by the QAD.

### 3.2.1 Fixed Limits

In general, acceptance limits for GC/MS and metals analyses for tuning, initial and continuing calibration, method blanks, surrogate standards, and precision and accuracy of matrix spikes and duplicates or duplicate matrix spikes are based on acceptance limits established in EPA methods and are detailed in the appendices to this QA Plan.

### 3.2.2 Variable Limits

Variable limits are based on laboratory-generated data and are updated semi-annually, at a minimum, by the QAD.

a. Accuracy

- o Acceptance limits for percent recovery of lab control standards and GC surrogate standards are calculated from actual QC data. The mean ($x$) and standard deviation (s) are calculated from the most recently generated percent recovery data. A minimum of 20 values are necessary to establish limits; up to 100 values will be used when available. Outliers, which are excluded from the calculation of acceptance limits, are identified as described in paragraph 3.4.

  Until sufficient data have been generated to calculate acceptance limits, the following limits will apply:

  - Inorganic chemistry: 75.0 - 125% recovery
  - Metals: 75.0 - 125% recovery (water); 50.0 - 150% recovery (soils)
  - Organic chemistry - Volatiles: 75.0 - 125% recovery
  - Organic chemistry - Base-neutrals: 50.0 - 150% recovery
  - Organic chemistry - Acids: 25.0 - 125% recovery.
  - Other analyses: 75.0 - 125% recovery

- o Acceptance limits are calculated as follows, where $x_i$ represents the individual values and n is the number of values:

| Parameter | Symbol | Formula |
|---|---|---|
| Upper Control Limit | UCL | $x + 3s$ |
| Upper Warning Limit | UWL | $x + 2s$ |
| Center Line | $x$ | $(\text{Sum } x_i)/n$ |
| Lower Warning Limit | LWL | $x - 2s$ |
| Lower Control Limit | LCL | $x - 3s$ |

- o Acceptance limits are tested initially by determining the percentage of points falling in the range of $x \pm 1s$. It

is expected that approximately 68% of the data will fall within this range. If <50% of the data fall within this range, the limits are suspect and must be verified prior to use.

b. Precision

- Acceptance limits for the range or RPD of duplicate analyses are calculated from the standard deviation (s) of the most recently generated range or RPD data. A minimum of 20 values are necessary to establish limits; up to 100 values will be used when available. Outliers, which are excluded from the calculation of control limits, are identified as described in paragraph 3.4.

  Until sufficient data have been generated to calculate acceptance limits, the following limits will apply:

  - Range: $\leq$2 times the method detection limit

  - RPD: $\leq$20%

- Acceptance limits are calculated as follows, where $x_i$ represents the individual values and n is the number of values:

| Parameter | Symbol | Formula |
|---|---|---|
| Upper Control Limit | UCL | $x + 3s$ |
| Upper Warning Limit | UWL | $x + 2s$ |
| Center Line | $x$ | (Sum $x_i$)/n |

  For radiochemistry, precision acceptance limits are established for the ranges shown in Table 8-1. Variable limits based on in-house data must not exceed the maximum listed.

c. Acceptance Limit Updates

Acceptance limits will be updated semi-annually at a minimum, when 5 or more new values have been generated. The summary of acceptance limits is revised and distributed to the appropriate lab groups after each update.

## 3.3 OUT-OF-CONTROL SITUATIONS

Whenev~ an out-of-control situation occurs, with the possible exception of matrix spike recoveries (see 3.1.1), corrective action is required prior to continuation of analysis and/or reporting of the data for the entire batch. The corrective action taken for <u>each</u> out of control event must be described in the analysis log. In addition, when corrective action cannot be completed by the analyst within the same work shift, a nonconformance/corrective action record is completed. (See LSG Procedure QA-15, Corrective Action.)

### 3.3.1 <u>Fixed Limits</u>

Analyses are out of control whenever the acceptance limits are exceeded.

### 3.3.2 <u>Variable Limits</u>

Analyses are out of control whenever any of the following events occur:

- 1 point is outside the control limits
- 2 consecutive points are outside the warning limits
- 7 consecutive points are on one side of the center line
- 7 consecutive points increase or decrease
- An obvious cyclical pattern is observed in the distribution of points

In order to evaluate the data in this manner, the quality control data will be graphed on control charts or tabulated in chronological order.

## 3.4 IDENTIFICATION OF OUTLIERS

Outliers, which are excluded from the data used to calculate acceptance limits, are identified as follows (according to the procedure described in ASTM E178-80, Sections 4.1 and 4.2):

- o $\bar{x}$, s, and n are those values calculated the last time acceptance limits were updated. (This differs from ASTM E178-80 which uses the values from the data set under evaluation.)

- o $x_f$ is that value in the current set of data furthest from $x$. (The current data is the set of data under evaluation.)

- o $T_{1\%}$ is the T value from Table I in ASTM E178-80 for n at the 1% significance level.

- o If the absolute value of $(x - x_f)/s \leq T_{1\%}$, $x_f$ is not an outlier. Use this value and all other values in the data set to calculate acceptance limits.

- o If the absolute value of $(x - x_f)/s > T_{1\%}$, $x_f$ is an outlier. Delete this value from the data set and do not use it to update acceptance limits. Add the next most recent value (if available) to the data set and repeat the test for outliers.

3.5 METHOD OF STANDARD ADDITIONS

When requested, the method of standard additions (MSA) is used to compensate for matrix effects. MSA involves the analysis of an unspiked aliquot of sample and three additional aliquots spiked at varying levels. The unspiked sample result must be at least 5 times the reporting limit, whenever possible. All of the spiked aliquots must be within the linear range.

The Method of Standard Additions for inorganics and metals analysis is performed as follows.

3.5.1 Dilutions must be kept at a minimum. Larger or successive dilutions may be required if severe matrix interference is encountered (i.e., very low or no spike recovery.)

3.5.2 To begin MSA one unspiked (0 ADD) aliquot is to be prepared and analyzed.

3.5.3 Based on the 0 ADD result, determine the appropriate spiking levels.

a. If analysis of the unspiked (0 ADD) aliquot yields a result greater than or equal to ten times the detection limit, three additional spikes must be prepared at approximately 50%, 100%, and 150% of the concentration inherent in the unspiked (0 ADD) aliquot. The volume of sample and final volume in the 0 ADD aliquot must be maintained throughout all spikes.

The final analyte concentration shall be determined by statistics. The correlation coefficient of the MSA must

be greater than or equal to 0.995, or the MSA must be repeated once, employing additional dilution if deemed necessary. If the correlation coefficient on the second MSA is again less than 0.995, the result of the best correlation is reported. The data should be flagged with the following:

> Result was obtained by method of standard addition. A linear correlation was unable to be established. Matrix interference is suspected. This should be considered when evaluating the data.

b. If analysis of the unspiked (0 ADD) aliquot yields a result at or above the detection limit but less than ten times the detection limit, three additional spikes must be prepared at 5, 10, and 15 times the detection limit, whenever linear range permits. The volume of sample and final volume in the 0 ADD aliquot must be maintained throughout all spikes. The final analyte concentration shall be determined by statistics. The correlation coefficient of the MSA must be greater than or equal to 0.995 or the MSA must be repeated once. If the correlation coefficient on the second MSA is again less than 0.995, the result of the best correlation should be reported. The data should be flagged with the note in (a) above.

c. If analysis of the unspiked (0 ADD) aliquot yields a result less than the detection limit, two additional spikes must be prepared at 5 and 10 times the detection limit, whenever linear range permits. The volume of sample and final volume in the 0 ADD aliquot must be maintained throughout all spikes. If recovery of either spike is <40% the 0 ADD aliquot and two additional spikes, must be prepared, employing an additional 5 or 10 fold dilution. If recovery is still <40%, the result of the largest dilution should be reported. The data should be flagged with the following:

> Result was obtained by method of standard addition. Although the reported result is below the detection limit spike recovery was less than 40% matrix interference is suspected. This should be considered when evaluating the data.

## 4.0 RECORDS

All quality control data and a history of acceptance limits will be maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

TABLE 8-1

| Parameter | Level | Maximum Acceptance Criteria[1] |
|---|---|---|
| Gross Alpha | <20 pCi/L | Range <10 pCi/L |
| | ≥20 pCi/L | RPD <50% |
| Gross Beta | <100 pCi/L | Range <10 pCi/L |
| | ≥100 pCi/L | RPD <10% |
| Radium-226/228 | All levels | RPD <30% |
| Gamma Emitters | <100 pCi/L | Range <10 pCi/L |
| | ≥100 pCi/L | RPD <10% |
| Strontium-89 | <100 pCi/L | Range <10 pCi/L |
| | ≥100 pCi/L | RPD <10% |
| Strontium-90 | <30 pCi/L | Range <3.0 pCi/L |
| | ≥30 pCi/L | RPD <10% |
| Tritium | <4000 pCi/L | $2x\ 169.85\ x\ (mean)^{0.0933}$ |
| | ≥4000 pCi/L | RPD <20% |

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(1) Adapted from EPA 600/4-81-004, Table 3

# CORRECTIVE ACTION

## 1.0 PURPOSE AND APPLICABILITY

This procedure describes the mechanisms by which corrective actions for nonconformances detected through routine sampling and laboratory operations, or systems audits are identified and closed. This procedure is applicable to all LSG operations. It interfaces directly with the following LSG Procedures.

- o QA-7, Laboratory Sample Custody
- o QA-8, Laboratory Quality Control
- o QA-10, Data Handling
- o QA-11, Systems Audits
- o QA-12, Performance Audits
- o QA-14, Data Quality Assessment Procedures

## 2.0 RESPONSIBILITIES

### 2.1 OPERATIONS MANAGERS, GROUP LEADERS, AND FIELD SUPERVISORS

The Laboratory Operations Managers, Field Operations Manager, Group Leaders, and Field Supervisors determine appropriate measures to correct nonconformances identified during routine laboratory operations and systems audits, and are responsible for implementing these actions and for providing feedback to the Quality Assurance Department on progress of corrective actions.

### 2.2 QUALITY ASSURANCE DEPARTMENT

The Quality Assurance Department (QAD) performs follow-up activities to ensure that any corrective action is implemented, and effective in resolving the nonconformances.

## 3.0 PROCEDURE

### 3.1 CORRECTIVE ACTIONS FOR NONCONFORMANCES IDENTIFIED DURING ROUTINE LABORATORY OPERATIONS

3.1.1 Nonconformances can occur at any time during routine laboratory operations -- during sample bottle preparation, sample receipt, sample analysis, and data reduction and reporting. When a nonconformance is immediately correctable (i.e., fully correctable by the person identifying the nonconformance within the same work shift), corrective action need only be documented through the records routinely generated for that activity. However, when corrective action cannot be completed by the person identifying the nonconformance within the same work shift, a nonconformance/corrective action record (Figure 15-1 for Sample Control, and Figure 15-2 for Sample Analysis) is completed.

3.1.2 The nonconformance/corrective action record is a tool by which problems and their consequences, and corrective action measures and their outcomes are documented and communicated. These records are used as follows:

"Nonconformance/Corrective Action Record -- Sample Control:" The individual reporting the nonconformance completes the first two sections of the form. The AE, Group Leader, or supervisor of the department reviews the corrective action taken, and approves it or indicates additional measures to be taken. Copies of the form are distributed to Group Leaders of the appropriate departments and to the QAD. The original form is filed with the sample log-in sheet.

"Nonconformance/Corrective Action Recorded -- Sample Analysis:" The individual reporting the nonconformance completes the first two sections of the form. The Group Leader or Assistant Group leader reviews the corrective action taken, and approves it or indicates additional measures to be taken. The original form is filed with the raw data. A copy of the form is forwarded to the QAD. A second copy is forwarded to the CSD Manager whenever the nonconformance impacts turnaround commitments and/or is not correctable. When another department is involved in the corrective action, as when a sample must be re-extracted when surrogate recoveries exceed acceptance limits, a copy of the form is forwarded to the Group leader of that department.

3.1.3 The QAD also evaluates the corrective action for appropriateness and completeness, and requests additional corrective measures when warranted. The QAD also determines whether the nature and extent of nonconformance warrants long-term monitoring. If so, this is summarized on the QA copy of the form and pursued.

3.1.3 During monthly quality control meetings, the QAD discusses favorable and unfavorable trends evident from the nonconformances and corrective actions reported.

## 3.2 CORRECTIVE ACTIONS FOR SYSTEMS AUDIT FINDINGS

Nonconformances identified through systems audits are documented on quality notices (Figure 15-3) in order to track corrective actions. (See LSG Procedure QA-11.) Quality notices are distributed to personnel responsible for corrective action along with the systems audit report (internal audits) or audit summary (external audits). Their disposition is described below.

3.2.1 A log of quality notices is maintained by the QAD in order to track corrective action completion.

3.2.2 Upon receipt of a quality notice, the responsible management staff completes the response section of the quality notice, addressing each of the four topics:

- o Root cause assessment.
- o Corrective action for immediate problem(s).
- o Corrective action to preclude recurrence of the problem.
- o Schedule (dates) for corrective action implementation.

The form and any supporting documentation is returned to QAD. If a response is not received by the due date, the QAD issues one reminder, allowing no more than 5 working days to respond. Failure to respond or to initiate timely corrective action results in referral of the nonconformance to the Assistant General Manager for resolution.

3.2.4 The QAD evaluate quality notice responses. If a response is insufficient or requires clarification, the quality notice is returned further action.

3.2.5 Monthly, at a minimum, the QAD verifies that corrective actions have been implemented in accordance with quality

3.2.5 Monthly, at a minimum, the QAD verifies that corrective actions have been implemented in accordance with quality notice response commitments. Verification is documented on the back of the quality notice form. When corrective actions are satisfactory, the quality notice is closed. Closure is noted on the corrective action log and the quality notice form. A copy of the form acknowledging closure is sent to the respondent; the original form is included with the program monitoring report (internal audit) or the audit summary (external audits).

3.2.6 If closure of the item will require more time than was designated, the QAD may grant an extension. Further extensions may be granted on a case-by-case basis by the Assistant General Manager.

Failure to complete corrective actions within a reasonable time frame results in referral of the nonconformance to the Assistant General Manager for resolution.

## 4.0 RECORDS

The following records are maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

- Nonconformance/corrective action records.
- Corrective action log, quality notices, and supporting documentation.

Figure 15-1

| NUS CORPORATION | NONCONFORMANCE/CORRECTIVE ACTION RECORD - SAMPLE CONTROL | LABORATORY SERVICES GROUP |
|---|---|---|

Copies:
- o Check-in
- o Bottle Prep
- o CSD Manager
- o QA Department
- o Metals
- o GC
- o GC/MS
- o Organic Prep
- o Inorganics
- o RCRA/Geo
- o Metals Preparation
- o Bioassay
- o Industrial Hygiene
- o Radiochemistry
- o Other _____

Sample Number(s): _____

Client(s): _____

Indicate the nonconforming condition(s):

- o Sample broken
- o Sample missing
- o Sample mislabeled
- o Other: _____
- o Incomplete information received with samples
- o Sample stored improperly
- o Sample disposed of prematurely

Additional Comments: _____

Corrective measures: _____

Reported by: _____ Date: _____

Reviewed by: _____ Date: _____

Comments: _____

Additional Comments:

Figure 15-2

| NUS CORPORATION | NONCONFORMANCE/CORRECTIVE ACTION RECORD - SAMPLE ANALYSIS | LABORATORY SERVICES GROUP |
|---|---|---|

Department: _____ Copies: QA Department
CSD Manager
Other: _____

Test: _____ Date/Time: _____

Sample Number(s): _____ Instrument: _____

Client(s): _____

Indicate the nonconforming condition(s):

- o Hold time
- o Tune
- o Initial calibration
- o Continuing calibration
- o Calibration verification
- o Internal standard area/RRT
- o Surrogate spike recovery
- o Retention time shift
- o DDT Breakdown
- o MS and/or MSD recovery
- o Duplicates or MS/MSD precision
- o Lab control sample recovery
- o Method blank contaminants
- o Calibration blank shift
- o Performance evaluation failure
- o Other: _____

Additional comments: _____

Corrective measures: _____

Reported by: _____ Date: _____

Reviewed by: _____ Date: _____

Comments: _____

Additional Comments:

Figure 15-3

| NUS CORPORATION | QUALITY NOTICE | LABORATORY SERVICES GROUP |
|---|---|---|

| AUDIT SN: | QN NO: | PROGRAM/PROJECT: | |
|---|---|---|---|
| PROCEDURE/DOCUMENT REFERENCE: | | ACTIVITY: | |
| RESPONSE ASSIGNED TO: | DUE DATE: | REPORTED BY: | DATE: |

REQUIREMENT:

☐ SEE ATTACHMENT

CONDITION OBSERVED:

☐ SEE ATTACHMENT

USE BACK OF FORM FOR RESPONSE

9/89

Figure 15-3 (continued)

| RESPONSE | |
|---|---|
| COMPLETE EACH ITEM.<br><br>1. ROOT CAUSE ASSESSMENT:<br><br>2. CORRECTIVE ACTION FOR IMMEDIATE PROBLEM(S):<br><br>3. CORRECTIVE ACTION TO PRECLUDE RECURRENCE:<br><br>4. SCHEDULE (DATES) FOR CORRECTIVE ACTION COMPLETION: | |
| RESPONSE SUBMITTED BY: | DATE: |

| QA EVALUATION AND FOLLOW-UP | | |
|---|---|---|
| REMARKS: | | |
| C/A VERIFIED ☐ YES ☐ N/A | QM CLOSED BY: | DATE: |

# QUALITY ASSURANCE RECORDS

## 1.0 PURPOSE AND APPLICABILITY

This procedure defines controls on generation, maintenance and retrieval, transmittal, and retention of quality assurance (QA) records. The intent is to ensure that the records generated by LSG provide a valid and complete account of the work performed. This procedure applies to all quality assurance records generated and/or maintained by LSG at all operations (fixed or remote).

This procedure also defines controls on applications software and electronically stored data files.

## 2.0 RESPONSIBILITIES

### 2.1 ALL LSG PERSONNEL

All LSG personnel shall comply with this procedure in generating and maintaining hard copy and electronic records.

Additionally, during review of data, logs,etc., the reviewer shall not approve data that are not documented in compliance with this procedure until noncompliances have been corrected.

### 2.2 DOCUMENT CUSTODIAN

The Document Custodian controls distribution and storage of laboratory notebooks, maintains project files, prepares document purges, implements long-term records storage, and maintains applications software disaster recovery file.

### 2.3 PROGRAMMERS

Programmers document and test applications programs in accordance with this procedure.

## 3.0 PROCEDURE

### 3.1 HARD COPY QA RECORDS

The evidentiary value of the data produced by LSG is dependent upon the proper generation, maintenance, and retrieval of quality assurance

records. These procedures are established to ensure that all records attesting to the validity of sampling and analytical work have been properly prepared and are accounted for when work is completed.

3.1.1 Laboratory Notebooks

- All analytical work is documented in a bound laboratory notebook. Notebooks are preferably hardback books with pre-numbered pages. However, where it is necessary to use a pre-printed grid, a spiral-bound, velo-bound, or 3-ring notebook with numbered pages may be used at the discretion of the Quality Assurance Coordinator. (See LSG Procedure QA-10, section 3.1.1 for further discussion of the use of laboratory notebooks.)

- Each notebook is assigned a unique numerical identification as follows:

  "888-77"

  where "888" is a three digit number that begins at 001 with the first book issued in a calendar year and increases consecutively for each subsequent book; and "77" is the year in which the book was issued. (For example, 075-89 is the 75th book issued during 1989.)

- Notebooks are issued by the Document Custodian. The date issued, notebook number, and activity to which the book is assigned are recorded on each notebook and on the notebook index maintained by the Document Custodian.

- Notebooks are maintained in the laboratory while in use. Upon completion, each notebook is returned to the Document Custodian, who notes the completion date on the notebook index and the storage location. Completed notebooks are stored in a central location or in the laboratory if they will be referenced frequently.

3.1.2 QA Records Generation

- All QA records are type-written, computer-generated, or hand written in ink. Pencil or water-soluble marker are unacceptable.

- QA records are adequately identified as to the activity or item to which they apply, the person(s) performing the work, and the date the work is performed. They are considered valid only when signed, initialed, or otherwise authenticated and dated by authorized personnel.

- Corrections to QA records are made by drawing a single line through the incorrect information, and initialing and dating the correction. Incorrect entries are <u>never</u> obliterated.

- QA records may be originals or reproductions.

### 3.1.3 <u>QA Records Maintenance and Retrieval</u>

- Each person responsible for the maintenance of a series of records maintains an index of the records. The index may take any form that allows specific records to be located quickly.

- Records are not filed loosely; they are either bound or filed in manila folders.

- Sign-out cards (Figure 20-1) are provided in all QA records files. When a record is removed from a file, the individual records their initials, the date, and the specific records being removed on the sign-out card, then places the card in the position that had been occupied by the records. When the records are returned to the file, the individual returns the records to the proper position, crosses out their entry on the sign-out card, and returns the card to the front of the file.

  The use of these cards by all personnel is essential to the maintenance of complete records.

### 3.1.4 <u>QA Record Retention</u>

- QA records are maintained for a minimum of seven full years.

- Safe, permanent, archival storage is also established for those records that must be maintained, by law or agreement, in perpetuity.

### 3.1.5 <u>Confidential Records</u>

Requests for confidential treatment of project records is handled as follows.

- The project file is maintained in a separate, locked file for confidential documents.

- Upon receipt of confidential documents, which includes all data generated from samples associated with the request for confidentiality, the Document Custodian logs the documents into a confidential inventory log.

- Confidential records are made available to authorized personnel only after they have been signed out to that person by the Document Custodian. Confidential information is returned to the Document Custodian and filed before the close of each working day.

- Confidential information is not disposed of except upon written approval of the client. The Document Custodian retains the cover page of any confidential information that is disposed of and records destruction of the records on the confidential inventory log.

3.1.6 Document Purge

- When documents are transmitted to a client in a document purge, (i.e., when LSG purges original records and does not retain a complete copy of them), the Document Custodian prepares the document purge as follows.

  The Document Custodian prepares a document inventory for the project file. (See Figure 7-9 of LSG Procedure QA-7.) He/she verifies that the project file is complete and counts the pages twice, at a minimum, to ensure that the count is accurate. The Document Custodian prepares a formal transmittal letter than includes a document receipt acknoweldgment form that contains an itemized table of contents. The letter will require the recipient to acknowledge receipt of the documents in writing and return the acknowledgment to the Document Custodian. The case file purge shipping container is sealed with custody seals prior to shipment such that the seals will be broken if the shipping container is opened. The case file is then delivered to the client or the client's designee.

- The Document Custodian retains a copy of the following records in the client or project file following the document purges:

  - Case narrative
  - Document inventory
  - Transmittal letter
  - Air bill from shipment of the document purge
  - Signed receipt acknowledgment from the recipient
  - QC summaries
  - Case narrative/comments

## 3.2 ELECTRONIC RECORDS

All applications software prepared in-house and related to data handling (i.e., data colection, data reduction, data review, and/or data reporting) must be adequately documented and tested to ensure that it produces the desired results accurately. It is also essential that loss of electronically stored records related to data handling through the use of worn or damaged diskettes or tapes, accidental overwriting due to improper labeling, or loss of the diskette or tape be minimized. To that end, the following controls on records produced and/or maintained electronically have been established.

### 3.2.1 Diskette/Tape Labeling

When a diskette or tape is put into service, the user labels it with the department code and the usage. Usage is described in sufficient detail to allow specific records on the diskette or tape to be retrieved (e.g., information such as inclusive dates or instrument are identified in addition to the type of data stored). The QA records on each diskette or tape are indexed in a log maintained by the user.

### 3.2.2 Applications Software Control

o Documentation and Testing

Each noncommercial application and any subsequent revisions written for use by LSG is documented by the programmer through the following, at a minimum.

- Updated listing of the application.
- Definition of all variables.
- Flow chart depicting the flow of data within the application.
- All calculation formulas, with an explanation of the logic for using the procedures in attaining the end result of the formula.
- The outcome of testing showing that the application produces the desired results.
- User's guide to the application.

o Disaster Recovery

The programmer provides the Document Custodian with a current copy of each application developed within LSG, labeled with the application, revision number, and date of copy. The Document Custodian maintains the copy in a central file for disaster recovery purposes. Whenever a revision is made to an application, a new copy of the application is provided to the Document Custodian for storage.

3.2.3 Data Files Control

A daily back-up of all data files is maintained, at a minimum. Each back-up is labeled with the date of back-up, and the department code and the usage of the tape from which the data has been copied.

## 4.0 RECORDS

The following records are maintained in accordance with and in support of this procedure.

- o Data files.
- o Applications software and supporting documentation.
- o QA records indices.
- o Laboratory notebook index.
- o Confidential information index.
- o Diskette/tape indices.

Figure 20-1

Example Sign-Out Card

OUT

| OUT TO | FILE NUMBER OR NAME OUT | DATE | OUT TO | FILE NUMBER OR NAME OUT | DATE | OUT TO | FILE NUMBER OR NAME OUT | DATE |
|---|---|---|---|---|---|---|---|---|
| LAM | NJDEP Corresp. | 8/20/90 | | | | | | |
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# DATA HANDLING

## 1.0 PURPOSE AND APPLICABILITY

This section defines Laboratory Services Group (LSG) procedures for data collection, reduction, entry into the LIMS, validation, and reporting. Where procedures for CLP work and non-CLP work diverge, data handling is described for both.

All LSG data is collected, reduced, entered, validated, and reported in accordance with this procedure unless an alternate scheme is outlined in an LSG project-specific plan.

## 2.0 RESPONSIBILITIES

### 2.1 ANALYSTS

Analysts conduct data collection and reduction in accordance with this procedure.

### 2.2 GROUP LEADERS

Group Leaders review and approve analytical data. This task may be delegated to Assistant Group Leaders and/or experienced analysts.

### 2.3 LABORATORY OPERATIONS MANAGERS

Laboratory Operations Managers review and approve sample data and laboratory analysis reports through sample check-out.

### 2.4 ACCOUNT EXECUTIVES (AEs)/LSG PROJECT MANAGER

Account Executives are responsible for compiling reports, preparing cover letters to accompany reports, and authorizing report delivery to the client.

## 3.0 PROCEDURE

### 3.1 DATA COLLECTION

3.1.1 Analytical activities are documented in sufficient detail to allow the analysis to be recreated. This includes the following, at a minimum, for sample preparation and analysis. The method, analytical sequence, date, time, analyst, and instrument must be documented in a laboratory notebook. The remaining information must be recorded in the notebook or on preprinted worksheets, or retrievable from instrument output.

- The analytical activity being performed (i.e., the specific analytical method or preparation method performed).

- The person(s) perform g the activity and the date and time that the activity was initiated.

  - When more than one analyst works on an analytical run, each must be identified.

  - If an activity has discrete components that extend over more than one shift, the person performing each component and the date and time that each component is initiated are documented. For example, in suspended solids analysis, filtration of samples and determination of initial weight are performed on one day, and determination of final weight after drying is performed the following day. Thus the analysis breaks down into two discrete components. The analyst performing each component and the date and time that each component is initiated are documented in the analysis log.

- Instrument parameters, including instrument identification and settings. (Instrument settings may be referenced to previous documentation of instrument parameters.)

- The analytical sequence must be documented (i.e., the chronological order of analysis). The following data for each sample, standard, and QC check run in the analytical sequence must be recorded and/or retrievable from an instrument printout (quantitation report, printer tape, etc.). <u>Units for all variables are specified</u>, preferably in column headings.

  - LSG sample number.

  - Client identification if CLP sample or QC sample type identification (prep blank, ms, etc.) if QC sample.

  - Dilutions made prior to taking a sample aliquot (actual initial and final volumes, not a ratio).

- Sample aliquot/final volume.

- Cell size (colorimetric analyses).

- Instrument reading.

- Final result.

- Percent recovery, RPD, range, or percent difference of quality control checks.

o The calibration curve from which data are quantified, identified by instrument and date run, if the initial calibration is not included in the analytical run.

o Notes regarding any anomalies (e.g., change in color, formation of precipitate) or difficulties (e.g., instrument malfunction) encountered during analysis.

o The notebook identification number on each page.

o For CLP work, data for only one case may be recorded on a page. The sample delivery group is identified at the top of the page.

o Whenever additional pages must be added to a laboratory notebook, the attachment is described on the notebook page and the book and page number are recorded on the attachment. This allows the documents to be re-attached if they become separated.

3.1.2 Preparation of reagents and standards (calibration, calibration verification, surrogate spike, and matrix spike) is also documented in support of sample analysis in a lab notebook as follows:

o Compound or element name and/or formula and final concentration or normality.

o Identification number (standards only), which takes the following form:

99-888-88-77

where "99" is the number of the entry on the standards log page, and "888-88" and "77" are the notebook number and page number of the entry, respectively.

- o Manufacturer and lot number of all standard materials.
- o Date prepared and preparer.
- o Expiration date (when specified).
- o Brief description of preparation. (This may be referenced from a previous description of preparation or the lab method, providing that the standard or reagent was prepared in exactly the same fashion as the referenced description.)

3.1.3 Bottles or flasks containing standards or reagents must be labeled with the following:

- o Compound or element name and/or formula, and final concentration or normality.
- o Identification number (standards only).
- o Date prepared and preparer.
- o Expiration date (when specified).

## 3.2 DATA REDUCTION

### 3.2.1 Qualitative Identification

Qualitative identification of organic compounds is performed according to CLP Statement of Work Guidelines, which are delineated in Appendices B and C to this QA Plan. (Note: Second column confirmation by GC is performed upon request at an additional charge.)

### 3.2.2 Quantitation

The equations used to calculate final results are specified in the appropriate laboratory methods. In general, the following rules concerning reporting limits, significant figures, and rounding rules apply to those calculations.

- Round all calculation results to the correct number of digits as the final calculation step. Do not round any result before reaching the final answer, even in a lengthy calculation.

- To round a number, first determine the number of digits to be reported (the reportable figures). Determine whether the digit to the immediate right of the right-most reportable figure is greater than, equal to, or less than 5. Ignore any digits further to the right unless the number is 5.

  - If the number is greater than 5, round up (i,e., increase the right-most reportable figure to the next highest number).

  - If the number is less than 5, simply truncate after the last reportable figure.

  - If the number is equal to 5 and there are non-zero digits to the right of it, round up.

  - If the number is equal to 5 and there are no non-zero digits to the right of it, round up when the preceding figure is odd; truncate when the preceding figure is even.

- Round results at the end of calculations to one or two digits as follows, with the exceptions noted below.

  - If the initial concentration of the sample (i.e., the concentration before any dilutions are taken into account) is less than the reporting limit, express the reporting limit as 1 digit (e.g., <1 mg/L, not <1.0 mg/L).

  - If the initial concentration of the sample is above the reporting limit, and if expressed in scientific notation its exponent would be equal to that of the reporting limit expressed in scientific notation, report the result to 1 digit. (For example, if the reporting limit is 1 mg/L, the initial concentration is 7.8965 mg/L and no dilutions were made, report the result as 8 mg/L.)

  - If the initial concentration is above the reporting limit, and if expressed in scientific notation its exponent would be greater than that of the reporting limit expressed in scientific notation, report the result to 2 digits. (For example, if the reporting

limit is 1 mg/L, and the initial concentration is 78.965 mg/L and no dilutions were made, report the result as 79 mg/L.)

Note: (1) For CLP work, report results in accordance with the statement of work, which may differ from these guidelines. (2) For radiochemistry results, which include an estimation of the error of the measurement, 2 digits should be used to express all positive results and their error. (3) For quality control checks, express results, recoveries, relative percent differences, and ranges using at least three significant figures whenever possible. (Additional reportable figures are not required for method blanks.)

- Report solid samples (soil/sediment/non-organic wastes) for non-CLP work on an as-received (wet weight) basis. Percent moisture/solids will also appear on the report so that conversion to dry weight can be made. (Percent moisture determinations are not required for organic wastes.) CLP work must be reported on a dry weight basis.

3.2.3 Evaluation

The quality control data for each batch or analytical run are evaluated against acceptance limits. (See LSG Procedure QA-8, Laboratory quality Control.) Whenever a quality control result exceeds acceptance limits, with the possible exception of matrix spike recoveries (see QA-8, 3.3.1), corrective action is required prior to turning in data for the batch or analytical run for independent data review. Corrective actions are documented in the analysis log. When corrective action requires the efforts of someone other than the analyst, or the corrective action will not be completed during the work shift, the analyst completes a nonconformance/corrective action record. (See LSG Procedure QA-15, Corrective action.)

3.3 DATA ENTRY

After data reduction, the analyst enters the following data from the analytical run into the laboratory information management system (LIMS). This process is detailed in the "LIMS User's Guide."

- Date and time of analysis (time initiated).
- Analyst.

- o Instrument.
- o Sample results.
- o QC sample results.
- o Lab notebook reference.

For CLP work, data is entered into the appropriate CLP forms-generation software. Quality control data are entered into the LIMS. Sample results are simply entered into the LIMS as "done."

## 3.4 DATA VALIDATION AND REPORTING

The data validation and reporting sequence for CLP and non-CLP work are described below. The independent data and check-out reviews conducted by the operations staff are intended to compliment one another. The independent data review evaluates the results obtained for many samples for one test; check-out evaluates the results for all tests run for one sample. Errors and inconsistencies that are not apparent from the initial review may be evident in the second review.

### 3.4.1 Independent Data Review -- CLP and Non-CLP Work

- o Following data reduction and before or after data entry, the raw data associated with the analytical run -- analysis log, instrument output (quantitation reports, chromatograms, spectra, strip chart recordings), calibration curves, etc. are forwarded to the Group Leader or his/her designee for independent review and approval. The review encompasses the correctness, acceptability, and completeness of the following elements of data generation and handling. (All elements are not applicable to all tests.)

  - Data entry
  - Instrument tuning
  - Initial calibration
  - Continuing calibration/calibration verification
  - Calibration blanks
  - Method or preparation blanks
  - Surrogate or lab control standard recovery

- Qualitative identifications
- Quantitation, including units and reportable figures
- Precision of duplicates
- Recovery of matrix spikes
- Holding time
- Data qualifiers/comments

When an unacceptable calibration or quality control check is generated, the data reviewer ensures that appropriate corrective action was taken prior to approving the data. Any defects are corrected. Raw data and data entry are also corrected as necessary. If corrective action cannot be taken, the sample results are qualified appropriately.

- o If independent data review is conducted prior to data entry, data entry is verified separately. Any problems with the data must be corrected prior to approval of the data.
- o Upon approval of the data, the reviewer initials the lab notebook page(s) and indicates approval of the data in the LIMS (see the "LIMS User's Guide"), which allows the data to proceed to check-out.
- o Following independent data review, "preliminary results may be provided to the client when necessary. The results must clearly be labeled as being preliminary and subject to change upon completion of laboratory review.

3.4.2 Sample Check-out -- Non-CLP Work

When all of the results for the parameters assigned to a sample have passed independent data review, they are evaluated by the Laboratory Operations Manager during check-out. Errors and inconsistencies that were not evident in the initial review may become apparent when each result is evaluated in light of the results obtained for the other parameters. Specifically, the following are reviewed.

- o Units and reportable figures.
- o Interparametric relationships (e.g., TDS/conductance, TOC/BOD/COD, dissolved/total, etc.).

- o Reasonableness of results given the available information about the sample.

- o Method references.

Any problems with the data must be corrected before the data are approved at check-out.

### 3.4.3 Sample Check-out -- CLP Work

CLP data go through check-out. However, this is largely an administrative formality to clear the data through the LIMS since sample results are not entered.

### 3.4.4 Report Preparation -- Non-CLP Work

- o Following check-out, data are available for report preparation through the LIMS. Reports consist of a lab analysis report or a lab analysis report and a quality control report, according to the client's preference. The lab analysis report contains the following information:

  - Client name and address (including the person to whose attention the report is being sent).

  - LSG report number.

  - Report date.

  - LSG client number.

  - LSG vendor number*.

  - LSG work order number*.

  - Project name*.

  - Identification of the person who reviewed and approved the data at check-out.

  - Date sampled (when provided to LSG) and date of sample receipt for each sample.

---

* Optional information

- Determination, result, and units for each analyte for each sample.

- Any comments about the sample or results (e.g., presence of a matrix interference).

o The quality control report contains the following information as applicable to the analytes:

- Supplemental information, including batch number, method reference, date and time of analysis, analyst, and instrument used for each determination.

- Surrogate standard recoveries and acceptance limits.

- Laboratory control sample recoveries.

- Method blank results.

- Matrix spike and duplicate or matrix spike duplicate results.

o The quality control report may be further supplemented with initial and continuing calibration data and/or raw data upon request. This information is collected by data management personnel.

o The report from the LIMS and any supplemental information is forwarded to the AE (production-managed jobs) or LSG Project Manager (project-managed jobs). The AE or LSG Project Manager compiles the report, ensures that all deliverables are included, prepares a cover letter as required, and authorizes the delivery of the report to the client.

3.4.5 Report Preparation -- CLP Work

o When a portion (VOA, BNA, Pesticides/PCBs, Inorganics) of the CLP data package is completed, the Group Leader reviews it for technical accuracy and completeness. When any defects have been corrected (to the extent possible), the Group Leader signs the case narrative data release statement.

o Components of the data package are forwarded to the LSG Project Manager, who finalizes the case narrative, compiles

the completed data package, and authorizes its delivery to the client.

## 4.0 RECORDS

The following records are maintained in support of LSG's analytical activities and this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

### 5.1 HARDCOPY RECORDS

- Analysis logs
- Instrument printouts
- Calibration curves
- Complete deliverables for each job, original and any revisions

### 5.2 ELECTRONIC RECORDS

- Records entered at data entry into the LIMS
- Records of data approval in the LIMS

# SYSTEMS AUDITS

## 1.0 PURPOSE AND APPLICABILITY

Systems audits evaluate the performance of an activity against applicable procedural requirements. The Laboratory Services Group (LSG) plan for regularly monitoring the implementation of this General Quality Assurance Plan through systems audits is described in this procedure. Correction of identified nonconformances is described in LSG Procedure QA-15, Corrective Action.

Radiation safety and waste handling and disposal procedures are also monitored in accordance with this procedure. Work performed under project checklists or work plans, quality assurance project plans, and contracts may also be audited at the discretion of the Quality Assurance Coordinator, the Vice President and General Manager, or Assistant General Manager.

External systems audits (those conducted by organizations other than LSG) are also used as sources of feedback on the quality and performance of the laboratory. Nonconformances identified during external systems audits are documented and corrected in the same manner as internal systems audit findings.

## 2.0 RESPONSIBILITIES

### 2.1 CUSTOMER SERVICES DEPARTMENT (CSD) MANAGERS

CSD Managers identify client concerns about the level of quality to the Quality Assurance Coordinator (QAC) and work with the Quality Assurance Department to resolve deficiencies where data reported to clients has been compromised or may be invalidated. CSD Managers also participate in resolving significant quality findings identified by clients as requested by the QAC or senior LSG management.

### 2.2 QUALITY ASSURANCE DEPARTMENT (QAD)

The QAD is responsible for the following:

- Internal Systems Audits
  - Performing the systems audits and submitting the findings in a written report in accordance with the requirements of this procedure.
  - Tracking corrective actions.

o External Systems Audits

- Coordinating external systems audits with the client or regulatory agency representative(s).

- Summarizing strengths and weaknesses identified in the audit to laboratory management.

- Preparing LSG's response to the audit findings.

- Tracking corrective actions.

## 3.0 PROCEDURE

### 3.1 INTERNAL SYSTEMS AUDITS

3.1.1 The Quality Assurance Coordinator schedules program monitoring activities so that all elements of the Quality Assurance Program, Radiation Safety Program (at applicable facilities), and Laboratory Waste Disposal Procedure, at a minimum, are audited each year. Work performed under project checklists or work plans, quality assurance project plans, and contracts, and individual lab methods may also be audited at the discretion of the Quality Assurance Coordinator, the General Manager, or Assistant General Manager.

3.1.2 Using a cross-section of the LSG procedural requirements as guidance, the auditor determines how the activities described in the procedure are performed. Observation, review of documentation, and discussions with those who perform the activities are used to determine conformance or nonconformance to the procedure. When a nonconformance is found, the auditor determines whether the problem is isolated or general. Nonconformances are brought to the attention of the appropriate management personnel as soon as possible after detection so that corrective action may proceed.

3.1.3 A systems audit report containing the following information is prepared for each audit:

o Date(s) of conduct of the audit.

o The procedural requirements audited.

- How the activities were audited (including the specific activities observed and when, the documents reviewed, the personnel interviewed) and the findings.

- Conclusion as to conformance or nonconformance to procedural requirements.

The report is submitted to the General Manager, the Assistant General Manager, the Laboratory Operations Manager or Field Operations Manager (as appropriate to the audit), the Quality Assurance Coordinator and to personnel responsible for corrective actions.

3.1.4 Nonconformances identified through systems audits are documented on quality notices (Figure 15-4) in order to track corrective actions. Quality notices, which are distributed to the personnel responsible for corrective actions along with the systems audit report, are dispositioned in accordance with LSG Procedure QA-15, Corrective Action.

When a nonconformance has been corrected prior to completion of the systems audit report and the auditor is satisfied that the nonconformance was isolated, the root cause of the nonconformance was identified, and the corrective actions taken were sufficient to preclude recurrance, a quality notice need not be opened. The program monitoring report must contain a description of the nonconformance, identify its root cause, and describe the corrective and preclusive actions. These nonconformances are included in the monthly QA report to LSG management to assist in trend analysis.

## 3.2 EXTERNAL SYSTEMS AUDITS

3.2.1 The QAD serves as the interface between LSG and the client and regulatory agency representatives performing systems audits of LSG. Upon notification of intent to audit by a client or regulatory agency, the QAD notifies Corporate Quality Assurance and key LSG personnel of the audit.

3.2.2 The QAD participates in the audit; additional LSG personnel are called upon as necessary.

3.2.3 The QAD provides a written summary of the results of each audit to LSG management, including strengths and deficiencies identified by the auditors. Any deficiencies identified during the audit are documented as quality

notices and issued to the appropriate LSG personnel with the audit response. The quality notices are dispositioned in accordance with LSG Procedure QA-15, Corrective Action.

When a nonconformance has been corrected prior to completion of the systems audit report and the audit is satisfied that the nonconformance was isolated, the root cause of the nonconformance was identified, and the corrective actions taken were sufficient to preclude recurrance, a quality notice need not be opened. The audit summary must contain a description of the nonconformance, identify its root cause, and describe the corrective and preclusive actions. These nonconformances are included in the monthly QA report to LSG management to assist in trend analysis.

3.2.4 The QAD, in consultation with appropriate management personnel, responds to external audit findings.

## 4.0 RECORDS

The following records are maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

- Internal systems audit reports and supporting documentation.
- External audit reports, LSG responses, and audit summaries.
- Quality notices.

# QUALITY ASSURANCE REPORTS TO MANAGEMENT

## 1.0 PURPOSE AND APPLICABILITY

This procedure defines vehicles for the discussion of quality control issues among mid-level group management and reporting of the Quality Assurance Department's activities and concerns to upper-level management.

## 2.0 RESPONSIBILITIES

### 2.1 QUALITY ASSURANCE DEPARTMENT

The Quality Assurance Department (QAD) holds monthly quality control meetings and distributes meeting minutes to the participants.

### 2.2. QUALITY ASSURANCE COORDINATOR

The Quality Assurance Coordinator (QAC) prepares the monthly Quality Assurance Activities and Corrective Action Report for upper-level management.

## 3.0 PROCEDURE

### 3.1 MONTHLY QUALITY CONTROL MEETINGS

Once each calendar month, the QAD meets with Managers and Group Leaders from Operations, CSD, and Logistic Support to discuss relevant quality issues, including findings from systems and performance monitoring. Quality issues not addressed by the corrective action mechanisms defined in LSG Procedure QA-15, Corrective Action, will be discussed and, if necessary, treated as action items for resolution by appropriate staff and/or task teams. The QC Meeting will be supplemental to, not in lieu of, the Quality Improvement Process (QIP). The QAD is responsible for setting the meeting agenda and communicating the minutes of the meeting to meeting participants and group management.

Part of the monthly agenda will consist of a round table discussion of factors affecting quality from the perspective of each Manager and Group Leader. These items will not be assigned as formal action items or logged for QA follow-up unless tracking of the minutes indicates a recurrent problem.

## 3.2 QUALITY ASSURANCE ACTIVITIES AND CORRECTIVE ACTION REPORTS

On a bimonthly basis, the QAC, with the assistance of the QA Representatives, submi - a report to management summarizing QA activities and nonconformances identified for all LSG operations. The report shall summarize the following information:

- o Performance Audits
  - A summary of the results and acceptability of internal or external performance evaluation samples submitted by the QAD or by outside evaluators.
  - The status of all open performance evaluation nonconformances, including those closed since the last report.
- o System Audits
  - A listing of internal systems audits performed, including a summary of any nonconformances found.
  - A listing of external systems audits conducted during the prior month, including a summary of any nonconformances found.
  - The status of all open quality notices, including those closed since the last report.
- o Other Critical Issues
  - A discussion of significant issues from the QC meetings, data assessment, SOP review, or other activities.

The QAC also prepares an annual summary of QA activities and corrective actions for each year.

## 4.0 RECORDS

The following records are maintained in support of this procedure in accordance with LSG Procedure QA-20, Quality Assurance Records.

- o Minutes from the Quality Control Meetings.
- o Quality Assurance Activities Reports.
- o Annual QA summary.

# ATTACHMENT C

## FORMS

**Field Modification Record Form**
**Field Forms**

# FIELD MODIFICATION RECORD FORM

# FIELD FORMS

# APPENDIX C

# HEALTH AND SAFETY PLAN

EPA ID No. IN5 170 023 498

# RCRA FACILITY INVESTIGATION PHASE II RELEASE ASSESSMENT
# DRAFT HEALTH AND SAFETY PLAN
# FOR
# SOLID WASTE MANAGEMENT UNITS
# #15/06, #14/00, #16/16
# NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
# CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Southern Division
Environmental Branch, Code 186ND
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29411-0068

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Contract No. N62472-90-D-1298
Contract Task Order 0078

May 1993

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## LIST OF ACRONYMS/ABBREVIATIONS

| | |
|---|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ACM | Asbestos Containing Material |
| BZ | Breathing Zone |
| CFR | Code of Federal Regulations |
| CGI | Combustible Gas Indicator |
| CHSM | Corporate Health and Safety Manager |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| CPR | Cardiopulmonary Resuscitation |
| CRZ | Contamination Reduction Zone |
| CZ | Control Zone |
| EPA | Environmental Protection Agency |
| EZ | Exclusion Zone |
| FAR | Federal Acquisition Regulation |
| FID | Flame Ionization Detector |
| HEPA | High Efficiency Particulate Air (Filter) |
| HSM | Health and Safety Manager |
| HASP | Health and Safety Plan |
| HR | Heart Rate |
| MSDS | Material Safety Data Sheet |
| MSHA | Mining Safety and Health Administration |
| NAVSURFWARCENDIV | Naval Surface Warfare Center, Crane Division |
| NIOSH | National Institute for Occupational Safety and Health |
| OSHA | Occupational Safety and Health Administration |
| OTA | Ordnance Testing Area |
| OVA | Organic Vapor Analyzer |
| PID | Photoionization Detector |
| RCRA | Resource Conservation Recovery Act |
| RFI | RCRA Facility Investigation |
| SCBA | Self-Contained Breathing Apparatus |
| SOP | Standard Operating Procedure |
| SSO | Site Health and Safety Officer |
| SWMU | Solid Waste Management Unit |
| SZ | Support Zone |
| USACE | U.S. Army Corps of Engineers |
| USCG | U.S. Coast Guard |
| UXO | Unexploded Ordnance |
| WBGT | Wet Bulb Globe Temperature (Index) |
| WZ | Work Zone |

# 1.0 GENERAL

This site-specific Health and Safety Plan (HASP) was prepared for the Naval Surface Warfare Center, Crane Division (NAVSURFWARCENDIV), in Crane, Indiana, under Contract No. N62472-90-D-1298 to Halliburton NUS Corporation for the U.S. Navy, Northern Division, Philadelphia, Pennsylvania, in accordance with the regulatory requirements of 29 Code of Federal Regulations (CFR) 1910.120, "Hazardous Waste Operations and Emergency Response." In addition, the scope of work shall comply with and reflect the following applicable regulations and appropriate guidance publications, as a minimum:

- Federal Acquisition Regulation, F.A.R. Clause 52.236-13: Accident Prevention.
- U.S. Army Corps of Engineers (USACE), Safety and Health Requirements Manual, EM 385-1-1 (latest revision, 1987).
- Occupational Safety and Health Administration (OSHA), Construction Industry Standards, 29 CFR 1926, and General Industry Standards, 29 CFR 1910.
- NIOSH (National Institute for Occupational Safety and Health)/OSHA/USCG (U.S. Coast Guard)/EPA (Environmental Protection Agency), "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985.
- Other applicable Federal, State, and local safety and health requirements.

The purpose of this HASP is to summarize the project organization and responsibilities; establish standard operating procedures (SOPs) for preventing accidents, injuries, and illnesses; identify hazards; discuss the personal protective equipment that may be used; identify personnel health and safety training requirements; summarize the monitoring techniques; establish emergency procedures; describe the medical surveillance program; provide appropriate first aid equipment for site activities; provide for accident record-keeping; and establish a schedule for safety inspections.

This HASP addresses those activities associated with Resource Conservation Recovery Act (RCRA) facility investigation (RFI) activities to be conducted at NAVSURFWARCENDIV which is located approximately 75 miles southwest of Indianapolis in south central Indiana and encompasses 63,000 acres in Martin County

(Figure 1-1). Specifically, field investigation activities will be conducted at three solid waste management units (SWMUs) where activities associated with hazardous material operations took place (Figure 1-2). Investigative areas are listed by the SWMU designation and the SWMU name. These areas include the Roads and Grounds Area, Sanitary Landfill and Lithium Battery, and Cast High Explosive Fill/Incinerator Building 146.

This HASP will be implemented by the RUST E&I Inc. Corporate Health and Safety Manager (CHSM), Comprehensive Long-Term Environmental Action Navy (CLEAN) Health and Safety Health Manager (CLEAN HSM), and the Site Safety Officer (SSO) during site work.

Compliance with this HASP is required of all personnel who enter this site. Assistance in implementing this HASP can be obtained from the CHSM and the CLEAN HSM.

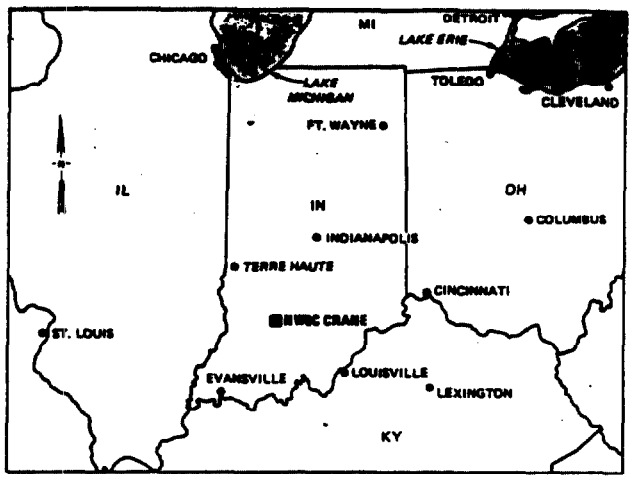
The content of this HASP may change or undergo revision based upon additional information made available to health and safety personnel through monitoring results or due to changes in the technical scope of work. Any changes proposed must be approved by the CHSM and the CLEAN HSM.

## 1.1 SCOPE OF WORK

In order to identify potential releases of hazardous waste or hazardous constituents at each of the three SWMUs, the following media-specific sampling activities will be implemented.

- Surface Soil Sampling
- Soil Boring Installation (Subsurface Soil Sampling)
- Electromagnetic Survey
- Groundwater Sample Collection Activities
- Surface Water/Sediment Sampling
- Landfill Gas Sampling
- In-Situ Hydraulic Conductivity Testing
- Monitoring Well Inventory Activities
- Equipment Decontamination

Sampling procedures are briefly summarized in the following subsections and detailed in Section 5.0 of the Work Plan.

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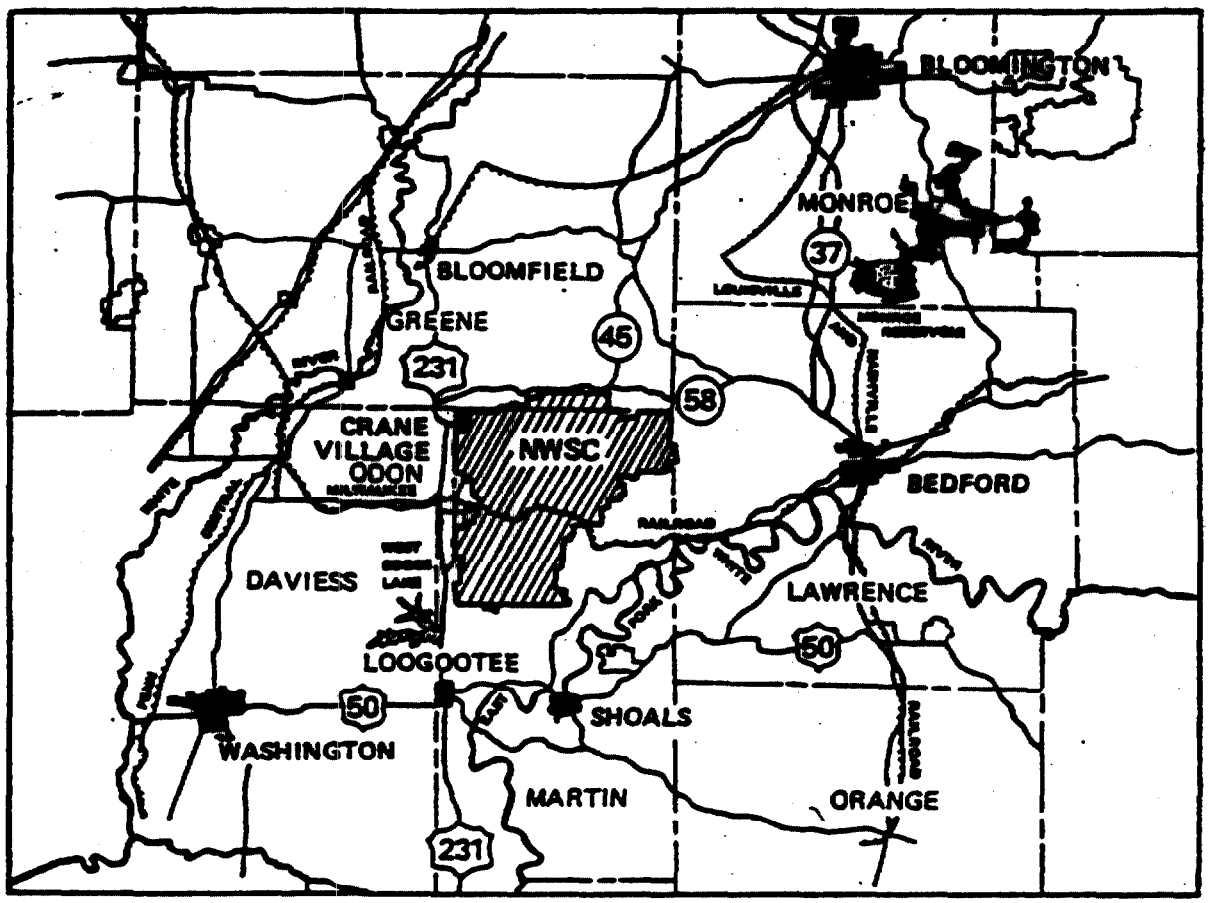
NO SCALE




SOURCES: CHESAPEAKE DIVISION, NAVAL FACILITIES ENGINEERING COMMAND, 1979 AND NAVAL ENERGY AND ENVIRONMENTAL SUPPORT AGENCY, 1983.

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

**FIGURE 1-1**

**SITE LOCATION MAP**

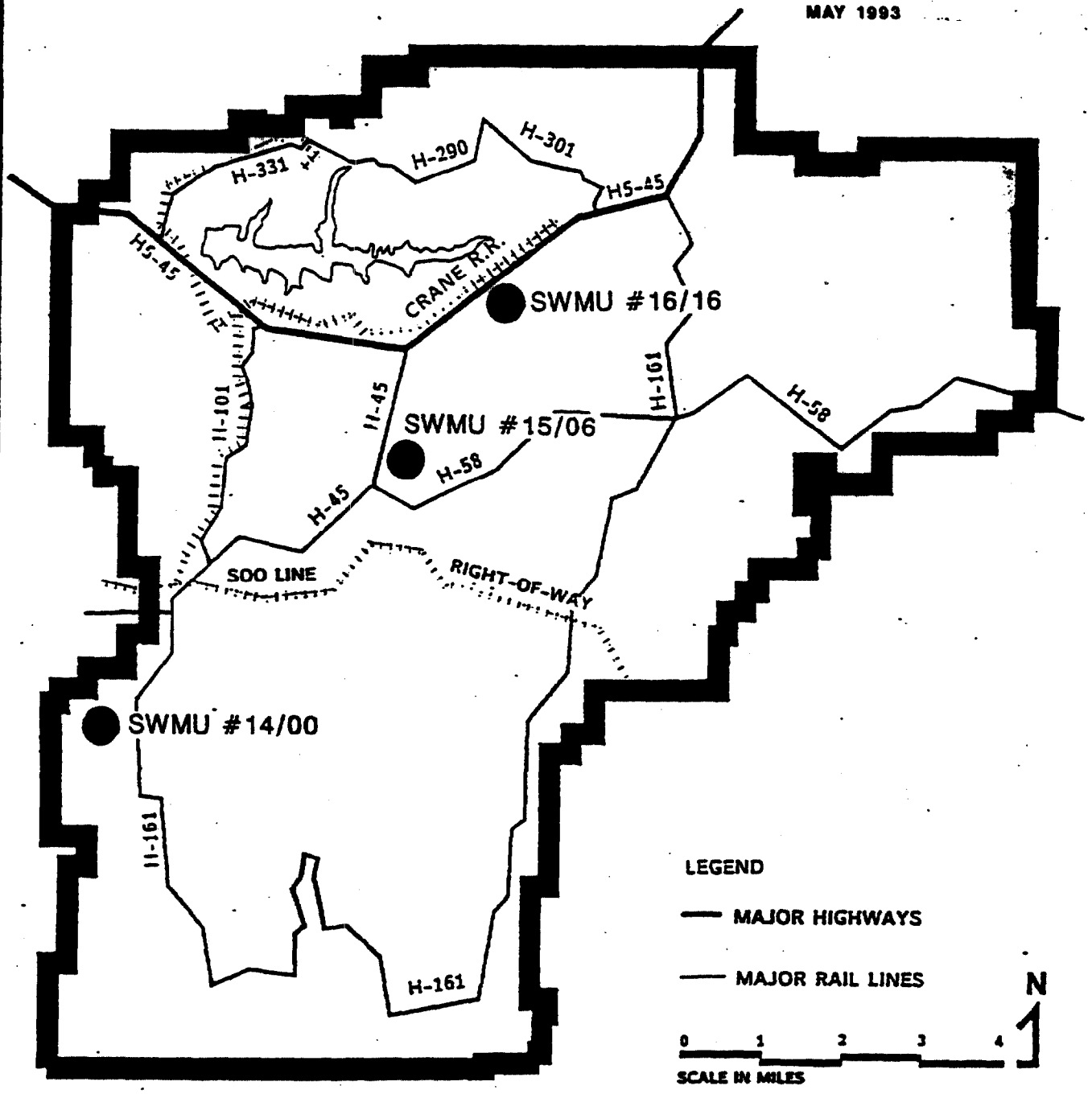
RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

20617

DUNCAN-PARNELL, INC. CHARLOTTE, NC 800-768-7768

CLEAN CTO #0078
DRAFT

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA HASP
MAY 1993




SWMU #16/16: CAST HIGH EXPLOSIVE FILL/INCINERATOR BLDG. 146
SWMU #15/06: ROADS AND GROUNDS AREA
SWMU #14/00: SANITARY LANDFILL AND LITHIUM BATTERY

SOURCE: NORTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND, NWSCC MASTER PLAN, 1986

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993 **FIGURE 1-2** 20617

**SWMU - LOCATION MAP**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

DUNCAN-PARNELL, INC. CHARLOTTE, NC 800-768-7768

### 1.1.1 Surface Soil Sampling

Discrete surface (0 to 2 feet) soil grab samples will be collected with a stainless steel hand trowel or hand auger, examined for visual signs of contamination, and placed directly into appropriate sample jars.

### 1.1.2 Subsurface Soil Sampling

Soil borings will be completed at the Roads and Grounds Area and the Sanitary Landfill to assess potential releases associated with underground storage tanks and lithium battery disposal, respectively. Borings will be advanced using hollow stem auger techniques with split spoon samples.

### 1.1.3 Electromagnetic Survey

At the lithium battery disposal area (Sanitary Landfill), an electromagnetic geophysical survey will be performed using a Geonics EM-31 Terrain Conductivity Meter. The geophysical survey is nonintrusive and will be conducted on a surveyed grid to delineate the configuration of electromagnetic anomalies indicative of buried materials. Based on establishing the limits of the lithium battery disposal, soil borings will be located so as not to drill through any batteries.

### 1.1.4 Groundwater Sampling

If encountered, groundwater will be sampled from within the borehole at borings described in Subsection 1.1.2. Additionally, one round of groundwater samples will be collected from existing monitoring wells at the Sanitary Landfill and at Building 146. Groundwater samples will be collected using a Keck Pump.

### 1.1.5 Surface Water/Sediment Sampling

Surface water and sediment samples will be collected at drainageways, leachate ponds, streams, and settling basins. Samples will be collected bankside where possible or by wading into shallow water where practical. Surface water samples will be collected by immersing the sample container in the body of water, while sediment samples will be collected with a stainless steel sampling tube.

### 1.1.6 Landfill Gas Sampling

Landfill gas sampling will be accomplished through advancement of barhole probes. A plunger bar will be used to make a hole to a depth of approximately 3 feet. Upon removal of the plunger bar, the sampling probe is inserted into the hole. A FID and CGI will be placed over the probe to identify the presence/absence of landfill gas.

### 1.1.7 In-Situ Hydraulic Conductivity Testing

Slug tests will be conducted in all existing groundwater monitoring wells. The slug tests will consist of rising and falling head tests.

### 1.1.8 Monitoring Well Inventory Activities

An inventory of the existing monitoring wells will be completed to assess the structural integrity of the wells and to assure that specific monitoring well samples are representative of water quality conditions in the monitored interval. Well inventory data will include determination of static water levels, total well depths, well obstruction, and well integrity.

## 1.2 PROJECT PERSONNEL

| Name/Firm | Title | Work Phone | Home Phone |
|---|---|---|---|
| Lorrie Ransome, Ph.D., RUST E&I | Program Manager | 414-458-8711 | 414-452-1368 |
| Jeff Maletzke RUST E&I | Project Manager | 414-458-8711 | 414-458-8682 |
| Pam Markelz, CSS, CET RUST E&I | Corporate Health and Safety Manager | 414-458-8711 | 414-457-4570 |
| RUST E&I | Site Health and Safety Officer | (To be determined before field activities are initiated) | |

6/RP/78HSPD/TEXT

# 2.0 ASSIGNMENT OF HASP RESPONSIBILITY

The following describes the health and safety designations and general responsibilities which will be implemented for the RFI to identify presence or absence of contamination.

## 2.1 CORPORATE HEALTH AND SAFETY MANAGER

The CHSM and the CLEAN HSM have overall responsibility for development and implementation of this HASP. The HSMs shall approve any changes to this HASP due to modification of procedures or newly proposed site activities.

The HSMs will be responsible for the development of new company safety protocols and procedures necessary for field operations and will also be responsible for the resolution of any outstanding safety issues which arise during the site work. Health and safety-related duties and responsibilities will be assigned only to qualified individuals by the HSMs. Before personnel may work on-site, a current medical examination and acceptable health and safety training must be approved by the HSMs.

## 2.2 SITE SAFETY OFFICER

The CHSM shall direct the on-site health and safety efforts through an Assistant SSO as needed. The SSO will be responsible for implementing this HASP. The SSO may direct or participate in on-site activities as appropriate when this does not interfere with primary SSO responsibilities. The SSO has stop-work authorization which he/she will execute upon determination of an imminent safety hazard, emergency situation, or other potentially dangerous situations, such as detrimental weather conditions. Authorization to proceed with work will be issued by the HSMs in conjunction with the Project Manager. The NAVSURFWARCENDIV personnel also has stop work authorization based on exploded ordnance activities and their on-going operations. See Section 4.3 of this HASP.

## 2.3 SUBCONTRACTORS

Subcontracts will be issued for drilling activities at the site. Subcontractors shall comply with the requirements outlined in this HASP and in accordance with OSHA 29 CFR 1910 and 29 CFR 1926; but, in all cases, subcontractors shall be responsible for site safety related to or affected by their own field operations (i.e. heavy equipment operations).

# 3.0 SITE HISTORY AND BACKGROUND

## 3.1 LOCATION, SITE HISTORY, AND PAST RESPONSE ACTIONS

Information regarding site history and background can be found in Section 4.0 of the Work Plan.

6/RP/78HSPD/TEXT

# 4.0 HAZARD ASSESSMENT

## 4.1 WASTE DESCRIPTION/CHARACTERIZATION

The following chemical information is presented in order to identify the types of materials that may be encountered at the SWMUs. The detailed information on these materials was obtained from:

- ACGIH (American Conference of Governmental Industrial Hygienists), Threshold Limit Values and Biological Exposure Indices for 1992-93.
- Hazardlines.
- Chemical Data Sheets.
- NIOSH Pocket Guide to Chemical Hazards - 1990.

The following is a list of chemicals and compounds that are potentially found on-site. Chemical Data Sheets and/or Hazardlines for each compound listed below, providing information such as the chemical's characteristics, health hazards, protection, exposure limits, and first aid procedures are presented in Attachment A and will be made available on-site during start-up of field activities. These chemicals include:

| | | |
|---|---|---|
| Arsenic | Gasoline | Polychlorinated Biphenyls (PCBs) |
| Barium | Herbicides (Ureabor) | Polynuclear Aromatic Hydro-carbons (PAH) |
| Benzene | Lead | Selenium |
| Cadmium | Lithium | Silver |
| Chromium | Mercury | |
| Diesel Fuel | Pesticides | |

Waste Types: Liquid __X__ Solid __X__ Gas __X__
Sludge __X__ Semi-solid ___ Other _____

Characteristics: Corrosive __X__ Flammable __X__
Explosive __X__ Volatile __X__
Radioactive ____ Inert _____
Other __Toxic_____

Exposure limits for the chemical compounds of concern are presented in Table 4-1 and the tasks, hazards, and control measures are shown in Table 4-2.

**TABLE 4-1**

**EXPOSURE LIMITS**
**NAVSURFWARCENDIV**
**CRANE, INDIANA**

| Compounds | PEL ($mg/m^3$) | TLV ($mg/m^3$) | STEL ($mg/m^3$) | IP | Odor Thresholds |
|---|---|---|---|---|---|
| Metals | | | | | |
| Arsenic | 0.01 | 0.2 | --- | --- | --- |
| Barium | 0.5 | 0.5 | --- | --- | --- |
| Cadmium (dust) | 0.2 | 0.05 | 0.6 | --- | --- |
| Chromium (VI) | --- | 0.05 | --- | --- | --- |
| Lead (dust) | 0.05 | 0.15 | --- | --- | --- |
| Mercury[1] | 0.01 | 0.05 | 0.03 | --- | --- |
| Selenium | 0.2 | 0.2 | --- | --- | --- |
| Silver (Soluble) | 0.01 | 0.01 | --- | --- | --- |
| Explosive Compounds | | | | | |
| Dinitrobenzene | 1.0 | 0.15 | --- | --- | --- |
| 2,4-Dinitrotoluene | 1.5 | 1.5 | --- | --- | --- |
| 2,6-Dinitrotoluene | 1.5 | 0.15 | --- | --- | --- |
| HMX | --- | --- | --- | --- | --- |
| RDX | 1.5 | 1.5 | --- | --- | --- |
| 1,3,5-Trinitrobenzene | --- | --- | --- | --- | |
| 2,4,6-Trinitrotoluene | 0.5 | 0.5 | --- | --- | --- |
| Semivolatile Organic Compounds | | | | | |
| Polynuclear Aromatic Hydrocarbons (PAH) | | | | | |
| Volatile Compound | | | | | |
| Benzene | 1 ppm | 10 ppm | --- | 9.25 | 4.68-12 |
| Ethylbenzene | 100 ppm | 100 ppm | 125 ppm | 8.76 | 0.25-200 |

**TABLE 4-1 (Continued)**

**EXPOSURE LIMITS**
**NAVSURFWARCENDIV**
**CRANE, INDIANA**

| Compounds | PEL ($mg/m^3$) | TLV ($mg/m^3$) | STEL ($mg/m^3$) | IP | Odor Thresholds |
|---|---|---|---|---|---|
| Volatile Compound (Continued) | | | | | |
| Toluene | 100 ppm | 50 pm | 150 ppm | 8.82 | 0.17-40 |
| Xylene | 100 ppm | 100 ppm | 150 ppm | 8.44-8.56 | 1.1 |
| Pesticide | | | | | |
| Ureabor | | | | | |
| PCB | | | | | |
| PCB-1254 | 0.5 | 0.5 | --- | --- | --- |

References:

American Conference of Governmental Hygienists (ACGIH) Threshold Limit Values (TLV) for 1992-93.
Hazard Lines 1992.
1989 Amended Permissible Exposure Limits (PELs), U.S. Department of Labor, OSHA.

IP - Ionization Potential.
STEL - Short-Term Exposure Limit.
PEL - Permissible Exposure Limit.
TLV - Threshold Limit Value.
PPM - Parts Per Million.
[1] - All forms except alkyl vapor.

6/RP/78HSPR/TABLE4_1

# TABLE 4-2

## TASK SPECIFIC HAZARD ASSESSMENT TABLE
## NAVSURFWARCENDIV
## DECEMBER 1992

| TASK | HAZARD | CONTROL MEASURES |
|---|---|---|
| Surface Soil Sampling | Slip, Trip, Fall<br>Dermal Contact<br>Inhalation<br>Thermal Stress<br>Toxic Atmosphere | General Awareness<br>Flagging, Access Controls<br>PPE<br>Respiratory Protection<br>Work/Rest Cycles, Fluids<br>Continuous Monitoring |
| Soil Boring Installation | Contact with Moving Machinery<br>Dermal Contact<br>Inhalation<br>Thermal Stress<br>Slip, Trip, Fall<br>Overhead Hazard | PPE<br>Respiratory Protection<br>Work/Rest Cycles, Fluids<br>Access Controls<br>Hardhat |
| Groundwater Sample Collection | Dermal Contact<br>Inhalation<br>Thermal Stress<br>Toxic Atmosphere | General Awareness<br>Access Controls<br>PPE<br>Respiratory Protection<br>Work/Rest Cycles, Fluids<br>Continuous Monitoring |
| Surface Water/Sediment Sampling | Slip, Trip, Fall<br>Dermal Contact | Harness, Rope, Life Vest<br>PPE |
| Landfill Gas Sampling (Barhole Probe) | Inhalation<br>Slip, Trip, Fall<br>Fire/Explosion | Respiratory Protection<br>Access Controls<br>Nonsparking Tools,<br>Monitor Atmosphere |
| In-Situ Hydraulic Conductivity Testing | Dermal Contact<br>Inhalation | PPE<br>Respiratory Protection |
| Monitoring Well Inventory | Slip, Trip, Fall | General Awareness |
| Equipment Decontamination | Dermal Contact<br>Inhalation<br>Thermal Stress<br>Slip, Trip, Fall | PPE<br>Respiratory Protection<br>Work/Rest Cycles, Fluids<br>Access Controls |

## 4.2 DEGREE OF HAZARD

On-site hazards at the SWMUs include physical and chemical hazards. No radiological, biological, or laboratory wastes are suspected on-site.

### 4.2.1 Chemical Hazards

The potential contaminants of concern at the base can affect the body if they are inhaled, come in contact with the eyes or skin, or are ingested. These materials may be released during intrusive soil sampling and water sampling. The primary concern is for skin exposure and inhalation exposure to contaminated soils and water, and potential inhalation of organic vapors or dust released during soil intrusive activities. Exposure to these substances by inhalation (in the breathing zone (BZ)) is not anticipated due to the levels found during past studies. Atmospheric monitoring in the worker's BZ, however, will be conducted during on-site activities to determine the need for upgrading to appropriate levels of respiratory protection. Exposure by skin absorption is a low to moderate possibility, and can be prevented by use of proper protective equipment, good hygiene practices, and engineering controls (i.e. wetting the work zone (WZ) with water to control dust).

Soil boring activities provide potential for encountering buried hazards such as utilities. Clearance shall be obtained from NAVSURFWARCENDIV and local utilities and shall be the subcontractor's responsibility to obtain "clearance" prior to initiating intrusive activities. If encountered, soil intrusive activities will be halted and the HSMs will be notified. Overhead electrical lines shall also be identified.

### 4.2.2 Physical Hazards

Primary physical hazards at the site are those associated with drilling, soil sampling, and sediment/surface water sampling activities, as well as general walking around off of pavement. Hazards that could be encountered during these activities include falls and trips on uneven surfaces, hidden holes and brush covered obstructions, injury from lifting heavy objects, falling objects, eye injuries, head injuries, and pinched or crushed hands and feet. Fire hazards may also be present due to the use of gasoline-powered heavy equipment.

During surface water/sediment sampling activities, there is a potential for slips and falls associated with wet surfaces and soft unstable sediment surfaces. Personnel sampling the pond will wear USCG approved life jackets. During sampling, the buddy system will be employed and one person will remain bankside.

Field activities shall be conducted in accordance with the OSHA standard for working in or near water (29 CFR 1926.106) as applicable.

Physical hazards which may be encountered at NAVSURFWARCENDIV during field activities include overhead and tripping hazards associated with drill rig operations. During drilling operations, matting and planking may be required around the drill rig to provide stability. The drilling contractor will make this decision. Additionally, protruding objects such as metal shrapnel and empty ammunition cartridges may exist at the SWMUs. Steel shank and steel toe shoes/boots will be required.

Surface water and sediment sampling activities provide the potential for slips and falls associated with wet surfaces and soft unstable sediment surfaces.

Pipe insulation identified during the site walkover is suspected to be asbestos containing material (ACM). Exposure to the possible presence of asbestos is not anticipated since sampling teams will not enter any buildings or disturb pipe insulation. The SSO, however, will watch for dry, windy conditions when working near these areas and upgrade personal protection (i.e. respirators) for the sampling team as appropriate. If the SSO determines that the presence of asbestos becomes an exposure hazard, sampling activities will be halted and procedures associated with OSHA 29 CFR 1910.1001 and 1926.58 will be implemented.

Depending on seasonal weather conditions, there is potential for workers on-site to be affected by heat stress if activities are scheduled for the summer months or cold exposure if activities are conducted during winter months. The SSO will monitor for heat stress or cold exposure in accordance with Section 12.7 of this HASP.

Noise related to soil boring operations is expected to be minimal; however as a precaution, hearing protection will be worn when working near the drill rig.

### 4.2.3 Natural Hazards

Natural hazards such as weather, poisonous plants, or bites from poisonous or disease-carrying animals (i.e. snakes, ticks) cannot always be avoided. Based on available information and current site conditions, the SSO and field personnel shall use their best judgement to mitigate these potential hazards.

### 4.2.4 Confined Space Entry

Confined space entry is not anticipated for these field activities and is, therefore, not addressed in this HASP. Personnel will not enter confined spaces. If confined space entry is necessary, work will be halted and the HSMs will be notified to prepare a plan before work continues.

### 4.2.5 Spill Containment

Field activities are unlikely to require spill containment and are, therefore, not addressed in this HASP.

## 4.3 ADDITIONAL PRECAUTIONS

It is possible, but extremely unlikely, that some unexploded ordnance may be present in the SWMUs to be sampled. Because of this, the Halliburton NUS Team shall, as needed, work with unexploded ordnance (UXO) specialists from NAVSURFWARCENDIV using equipment capable of detecting ordnance in areas where field activities are to be conducted. Any unexploded ordnance shall be marked and access restricted in the immediate area. Because sampling locations are located in the active SWMUs, the SSO shall arrange SWMU access with Thomas Brent (NAVSURFWARCENDIV Point of Contact).

6/RP/78HSPD/TEXT

# 5.0 TRAINING REQUIREMENTS

## 5.1 BASIC TRAINING REQUIRED

Personnel who are required to work in areas where the potential for toxic exposure exists shall complete training and have site experience conforming to the requirements of 29 CFR 1910.120(e). In keeping with 29 CFR 1910.20, medical records and exposure records will be available to workers or his/her designated representative upon request.

Training includes a 40-hour course which describes procedures for working at hazardous waste sites. The procedures include a safety and health program, medical surveillance, decontamination, site characterization and analysis, protective clothing and monitoring equipment, site control documentation, emergency response, engineering and administrative controls to reduce exposure, and site safety evacuation procedures.

Contractors/subcontractors shall provide written documentation that these training/ experience requirements have been met. An example of a training documentation form is presented on Figure 5-1. Personnel shall also be trained in the contents of Attachment B, "Respiratory Protection Program."

## 5.2 ADVANCED TRAINING

Advanced training as necessary will be provided to personnel who will be expected to perform other specialized operations to be undertaken at this site.

## 5.3 SITE-SPECIFIC TRAINING

Site-specific information will be provided by the SSO for on-site personnel and visitors to minimize exposure to potential on-site hazards. Site-specific information will address the activities, procedures, monitoring, and equipment for the field operations at NAVSURFWARCENDIV. This training will include identifying the names of personnel and alternate personnel responsible for site safety and facility layout.

Additionally, this information at a minimum will include the following:

1. Site description and history.
2. Project activities, including coordination with other contractors.
3. Hazard evaluation.
4. On-site safety responsibilities.

# FIGURE 5-1



## OSHA TRAINING COMPLIANCE LETTER
## NAVSURFWARCENDIV
## CRANE, INDIANA

Note: The following statements must be typed on company letterhead and signed by an officer of the company.

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Jeffrey D. Maletzke
RUST Environment & Infrastructure
4738 North 40th Street
Sheboygan, Wisconsin 53083

Subject: OSHA Compliance and Testing

Dear Mr. Maletzke:

As an officer of XYZ Corporation, I hereby state that I am aware of the potential hazardous nature of the subject project. I also understand that it is our responsibility to comply with all applicable occupational safety and health regulations including those stipulated in Title 29 of the Code of Federal Regulations (CFR), Parts 1900 through 1910 and Part 1926.

I also understand that Title 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response: Final Rule"; requires, but is not limited to, medical surveillance, for applicable employees, and appropriate level of training as required in paragraph (e) of 29 CFR 1910.120 for employees engaged in certain hazardous waste operations. I hereby state that I have reviewed these requirements; understand Title 29 of the CFR, Parts 1900 through 1910, and Part 1926; and that XYZ Corporation and all of its employees who will perform work at the Naval Surface Warfare Center, Crane Division, are in full compliance.

The following employees have had 40 hours of introductory hazardous waste site training and 3 days actual field experience as required by 29 CFR 1910.120(e)(3)(i), and have had 8 hours of refresher training as required by 29 CFR 1910.120(e)(8).

LIST EMPLOYEE NAMES, TYPE(S) OF TRAINING RECEIVED, AND DATES OF TRAINING

Sincerely,

(Name of Company Officer)
Title

5. Site control and WZs.
6. Personnel training.
7. Medical monitoring.
8. Atmospheric monitoring.
9. Personal protection, clothing, and equipment.
10. Decontamination procedures.
11. Emergency procedures.
12. Review of site-specific material safety data sheets (MSDSs).
13. Safe work practices.
14. Other elements covered in this site-specific HASP.

This information session will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safe operations. Information must include emergency preparedness, location of assembly areas, proper entry and exit procedures for exclusion zone (EZ), warning systems, location of emergency equipment, and route to the hospital.

## 5.4 SAFETY BRIEFINGS

Project personnel will be given briefings by the SSO on a daily or as-needed basis to further assist field personnel in conducting their activities safely. Briefings will be provided when new operations are to be conducted, changes in work practices must be implemented due to new information made available, or if site or environmental conditions change. Briefings will also be given to facilitate conformance with prescribed safety practices when performance deficiencies are identified during routine daily activities or as a result of safety audits.

## 5.5 SAFETY AUDITS

The CHSM, as necessary for particular projects, will conduct regular safety audits of field operations and subcontractor performance to review for compliance with health and safety policies and procedures. Health and Safety audit findings will be documented and corrective action taken.

## 5.6 FIRST AID AND CPR

At least two individuals shall be trained and qualified to administer first aid and cardiopulmonary resuscitation (CPR).

The HSMs will identify the individuals possessing this training in order to ensure that emergency treatment is available during every workshift from a person qualified in first aid and CPR. These courses will be consistent with requirements of the American Red Cross and/or American Heart Association.

6/RP/78HSPD/TEXT

# 6.0 MEDICAL SURVEILLANCE PROGRAM

All Halliburton NUS Team personnel and subcontractors performing field work at the SWMUs will be required to have passed a pre-assignment and/or periodic medical examination that is consistent with 29 CFR 1910.120(f). Medical examinations shall be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine. A release for work will be confirmed by the CHSM before an employee can begin hazardous site activities.

Additional medical testing may be required by the CHSM in consultation with the examining physician if an overt exposure or accident occurs, or if other site conditions warrant further medical surveillance.

Contractors/subcontractors will maintain the medical records for their own employees, but shall also provide the SSO with written documentation certifying that each employee at the site has met the requirements of the Medical Surveillance Program. This documentation will be provided before the first day of work for each employee assigned to the site. An example of a medical surveillance letter is presented on Figure 6-1. The pre-assignment and annual examinations are essentially the same in content and are the examining physician's discretion but generally include:

- An updated medical and occupational history
- A screening physical examination
- Blood and urine laboratory tests
- Chest x-ray
- Electrocardiogram
- Pulmonary function tests
- Audiometry
- Visual acuity test

## 6.1 EMERGENCY MEDICAL TREATMENT

Provisions for emergency medical treatment shall be integrated with the overall Site Emergency Plan (see Section 12.0) and shall include:

- At least two individuals per shift qualified to render first aid and CPR.

- First aid kits in compliance with OSHA requirements and first aid stations in the immediate work vicinity.

# FIGURE 6-1

## MEDICAL SURVEILLANCE LETTER
## NAVSURFWARCENDIV
## CRANE, INDIANA

Note: The following statements must be typed on company letterhead and signed by an officer of the company.

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Jeffrey D. Maletzke
RUST Environment & Infrastructure
4738 North 40th Street
Sheboygan, Wisconsin 53083

Subject: Medical Surveillance

Dear Mr. Maletzke:

As an officer of XYZ Corporation, I hereby state that the persons listed below participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations, Part 1910.120 entitled "Hazardous Waste Operations and Emergency Response: Final Rule." I further state that the persons listed below have had physical examinations under this program within the last 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear respiratory protection. I also state that, to my knowledge, no person listed below has any medical restrictions that would preclude him/her from performing their assigned activities at the Naval Surface Warfare Center, Crane Division.

LIST EMPLOYEE NAMES AND DATES OF MOST RECENT PHYSICAL EXAMS

Should you have any questions, please contact me at 555/555-5555.

Sincerely,

(Name of Company Officer)
Title

- Conspicuously posted telephone numbers and procedures for contacting ambulance services, fire department, police, and medical facilities.

- Maps and directions to medical facilities.

6/RP/78HSPD/TEXT

# 7.0 SITE CONTROL MEASURES

At the SWMU sites, an EZ, contamination reduction zone (CRZ), and a support zone (SZ) will be established. An equipment decontamination pad will be included in the EZ. Additionally temporary activity-specific WZs will be established at specific locations.

## 7.1 SITE ACCESS

The base currently occupies approximately 100 square miles. Five entry/exit gates are located around the perimeter of the base. Access is available to personnel with passes. Halliburton NUS Team personnel and subcontractors performing field work at the SWMUs will enter and exit through the Bloomington Gate on State Highway 45. The SSO is responsible for maintaining effective site control in the SWMU where work is occurring. The site as a whole is regulated by military police including traffic citations.

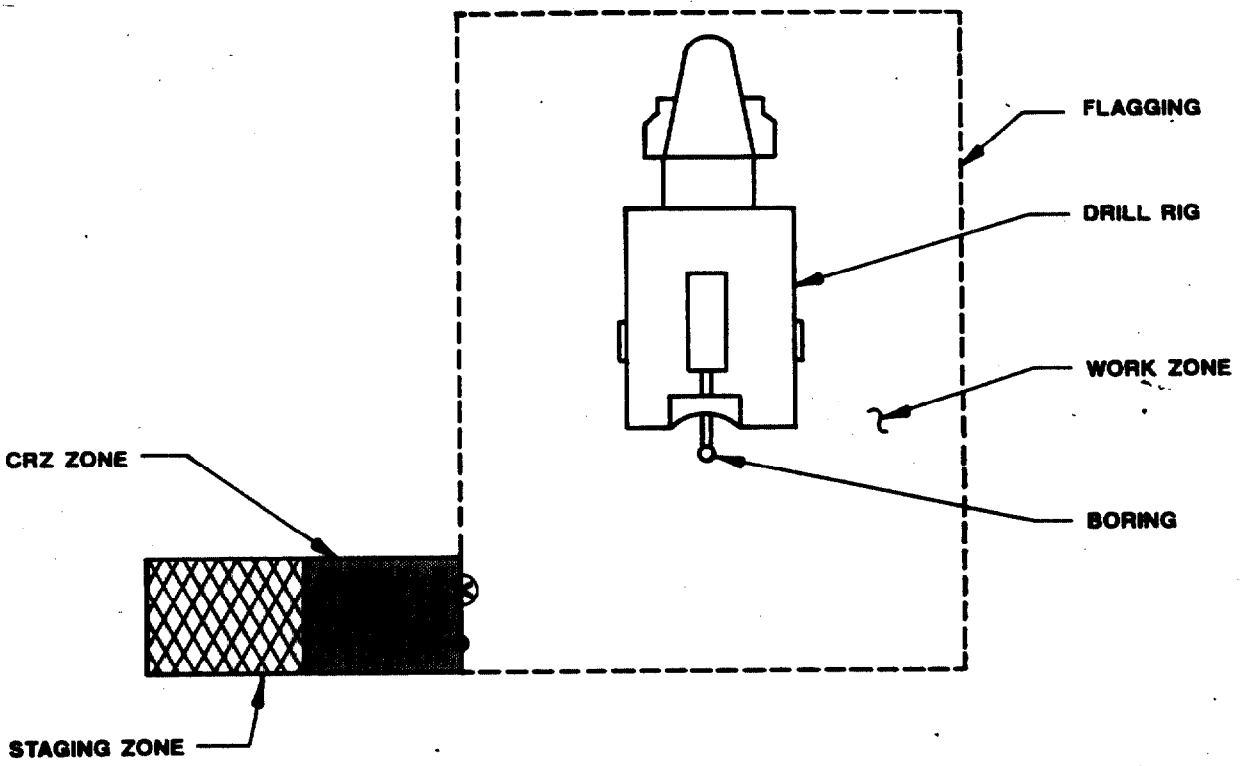
## 7.2 EXCLUSION ZONE

The EZ is the area containing or suspected of containing contaminated materials. Since investigation activities will be conducted throughout different SWMUs, the SWMU boundaries shall be delineated as the EZ.

### 7.2.1 Work Zones

Temporary activity-specific WZs, as presented on Figure 7-1, shall be established at each soil boring location. While completing soil borings, the WZ shall be established and marked by safety rope or tape. The WZ shall include a 30-foot or larger radius encompassing the drill rig. A CRZ shall be placed at the WZ perimeter at an upwind location. A portable eye wash unit, first aid kit, towels, plastic garbage bags, and decontamination supplies shall be placed in this CRZ. These supplies may be located in the vehicle parked adjacent to the WZ.

A temporary WZ shall be established at each sampling location where surface soil samples are to be collected. These WZ areas shall be established by laying about 5 square feet of plastic sheeting next to the sampling location for the placement of equipment and supplies. A portable eye wash unit, first aid kit, towels, plastic garbage bags, fire extinguisher, and decontamination supplies are also required in this area, which may be located in the trucks.




## NOTES:

1. THE CRZ ZONE WILL CONTAIN:
   - PORTABLE EMERGENCY EYEWASH UNIT
   - FIRST AID KIT
   - FIRE EXTINGUISHER
   - TOWELS / WIPE CLOTHS
   - WATER FILLED TUB
   - 55-GALLON DRUM OR PLASTIC BAG
2. ⊗ ENTRY EXIT POINT
3. THE STAGING ZONE (IF APPLICABLE) WILL CONTAIN SUPPORT ZONE ACTIVITIES AND PERSONNEL TRANSPORT VEHICLES

SCALE: NTS

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

20617

**FIGURE 7-1**
**WORK ZONE LAYOUT**
RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

DUNCAN-PARNELL, INC. CHARLOTTE, NC 800-768-7768

## 7.3 PERSONNEL DECONTAMINATION

Personnel decontamination areas will be established on-site. Personnel will decontaminate and/or dispose of soiled protective clothing (i.e. disposable boots and gloves, etc.) in the CRZ established next to the temporary WZ. A fixed personnel decontamination area will be established adjacent to the fixed equipment decontamination pad where, after equipment decontamination, personnel can decontaminate and dispose of protective clothing and equipment before exiting the SWMU. Refer to Section 10 for further decontamination procedures.

## 7.4 EQUIPMENT DECONTAMINATION PAD

To prevent off-site transport of contamination, drill rigs and associated equipment and vehicles will be decontaminated at a fixed temporary decontamination pad prior to exiting the EZ. This location will be selected by the SSO prior to start-up of field activities in each SWMU. Drilling equipment (augers, rods, etc.) will be steam-cleaned at the fixed decontamination pad as necessary. These activities will be performed in a location which will be downwind of the investigation area. Decontamination liquids will be allowed to infiltrate the soil. Refer to Section 10 for further decontamination procedures.

To prevent off-site transport of contamination, soil/sediment, surface water, and groundwater sampling equipment will be decontaminated at each sampling location. During decontamination, isopropanol rinses will be collected for later disposal (at the base wastewater treatment facility upon approval). Other decontamination liquids will be allowed to fall onto the ground at each location. Refer to Section 10 for further decontamination procedures.

## 7.5 SUPPORT ZONE

The SZ is considered the uncontaminated area. A building will be chosen for SZ activities. It will contain the Command Post which will provide for team communications and emergency response. A telephone will be located in this building. Appropriate sanitary facilities, safety, medical, and support equipment will be located in this zone. No potentially contaminated personnel or materials are allowed in the SZ except for appropriately packaged/decontaminated and labelled samples.

## 7.6 SITE VISITORS

Visitors are required to coordinate base visits with Thomas Brent, including obtaining passes. Visitors are required to report to the SSO prior to accessing the SWMU. The SSO will determine the purpose of individual visits, and will document decisions regarding their access to the SWMU. If granted limited access, visitors must adhere to base regulations and sign in and out daily under the SSO's direction for the duration of their approved visit. Under no circumstances will visitors be allowed to interfere with or participate in operations within the scope of the field investigation. All visitors shall be escorted throughout the SWMU by the SSO.

As needed, the SSO will establish a designated Level D area as an observation point for visitors during intrusive activities. This designated area will be located to offer proximate viewing of investigative operations, and positioned such that visitors in no way may inhibit base access, logistics, or general operations. Further, the SSO will locate the viewing areas such that visitors present are at minimal risk of exposure to site hazards.

Prior to gaining access to designated viewing areas described above, visitors must provide the SSO with documented compliance with Section 5.0 of this HASP, comply with other applicable sections, and satisfy additional conditions placed on them as deemed appropriate by the SSO to ensure visitor safety.

## 7.7 UXO CLEARANCE AND SITE CONTROL

All personnel involved with investigation activities associated with the SWMUs and the sediment/surface water sampling shall comply at all times with the UXO Team's SOPs as appropriate. Specifically, no one shall venture into any areas of the SWMUs which are not part of the investigation or which have not been cleared by the UXO Team. Furthermore, no one shall venture into any area of the site without being accompanied by base personnel.

At the start of each work day, the SSO shall contact Thomas Brent to inform him that personnel will be working at a particular SWMU.

# 8.0 PERSONAL PROTECTIVE EQUIPMENT

## 8.1 GENERAL

The level of protection to be worn by field personnel will be defined and controlled by the SSO. Personal protective equipment for general operations will be consistent with the requirements of 29 CFR 1910 Subpart I, "Personal Protective Equipment." Basic levels of protection for hazardous waste operations will be selected in accordance with the provisions of 29 CFR 1910.120(g)(3), "Personal Protective Equipment Selection," and Appendix A, "General Description and Discussion of the Levels of Protection and Protective Gear." Modification to basic protective equipment ensembles may be necessary for specific operations. In these cases, further definition will be provided by review of specific hazards, conditions, and proposed operational requirements, and by conducting air monitoring at the particular operation. Protection may be upgraded or downgraded, as deemed appropriate by the SSO and verified by the CHSM and the CLEAN HSMs.

## 8.2 ANTICIPATED LEVELS OF PROTECTION FOR SITE OPERATIONS

Field activities will be initiated in Level D protection with the contingency to upgrade to Level C protection (D/C) based on action levels presented in Section 9.2.

| | | |
|---|---|---|
| Task 1: | Surface Soil Sampling | D/C |
| Task 2: | Soil Boring Installation | D/C |
| Task 3: | Monitoring Well Sample Collection Activities | D/C |
| Task 4: | Sediment and Surface Water Sampling | D |
| Task 5: | Landfill Gas Sampling | D/C |
| Task 6: | In-Situ Hydraulic Conductivity Testing | D |
| Task 7: | Monitoring Well Inventory | D |
| Task 8: | Equipment Decontamination | D/C |
| Task 9: | Electromagnetic Survey | D |

Level D personal protective clothing and equipment includes:

- Standard Tyvek, coveralls - required in sampling areas when dusty conditions prevail.
- Polycoated Tyvek, coveralls - required in sampling areas when splashing by contaminated soils or water is a possibility.

- Hard hat (when overhead hazards exist).
- Safety glasses or goggles.
- Steel toe, steel shank boots.
- Chest waders - as warranted.
- Harness and lifeline - as warranted.
- USCG approved life preserver - as warranted.
- Disposable latex gloves - required when handling and collecting soil, sediment, and water samples.
- Outer nitrile gloves - required when handling and collecting soil, sediment, and water samples.
- Disposable outer boots - required.
- Noise protection - as warranted.

Level C protective clothing and equipment includes:

- Full-face air-purifying respirator (NIOSH, Mining Safety and Health Administration (MSHA) approved) fitted with acid gas/organic vapor/HEPA (High Efficiency Particulate Air filter) cartridges.
- Polycoated Tyvek, coveralls.
- Disposable latex inner gloves.
- Nitrile outer gloves.
- Steel toe, steel shank boots.
- Disposable outer boots.

Level B protective clothing and equipment includes the above Level C clothing with the addition of a self-contained breathing apparatus (SCBA) or supplied air-line respirator in place of an air-purifying respirator. If action levels are exceeded and based on

evaluation of the conditions, if Level B respiratory protection is deemed necessary, work activities will be halted and arrangements for Level B equipment will be implemented.

The use and care of respiratory protection will be in accordance with the protocols described in Attachment B.

Action levels used to determine the need to upgrade or downgrade the levels of protection are described in Section 9.2 of this HASP.

Personnel involved with surface water and sediment sampling shall wear waders as appropriate. The person conducting the sampling will wear a U.S. Coast Guard approved life vest.

6/RP/78HSPD/TEXT

# 9.0 AIR MONITORING

## 9.1 GENERAL

It will be necessary to monitor the atmospheric conditions during on-site field sampling activities to determine the possible need to upgrade the personal protection of on-site workers. Atmosphere at the sample extraction point during soil boring activities and fluids produced during drilling shall be monitored. Additionally, air monitoring will be performed in the worker's BZ.

### 9.1.1 Soil Sampling

Soil sampling activities shall be initiated in Level D personal protection with the contingency to upgrade the level of protection based on the action levels.

Air monitoring of the worker's BZ shall be performed continuously during the sampling activities. An Organic Vapor Analyzer (OVA) Flame Ionization Detector (FID) or HNu Photoionization Detector (PID) shall be used to monitor the BZ and the sampling extraction point.

### 9.1.2 Barhole Probe Operations

Barhole probe operations will be initiated in Level D personal protective equipment with the contingency to upgrade the level of protection based upon action levels.

The FID and CGI shall be used during the placement of the barhole probes. Prior to advancing the barhole probes, the area will be scanned with the FID and CGI to identify the potential for methane gas or combustible atmosphere to be present above the soil. after determining the absence of methane gas/explosive atmosphere or at levels below the action limits in the work area, a piece of decontaminated galvanized steel pipe approximately 5 feet in length will be advanced into the soil. The probe will be advanced using a metal post driver or equivalent to approximately 18 to 36 inches below ground surface.

The FID and CGI will then be placed over the probe to identify the presence/absence of landfill gas. If present, a gas sample will be obtained using a SUMMA Canister. The canister is under vacuum. Therefore, a stopcock will be opened, the landfill gas will flow into the canister, the stopcock will be closed, and the canister will be readied for shipment to the analytical laboratory.

The FID and CGI meter responses will be recorded for both inside the barhole probe and outside the probe in the general work area. If the readings in the general work area and BZ exceed action levels, the area will be allowed to vent and personnel will retreat to a safe distance. Additional work in the area will not be performed until it is safe.

### 9.1.3 Electromagnetic Survey

Electromagnetic survey activities will be conducted in Level D protection. Atmospheric monitoring will be unnecessary because organic emissions are not anticipated due to nonintrusive activities.

### 9.1.4 Soil Boring Operations

Soil boring activities will be initiated in Level D protection with the contingency to upgrade the level of protection based on the action levels.

Air monitoring of the worker's BZ will be performed continuously during the drilling activities. An OVA or HNu shall be used to monitor the BZ, the borehole, and soil samples upon their retrieval. Drill cuttings and fluids produced during drilling shall also be monitored.

### 9.1.5 Groundwater Sample Collection Activities

Groundwater sample collection activities will be initiated in Level D protection with the contingency to upgrade the level of protection based on the action levels.

The HNu and/or OVA shall be used to monitor the BZ and the well casing. Prior to sample collection, the sampling team will stand upwind of the well casing when removing the well cap, stand back, and allow the well casing to vent for about 5 minutes. If action levels are not exceeded in the BZ, development and/or sampling activities may proceed.

### 9.1.6 Sediment and Surface Water Sampling

Sediment and surface water activities will be conducted in Level D protection. Atmospheric monitoring will be unnecessary because offgasing is not anticipated due to the wet nature of the samples to be collected. Sampling activities will employ the buddy system with one person remaining bankside. Hip boots or waders will be worn including a life vest. The stream area does not pose a significant water hazard. If a small boat is needed to obtain samples from the pond, life vests and lifelines will be used with the buddy system and one person will be bankside.

## 9.2 ACTION LEVELS

Instrumentation will include an HNu PID and/or a Century 128 OVA FID. The action levels in this HASP will apply to site work during the duration of activities at the SWMUs and surface water areas. Action levels for direct-reading instruments in the worker's BZ are as follows:

| Instrument | Action Levels | Level of Respiratory Protection/Action |
|---|---|---|
| PID/OVA | Continuous sustained readings to 1 ppm above background (typically to 0.2 ppm) in BZ | Level D |
| PID/OVA | Continuous sustained readings of 1 ppm to 5 ppm above background | Level C (based on identification of contaminant) |
| HNu/OVA | Continuous readings at 5 to 250 ppm above background in BZ | Level B (if applicable) |

If visible dust is detected while working in Level D, upgrade to Level C respiratory protection is required. However, engineering controls, such as wetting the WZ with water to control dust, will be implemented when feasible.

In the event any action levels are exceeded in the BZ, work activities shall be halted, and an attempt will be made to identify the contaminants present using colorimeter indicator tubes so that correct respiratory protection can be selected and action levels may be adjusted higher or more conservatively. The SSO shall notify the HSMs immediately prior to upgrading the level of respiratory protection.

## 9.3 EXPOSURE MONITORING/AIR SAMPLING PROGRAM

### 9.3.1 Personal and Perimeter Monitoring

Personal and perimeter air monitoring will not be conducted unless Level D action levels are exceeded in the EZ. The determination to perform personal and/or perimeter air monitoring will be determined by the CHSM after discussions with SSO. If an air monitoring program is deemed necessary, work activities will be halted and a monitoring plan will be developed. This will be determined by the CHSM. Based on current site

activities at each SWMU and the restrictions placed upon personnel during activities, it is not anticipated that personal exposure or migration of contaminants off-site will be of concern.

## 9.4 INSTRUMENT CALIBRATION AND MAINTENANCE

Instrument calibration and maintenance shall be performed according to manufacturer's specifications and documented on Field Instrument Calibration Logs. HNu/OVA calibration shall be completed on a daily basis or more frequently if needed.

6/RP/78HSPD/TEXT

# 10.0 DECONTAMINATION PROCEDURES

The SSO shall determine the level of decontamination necessary based on the evaluation of specific work activities and the potential degree of contamination. Temporary CRZs shall be established at each sampling location.

## 10.1 EQUIPMENT

Drill rigs and associated equipment and vehicles will be decontaminated at a location on-site selected by the SSO prior to start-up of field activities in the EZ. Drilling equipment (augers, rods, etc.) will be steam-cleaned between soil boring locations. Decontamination will be performed on the ground away from the drilling locations; preferably downslope and down gradient.

Non-disposable sampling equipment will be decontaminated before use, between samples, and before leaving the sampling location.

Equipment that cannot be immersed in soap solution and water will be wiped clean and rinsed with distilled water.

## 10.2 PERSONNEL

Personnel will perform decontamination in the personal decontamination area. Decontamination of personnel in Level D will consist of removal and disposal of coveralls (when worn), disposable boots, and gloves. Decontamination of personnel using Level C protective equipment will consist of:

1. Washing boots, waders, or other non-disposable protective equipment, suspected of being contaminated using soap solution followed by potable or distilled water rinse.

2. Removal and disposal of boot covers and waders if worn.

3. Removal and disposal of coveralls.

4. Removal and disposal of outer gloves.

5. Removal, cleaning, and storage of respiratory equipment.

6. Removal and disposal of inner gloves.

## 10.3 CONTAMINATION PREVENTION

One of the most important aspects of decontamination is the prevention of contamination. Good contamination prevention should minimize worker exposure and help ensure valid sample results by precluding cross-contamination. Procedures for contamination avoidance include:

Personnel

- Obey base regulations.
- Know the limitations of all personal protective equipment being used.
- Do not walk through areas of obvious or known contamination.
- Do not handle or touch contaminated materials directly. Do not sit or lean on potentially contaminated surfaces.
- Make sure all personal protective equipment has no cuts or tears prior to donning.
- Fasten all closures on suits, covering with tape, if necessary.
- Particular care should be taken to protect any skin injuries.
- Stay upwind of airborne contaminants.
- Do not carry cigarettes, gum, food, or candy into contaminated areas.
- Smoke only in designated areas (not in vehicles).
- On-site personnel are encouraged to shower at the end of their work day.

Sampling/Monitoring

- Cover instruments with clear plastic, leaving openings for sampling ports, and sensor points.

- Place sample containers in bags prior to placement of sample material into containers.

Heavy Equipment

- Care should be taken to limit the surface area of equipment that comes into contact with contaminated material.

General

- If contaminated tools are to be placed on non-contaminated equipment for transport to the decontamination pad, plastic should be used to keep the equipment clean.

- Spoils from sampling work should be placed so as not to be in the expected paths of individuals.

- Drilling cuttings should be kept out of the way of workers. Liquids generated during drilling should be minimized to limit the quantity of mud created around the drill rig.

## 10.4 DISPOSAL PROCEDURES

Waste materials and other field equipment/supplies shall be handled in such a way as to preclude the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on-site. Potentially contaminated materials, e.g., clothing, gloves, etc., will be bagged or drummed as necessary and segregated for disposal by the Navy. Decontamination wash, rinse water, and monitoring well development water shall be allowed to infiltrate soil. Isopropanol rinsate, collected during sampling activities, shall be containerized for disposal at the base wastewater treatment plant (WWTP) upon approval by the WWTP at completion of the field activities. Drill cuttings will be spread on the ground away from the soil boring location unless there is evidence of contamination. Cuttings that show evidence of contamination based on visual observation or instrument readings will be contained in drums and appropriately labeled. Drummed cuttings that are contaminated will be disposed of by the Navy. Non-contaminated materials shall be collected, bagged, and placed in an on-site dumpster for appropriate disposal as normal domestic waste.

# 11.0 GENERAL SAFE WORK PRACTICES AND COMMUNICATIONS

## 11.1 SAFETY EQUIPMENT

Basic emergency and first aid equipment will be available at the SZ and/or the CRZ, as appropriate. This shall include communications equipment, first aid kit, emergency eye wash unit, fire extinguishers, and other safety-related equipment. Fire extinguishers will be provided, inspected, and available on-site. Other safety equipment will be located at the site of specific operations, e.g. at the drilling rig, as appropriate.

## 11.2 COMMUNICATIONS

Walkie-Talkies - Hand-held units SHALL NOT be used on-site. Base restrictions prohibit the use of any communication devices (radios, telephones, other) except for on-site Navy-owned and operated equipment. Radio waves can detonate on-site ordnance.

Telephones - A Navy-supplied telephone will be located in the Command Post area in the SZ for communication with emergency support services/facilities.

Hand Signals - Hand signals will be used by downrange field teams in conjunction with the buddy system. These signals are very important when working with heavy equipment. They shall be known by the entire field team before operations commence and shall be reviewed during site-specific information sessions.

| Signal | Meaning |
|---|---|
| • Hand gripping throat | Out of air; can't breathe |
| • Grip partner's wrist | Leave area immediately; no debate |
| • Hands on top of head | Need assistance |
| • Thumbs up | OK; I'm all right; I understand |
| • Thumbs down | No; negative |

## 11.3 SAFE WORK PRACTICES

The following safe work practices will be implemented during site operations:

- Obey base regulations.
- Smoking and open flames are not allowed in the SWMU areas and must be left in designated areas or in the Command Post area. Smoking is allowed only in designated areas, not in vehicles.
- Only properly trained and equipped personnel will be allowed to work in potentially contaminated areas.
- The number of personnel and equipment in the sampling areas will be kept to a minimum, consistent with safe site operations.
- Workers shall adhere to the buddy system while working downrange and in designated EZs. Visual contact shall be maintained between pairs on-site in order to assist each other in case of emergencies.
- Workers shall not exit EZs until soiled equipment and clothing have been removed and decontaminated or properly disposed of.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer, ingestion, and inhalation of potentially contaminated materials is prohibited.
- As necessary, personnel will thoroughly wash their hands and faces upon leaving the investigation areas.
- Contact with potentially contaminated materials and surfaces shall be avoided. Personnel shall comply with contamination control measures.
- Personnel with facial hair or other facepiece seal obstructions will not be permitted to work where respirators are required.
- Work shall only be conducted if adequate illumination is provided, i.e. visual observation is not impaired due to loss of daylight conditions.
- Drive safely and at posted speed limits. Be aware of wildlife.

While the drilling subcontractor is responsible for safe means and methods of operating their drill rigs, (refer to Section 2.3 of this HASP), personnel working near drill rig operations shall be aware of the following safe work practices:

- Drillers shall inform personnel working with drill rig activities, (i.e. soil boring operations) as to the location of the emergency stop device.

- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked prior to initiating any subsurface activities.

- In the event the drill rig would come in contact with an electrical source, do not touch any part of the equipment or attempt to enter or leave it. Do not touch any person who may be in contact with electrical current. If rescue is attempted, only use a dry, clean rope or unpainted wooden pole.

- Personnel must develop hand signals with equipment operators.

- A remote sampling device must be used to sample drill cutting if the tools are rotating or if the tools are readily capable of rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools which could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- "All" compressed gas cylinders must be stored and used in an upright position, properly secured and protected from damage, and segregated and labeled as empty or full.

# 12.0 EMERGENCY PREPAREDNESS

## 12.1 EMERGENCY COORDINATOR

The Site Emergency Coordinator shall be the SSO with help from the UXO Team as needed. The SSO shall implement the Emergency Action Plan as outlined in 29 CFR 1910.38. The following items are applicable to operating facilities such as this base. The procedures will be determined in conjunction with the base safety department and will be implemented if needed.

- Emergency escape procedures and routes.
- Procedures for those remaining for critical operations (not applicable at this site).
- Procedures to account for employees after evacuation.
- Rescue and medical duties.
- Preferred means of reporting fires and emergencies.
- Names, job titles, or departments to contact for additional information of duties outlined in this HASP.

## 12.2 EMERGENCY SERVICES CONTACTS

The Site Emergency Coordinator shall verify appropriate emergency contacts and will make contact with them before beginning work on-site. The Site Emergency Coordinator will inform the emergency contacts about the nature and duration of work expected on the base and the type of contaminants and possible health or safety effects of emergencies involving these contaminants. Also at this time, the Site Emergency Coordinator and the emergency response units shall make arrangements to handle any emergencies that might be anticipated. These emergency contacts will be base facilities, initiated through dialing 3300 (base's version of 911).

**Emergency Phone Numbers:**

Police Department 3300 NAVSURFWARCENDIV
Fire Department 3300 NAVSURFWARCENDIV
Hospital Bloomington Hospital (812) 336-9515
Hospital Address 601 West Second Street, Bloomington, IN
Ambulance 3300 NAVSURFWARCENDIV; Hospital (812) 336-9515
National Response Center 1-800-424-8802
Poison Control Center 1-800-942-5969
CHSM Pamela B. Markelz (414) 458-8711 (work), (414) 457-4570 (home)
SSO To Be Determined

**Hospital Route:**

The NAVSURFWARCENDIV infirmary can treat minor injuries and emergencies. In the event of a major injury, other off-site facilities will be necessary. A map to the nearest hospital is presented on Figure 12-1.

Once the SZ is established, and before field activity start-up, the Site Emergency Coordinator shall drive the route to the hospital, post directions and/or a map to the hospital, and set up the first aid station, a 15-minute portable eye wash unit, 10-pound Type A/B/C fire extinguisher, and other emergency equipment.

## 12.3 IMPLEMENTATION

The Site Emergency Coordinator shall implement the emergency action procedures whenever conditions at the site warrant such action. The Site Emergency Coordinator will be responsible for coordinating the evacuation, emergency treatment, and emergency transport of site personnel as necessary, and for notification of emergency response units and the appropriate management staff. The following conditions may require implementation of emergency action procedures:

- Fire or explosion on-site.
- Serious personal injury.
- Release of hazardous materials, including gases or vapors at levels greater than the maximum use concentrations of respirators.
- Unsafe working conditions, such as inclement weather.

## 12.4 FIRE OR EXPLOSION

If an actual fire or explosion has taken place, emergency steps will include 1) evacuation of work area and, 2) notification of the NAVSURFWARCENDIV fire department and other appropriate emergency response groups if necessary.

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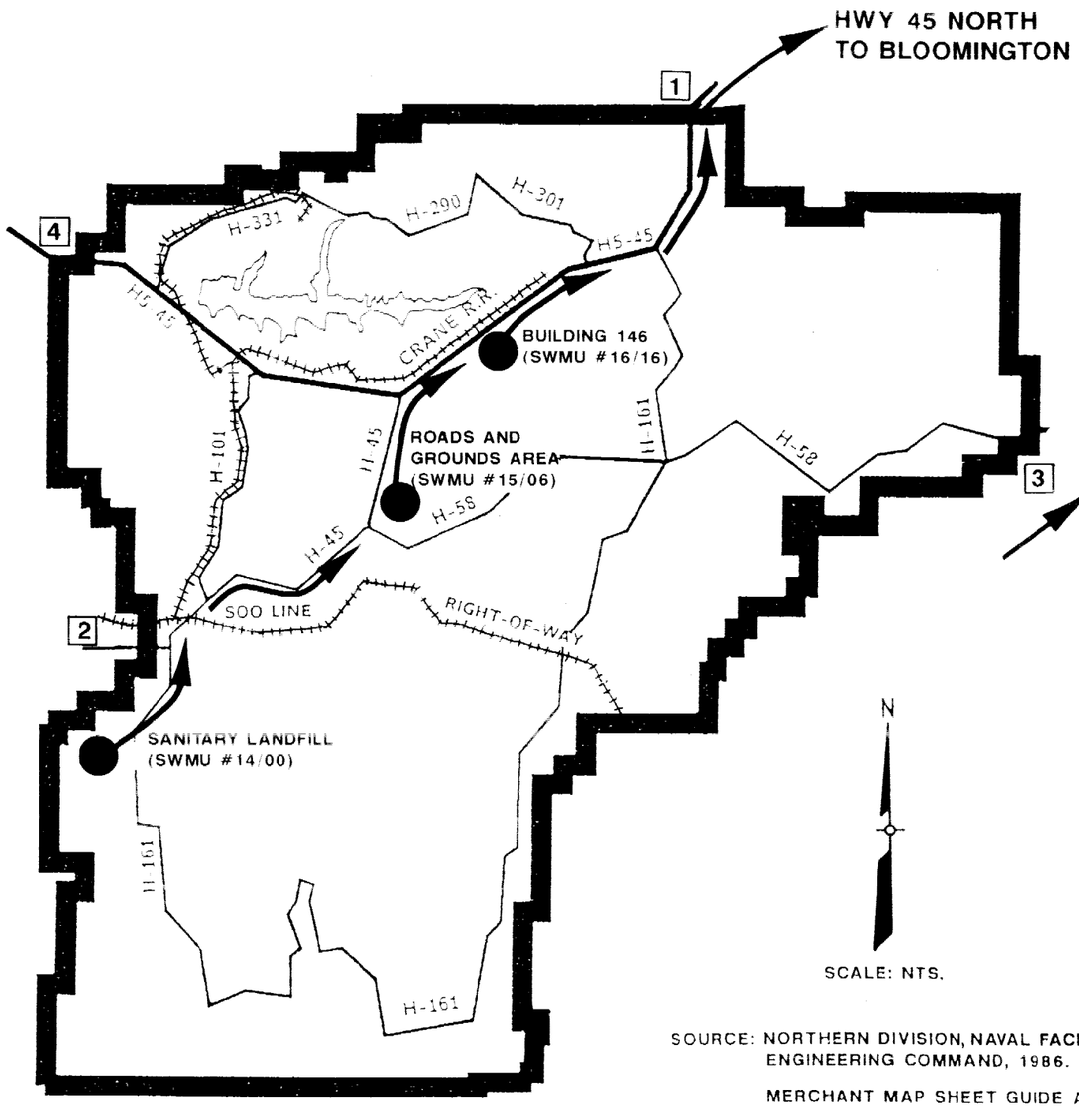
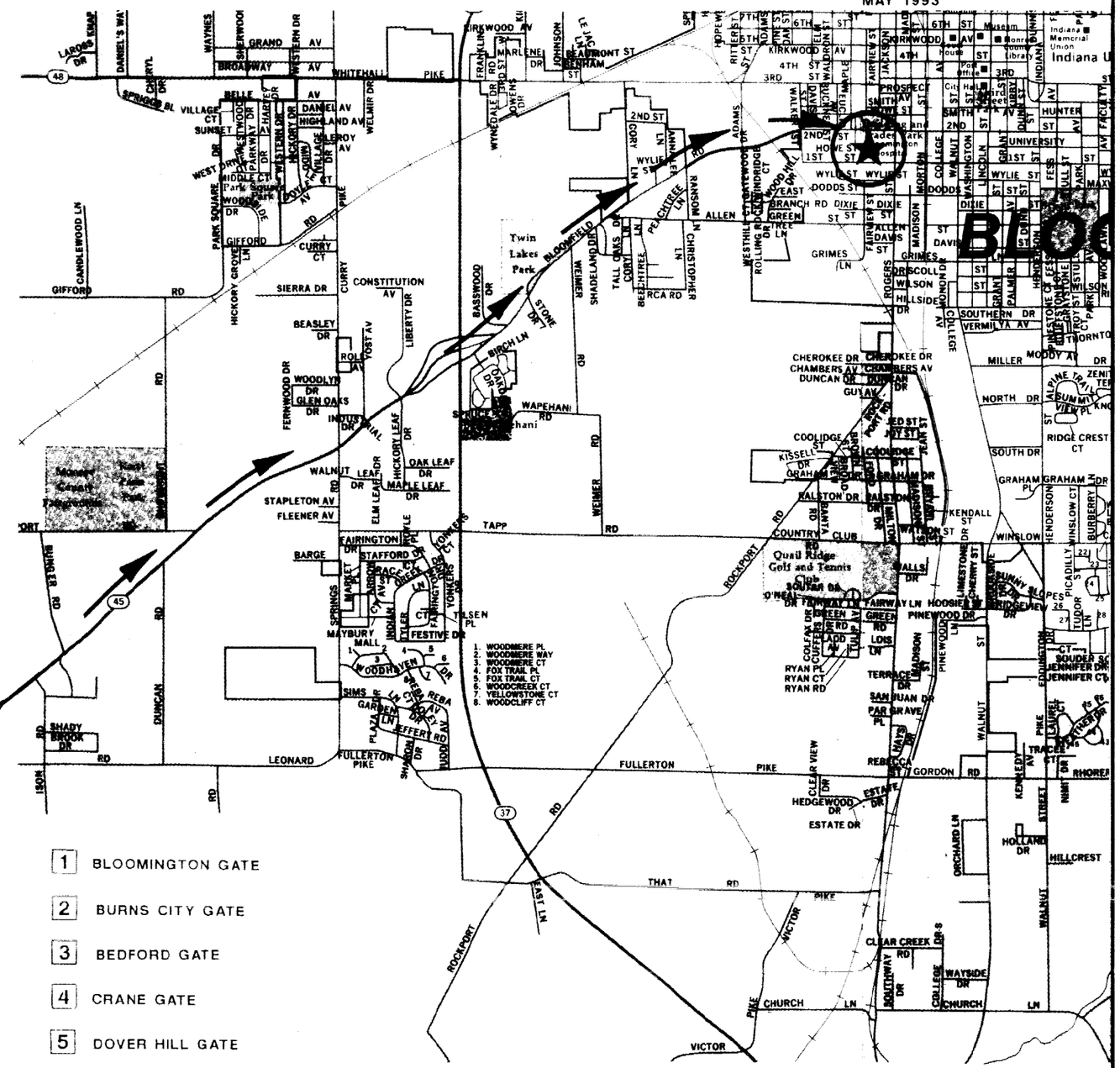
CLEAN CTO #0078
DRAFT

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA HASP
MAY 1993

## ROUTE TO BLOOMINGTON HOSPITAL

★ EXIT BASE ON H5-45 THROUGH THE BLOOMINGTON GATE; FOLLOW HWY 45 NORTH TO BLOOMINGTON AT HWY 45 AND HWY 37; CONTINUE GOING STRAIGHT OVER THE OVERPASS (BLOOMFIELD RD.); FOLLOW BLOOMFIELD RD. NORTH WHICH TURNS INTO 2ND. STREET; FOLLOW 2ND. STREET AND HOSPITAL IS ON YOUR RIGHT (601 WEST 2ND. STREET).




1 BLOOMINGTON GATE

2 BURNS CITY GATE

3 BEDFORD GATE

4 CRANE GATE

5 DOVER HILL GATE

SOURCE: NORTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND, 1986.

MERCHANT MAP SHEET GUIDE AND INDEX, 1992.

RUST ENVIRONMENT & INFRASTRUCTURE

MAY 1993

**FIGURE 12-1**
**HOSPITAL ROUTE MAP**

RFI PHASE II RELEASE ASSESSMENT
NAVSURFWARCENDIV
CRANE, INDIANA

20617

DUNCAN-PARNELL, INC. CHARLOTTE, NC 800-768-7788

C-65014

## 12.5 PERSONAL INJURY

Emergency first aid will be administered on-site as appropriate. Then the individual will be decontaminated if possible, depending on the severity of the injury, and transported to the nearest medical facility if needed.

## 12.6 OVERT CHEMICAL EXPOSURE

Typical response procedures include:

SKIN CONTACT: Use copious amounts of soap and water. Wash/rinse affected area thoroughly, then provide appropriate medical attention. Eye wash will be provided on-site at the CRZ and/or SZ. Eyes should be rinsed for 15 minutes upon chemical contamination.

INHALATION: Move to fresh air and/or, if necessary, decontaminate/transport to hospital.

INGESTION: Decontaminate and transport to emergency medical facility.

PUNCTURE WOUND OR LACERATION: Decontaminate and transport to emergency medical facility. The SSO will provide medical data sheets to medical personnel as requested.

## 12.7 ADVERSE WEATHER CONDITIONS

In the event of adverse weather conditions, the SSO will determine if work can continue without endangering the health and safety of personnel. Some items to be considered before determining if work should continue are:

- Potential for heat stress and heat-related injuries.
- Potential for cold stress and cold-related injuries.
- Treacherous weather-related working conditions.
- Limited visibility.
- Potential for electrical storms.

### 12.7.1 Heat Stress

The SSO shall visually monitor personnel to note for signs of heat stress. Field personnel will also be instructed to observe for symptoms of heat stress and methods on how to control it. One or more of the following control measures can be used to help control heat stress:

- Provide adequate liquids to replace lost body fluids. Employees must replace water and salt lost from sweating. Employees must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.
- Replacement fluids can be commercial mixes such as Gatorade.
- Establishment of a work regime that will provide adequate rest periods for cooling down. This may require additional shifts of workers.
- Cooling devices such as vortex tubes or cooling vests Can be worn beneath protective garments.
- Breaks are to be taken in a cool rest area (77°F is best).
- Personnel shall remove impermeable protective garments during rest periods.
- Personnel shall not be assigned other tasks during rest periods.
- Personnel shall be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

The heat stress of personnel on-site may be monitored utilizing biological monitoring or the Wet Bulb Globe Temperature Index (WBGT) technique when workers are not wearing protective coveralls (i.e. Tyvek,). This method will require the use of a heat stress monitoring device.

One of the following biological monitoring procedures shall be followed when the workplace temperature is 70*o*F or above.

- Heart rate (HR) shall be measured by the pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of rest period stays the same. If the pulse rate is 100 beats/minute at the

beginning of the next rest period, the following work cycle should be shortened by 33 percent. The length of the initial work period will be determined by using the table below.

PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUES

| | Work Load | | |
|---|---|---|---|
| Work-Rest Regimen | Light | Moderate | Heavy |
| Continuous Work | 80.0°F | 80.0°F | 77.0°F |
| 75% Work - 25% Rest, Each Hour | 87.0°F | 82.4°F | 78.6°F |
| 50% Work - 50% Rest, Each Hour | 88.5°F | 85.0°F | 82.2°F |
| 25% Work - 75% Rest, Each Hour | 90.0°F | 88.0°F | 86.0°F |

- Body temperature shall be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the oral temperature exceeds 99.7°F at the beginning of the next rest period, the following work cycle shall be further shortened by 33 percent. Oral temperature should be measured at the end of the rest period to make sure that it has dropped below 99°F. At no time shall work begin with the oral temperature above 99°F.

### 12.7.2 Cold Exposure

If field activities occur during a period when temperatures average below freezing, the following guidelines will be followed.

Persons working outdoors in temperatures at or below freezing may be subject to frostbite. Extreme cold for a short time may cause severe injury to the surface of the body, or result in profound generalized cooling of the body core, resulting in coma and death. Areas of the body which have high surface area-to-volume ratio such as fingers, toes, and ears are the most susceptible.

Two factors influence the development of a cold injury; ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For instance, 10°F with a 15-mile per hour (mph) wind is equivalent to chilling still air to -18°F.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration-soaked.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: Characterized by sudden blanching or whitening of skin.
- Superficial frostbite: Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite: Tissue is cold, pale, and solid; extremely serious injury.

Prevention of frostbite is vital. Keep the extremities warm. Wear insulated clothing as part of one's protective gear during extremely cold conditions. Check for symptoms of frostbite at every break. The onset is painless and gradual--you may never know you have been injured until it is too late.

To administer first aid for frostbite, bring the victim indoors and rewarm the areas quickly in water between 39°C and 41°C (102°F to 105°F). Give a warm drink--not coffee, tea, or alcohol. The victim should not smoke. Keep the frozen parts in warm water or covered with warm clothes for 30 minutes, even though the tissue will be very painful as it thaws. Then elevate the injured area and protect it from injury. Do not allow blisters to be broken. Use sterile, soft, dry material to cover the injured areas. Keep victim warm and get immediate medical care.

After thawing, the victim should try to move the injured areas a little, but no more than can be done alone (without help).

- Do not rub the frostbitten part (this may cause gangrene).
- Do not use ice, snow, gasoline, or anything cold on frostbite.
- Do not use heat lamps or hot water bottles to rewarm the frostbitten area.
- Do not place the body part near a hot stove.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95oF; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and, finally, 5) death.

Effects arising from cold exposure will be minimized by providing workers with insulated clothing when the equivalent chill temperature is less than 30°F as defined and presented in the ACGIH booklet in Table 5. Furthermore, field activities will generally be curtailed or halted if the equivalent chill temperature is below -20°F. The ultimate responsibility for delaying work at a site due to inclement weather rests with the SSO.

## 12.8 POISON IVY

If personnel come in contact with poison ivy, the individual should immediately wash the affected area with Ivy Cleaner provided in the first aid kit. If a rash develops, it should be treated at a medical facility as soon as possible.

## 12.9 SNAKES AND TICKS

### 12.9.1 Snake Bite Prevention and First Aid

On project sites, precautions against the possible presence of snakes should be taken when walking through overgrown vegetation and when moving debris (i.e. lumber, scrap metal, etc.). If someone is bitten by a snake and the snake bite occurs in a location that is within a 1-hour drive of a medical facility, a conservative approach is safest. Crane is within a 1-hour drive of the Bedford Hospital. Keeping the victim quiet, lying or sitting, and reassuring him/her is all that is required. He/she should be transported safely (no speeding) to the nearest medical facility. For the reassurance of both the victim and the first aider, a snake bite is not nearly as dangerous as popular mythology would suggest. In North America, death from snake bite to healthy adults is very rare. Many bites, even from known poisonous snakes, do not result in a significant amount of venom being injected. Even when significant envenom occurs, symptoms develop slowly over many hours and can be controlled with appropriate treatment. Field treatments advised against include ice, cutting and suction around the wound, and tourniquets. Studies indicate that ice leads to increased tissue destruction. Cutting and sucking out the wound can be shown to offer some help if it is done with the correct technique and equipment and if the victim has received a large dose of venom. In light of the damage that can be done, the risk of such a procedure is too high. It is best to transport the person immediately to a medical facility.

### 12.9.2 Tick Bite Prevention and First Aid

Routinely check for ticks after being outdoors. Remove ticks as soon as possible before they embed. To minimize exposure, wear light-colored clothing so ticks can be detected. Tuck pants into boots or socks and wear longsleeved shirts. Apply tick/insect repellent to clothing.

When a tick is found embedded, remove it by grasping it with a tweezers as close to the skin as possible and gently pull it straight out. Do not twist or jerk the tick because the head may remain embedded. Once the tick is removed, wash the bite area and your hands with soap and water and apply an antiseptic to the bite. Save the tick in a jar labeled with the date and the place where the tick was acquired. A physician may find this information and the tick specimen helpful in diagnosis if an infection results.

## 12.10 BASE DIRECTIONS

The NAVSURFWARCENDIV Facility encompasses approximately 100 square miles. The roads are marked, but there are no guidance or distance signs (guard post, entrance/exit points, SWMUs, etc.). Many bunkers throughout the site look similar, and they have signs near them designating a code known to the on-site fire department. If lost, drive on the marked roads such that you cannot read the sign. This will allow you to get back to the main administration area on the base. The signs are situated such that the fire department can read the signs as they approach the area of interest. Do not panic, and do not enter restricted areas.

## 12.11 ACCIDENT/INJURY REPORTING AND RECORDKEEPING

The SSO shall maintain logs and reports covering health and safety aspects of the project throughout the duration of work activities. In the event of an on-site accident resulting in an exposure or injury, the SSO shall immediately complete an Accident/Injury Report form and send a copy to the CHSM. In the event of an accident or injury, the CHSM and Project Manager shall notify the Navy. The SSO shall be responsible for maintaining, on-site, the routinely completed records and forms listed in Section 14.0 of this HASP.

# 13.0 AUTHORIZATIONS AND FIELD TEAM REVIEW

## 13.1 AUTHORIZED PERSONNEL

Personnel entering the NAVSURFWARCENDIV investigation area while field activities are being conducted must be authorized by the HSMs. Authorization will involve completion of appropriate training courses and medical examination requirements as required by OSHA 29 CFR 1910.120, current fit testing and review and sign-off of this HASP. All personnel must be escorted by appropriately trained personnel, and check in with the Field Team Leader at the Command Post.

PERSONNEL AUTHORIZED TO PERFORM WORK ON-SITE:

1. Jeff Maletzke
2. Pam Markelz
3. Douglas Graham
4. Lorrie Ransome
5. RUST E&I Inc. Personnel Authorized by HSMs
6. _____
7. _____

OTHER PERSONNEL AUTHORIZED TO ENTER SITE:

1. U.S. Navy Representatives
2. Subcontractor Personnel
3. Halliburton NUS Personnel
4. _____

## 13.2 FIELD TEAM REVIEW

Each field team member shall sign this section after site-specific training is completed and before being permitted to work on site.

I have read and understand this Health and Safety Plan. I will comply with the provisions contained therein.

Site/Project: RCRA Facility Investigation Phase II Release Assessment

| Name Printed | / Signature | / Date |
|---|---|---|
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6/RP/78HSPD/TEXT

## 14.0 RECORDKEEPING

The following records and reports will be established and kept as appropriate for the RCRA facility investigation:

- Accident/Incident Reports
- Daily Sign In/Sign Out Log
- Air Monitoring Records
- Sample Chain of Custody Form
- Personnel Training Certificates
- Personnel Exposure Record
- Site-Safety Orientation Log
- Health and Safety Audit Reports
- Instrumentation Calibration Logs
- Material Safety Data Sheets/Chemical Data Sheets/Hazardlines
- Medical Data Sheets (to be sent with injured personnel to hospital)
- Medical Examination Reports (Physician's Written Opinion)
- Respirator Fit Test Records
- Respirator Inspection Records

A blank Medical Data Sheet is included as the next page of this document. A Medical Data Sheet will be completed for each person working at the site.

6/RP/78HSPD/TEXT

# MEDICAL DATA SHEET

Project Name/Location: _____

Employee Name: _____ Home Telephone: _____

Address: _____

_____

_____

Birthdate: _____ Height: _____ Weight: _____

Drug and Other Allergies: _____

_____

_____

_____

Notable Medical Conditions/Medical Restrictions:

_____

_____

_____

_____

Do You Wear Contact Lenses? Yes ____ No ____
Dentures? Yes ____ No ____

Are you using any medications? Yes ____ No ____ Please list:

_____

_____

_____

Emergency Contact: _____ Relationship: _____
Address: _____ Phone: ( )_____

_____

Personal Physician: _____ Relationship: _____
Address: _____ Phone: ( )_____

_____

6/RP/78HSPD/TEXT

# ATTACHMENT A

## CHEMICAL DATA SHEETS/HAZARD LINES

C001 ENTER COMMAND IN CORRECT FORMAT._: ..PRINT 1 ALL/DOC=1

1
AN ACCESSION NUMBER: 1785. 9210.
CN CHEMICAL NAME: LITHIUM.
SY SYNONYMS: LITHIUM METAL. UN 1415. LITHIUM ELEMENT. STCC 4916428.
RN CAS NUMBER: 7439-93-2.

REG. TOXIC NUMBER: OJ5540000.

CHEMICAL FORMULA: LI.

PD
PHYSICAL DESCRIPTION:
SOFT, SILVER-WHITE METAL.

| | |
|---|---|
| MOL WT: | 6.94 |
| BOILING PT: | 2448 F (1342 C) |
| SOLUBILITY: | REACTS |
| FLASH PT: | FLAMMABLE SOLID |
| VAPOR PRES: | 0.49 MMHG @ 702 C |
| MELT PT: | 358 F (181 C) |
| UEL IN AIR: | |
| LEL IN AIR: | |
| MEC IN AIR: | NOT AVAILABLE |
| SPEC GRAVITY: | 0.534 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

L
PERMISSABLE EXPOSURE:
NO OCCUPATIONAL EXPOSURE LIMITS ESTABLISHED BY OSHA, ACGIH OR NIOSH
MUTAGENIC DATA (RTECS)
CERCLA HAZARD RATINGS - TOXICITY 2 - IGNITABILITY 3 - REACTIVITY 3 - PERSISTENCE 3
TOXICOLOGY: LITHIUM IS CORROSIVE TO THE EYES, SKIN AND MUCOUS MEMBRANES. THERE IS INSUFFICIENT DATA TO QUANTIFY THE TOXICITY. POISONING MAY AFFECT THE CENTRAL NERVOUS SYSTEM AND KIDNEYS. CONTACT WITH MOISTURE MAY RELEASE FLAMMABLE HYDROGEN GAS AND CORROSIVE LITHIUM HYDROXIDE. EXPOSURE TO CORROSIVE SUBSTANCES MAY CAUSE COUGHING, CHOKING, PAIN AND BURNS OF THE MUCOUS MEMBRANES. IN SOME CASES, PULMONARY EDEMA MAY DEVELOP, EITHER IMMEDIATELY OR MORE OFTEN WITH A LATENT PERIOD OF 5-72 HOURS. PROLONGED EXPOSURE MAY CAUSE INFLAMMATORY AND ULCERATIVE CHANGES IN THE MOUTH. BRONCHIAL AND GASTROINTESTINAL DISTURBANCES MAY OCCUR. INGESTION OF A CORROSIVE SUBSTANCE MAY CAUSE IMMEDIATE PAIN. THERE MAY BE DISCOLORATION OF THE TISSUES. SWALLOWING AND SPEECH MAY BE DIFFICULT AT FIRST AND THEN ALMOST IMPOSSIBLE. EXPOSURE TO LITHIUM MAY RESULT INITIALLY IN FINE TREMORS OF THE HANDS, DRY MOUTH, THIRST, POLYURIA, NAUSEA, VOMITING, AND DIARRHEA. OTHER SYMPTOMS MAY INCLUDE BLURRED VISION, CONFUSION, RESTLESSNESS AND EPILEPTIFORM SEIZURES.
LITHIUM MAY CROSS THE PLACENTAL BARRIER.
IPR-MUS LD50: 1 GM/KG SCU-RBT LDLO: 4000 MG/KG (THIDD6)
INV-DOG LDLO: 325 MG/KG (THIDD6)

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
SOFT, SILVER-WHITE METAL.

IC

INCOMPATIBILITIES:
SEND BACK AREA EXCEDED. ACETONITRILE: EXOTHERMIC REACTION. ACIDS: VIOLENT REACTION. ARSENIC (HEATED): VIOLENT REACTION. BERYLLIUM: ATTACKS AT 180 C. BROMINE: FORMS IMPACT-SENSITIVE MIXTURE. BROMINE PENTAFLUORIDE: VIOLENT REACTION AND POSSIBLE IGNITION. BROMOBENZENE: VIGOROUS REACTION WITH POSSIBLE EXPLOSION. BROMOFORM: EXPLODES ON IMPACT. CARBIDES: ATTACKS. CARBON, LITHIUM TETRACHLOROALUMINATE AND SULFINYL CHLORIDE: IGNITION OR EXPLOSION IF GREATER THAN 10% CARBON PRESENT. CARBON DIOXIDE: IGNITES. CARBON MONOXIDE: FORMS LITHIUM CARBONYL WHICH DETONATES VIOLENTLY WITH WATER. CARBON TETRABROMIDE: POSSIBLE EXPLOSION BY IMPACT. CARBON TETRACHLORIDE: POSSIBLE EXPLOSION. CHLORINE (VAPOR): REACTS WITH LUMINOUS FLAME. CHLOROFORM: MAY EXPLODE ON IMPACT. CHROMIC OXIDE: REACTION OCCURS AROUND 180 C WITH TEMPERATURE RISE TO 965 C. CHROMIUM: MOLTEN LITHIUM @ 180 C ATTACKS CHROMIUM SEVERELY. CHROMIUM TRICHLORIDE: BURNS VIGOROUSLY IN NITROGEN ATMOSPHERE. COBALT ALLOYS: MOLTEN LITHIUM ATTACKS COBALT ALLOYS.

CL

CLOTHING:
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING WHICH HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE OPERATION OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THERE IS ANY POSSIBILITY OF THIS SOLID CONTACTING THE EYES.

EMPLOYEE SHOULD WASH:
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE IMMEDIATELY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

IMMEDIATE WORK AREA FOR EMERGENCY USE.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
NO SPECIFIC; ADVISE:
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS
- CHEMICAL CARTRIDGE RESPIRATOR WITH A DUST, MIST, AND FUME FILTER
- POWERED AIR-PURIFYING RESPIRATOR WITH A DUST, MIST AND FUME FILTER

HIGH LEVELS
- TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE WITH A FULL FACE-PIECE, HELMET, OR HOOD OPERATED IN CONTINUOUS-FLOW MODE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
NO INFORMATION AVAILABLE FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS"; ADVISE: GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. GASTROINTESTINAL. CENTRAL NERVOUS SYSTEM. KIDNEYS. MUCOUS MEMBRANES.

SP

SYMPTOMS:
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). COUGHING, FORCEFUL EXPIRATION (SC0173). CHOKING, INTERRUPTED RESPIRATION (SC0781).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181).
CHEST, THE THORAX (SC0754);
TIGHTNESS, CONSTRICTION (SC0780). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). FROTHY SPUTUM, FOAMY MIXTURE OF SALIVA AND MUCOUS (SC0627).
CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). PULMONARY RALES, ABNORMAL RESPIRATORY SOUNDS (SC0206). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). HYPOTENSION, LOW BLOOD PRESSURE (SC0180).
MOUTH, OPENING OF ALIMENTARY CANAL (SC0076);

ULCERATION, LESION OF TISSUE (SC0313).
BRONCHIAL, PERTAINING TO THE BRONCHI (SC0346);
DISTURBANCE, INTERRUPTION OF A NORMAL STATE (SC0047).
GASTROINTESTINAL, PERTAINING TO STOMACH & INTESTINE (SC0070);
DISTURBANCE, INTERRUPTION OF A NORMAL STATE (SC0047).
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). DERMATITIS, INFLAMMATION OF SKIN (SC0044).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
DISCOLORATION, ABNORMAL COLOR (SC0589). DYSPHAGIA, DIFFICULTY IN SWALLOWING (SC0325). DYSPHONIA, DIFFICULTY IN SPEECH; HOARSENESS (SC0452).
ESOPHAGEAL, PERTAINING TO THE ESOPHAGUS (SC0340);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175).
GASTROINTESTINAL, PERTAINING TO STOMACH & INTESTINE (SC0070);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175).
GLOTTAL, PERTAINING TO THE GLOTTUS (SC0700);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181). SHOCK, SUDDEN PHYSICAL OR MENTAL DISTURBANCE(SC0228).
EXTREMITIES, ARMS OR LEGS (SC0062);
TREMORS, TREMBLING, SHAKING (SC0197).
DRY, FREE OR RELATIVELY FREE FROM WATER (SC0194);
MOUTH, OPENING OF ALIMENTARY CANAL (SC0762). THIRST, DESIRE FOR WATER (SC0210).
EXCESSIVE, SUPERFLUOUS (SC0737);
URINATION, DISCHARGE OF URINE FROM BODY (SC0617). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). BLURRED VISION, (SC0015).
DROWSINESS, FALLING ASLEEP (SC0049).
TRANSIENT, PASSING QUICKLY (SC0731);
SCOTOMA, BLIND GAP IN VISUAL FIELD (SC0147). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). CONFUSION, IN A BEWILDERED STATE (SC0030).
FASCICULATION, TWITCHING OF GROUPS OF MUSCLE FIBERS (SC0063).
INVOLUNTARY, NOT CONSCIOUSLY CONTROLLED (SC0615);
DEFECATION, EXCRETION OF WASTE FROM THE BOWELS (SC0616).
INVOLUNTARY, NOT CONSCIOUSLY CONTROLLED (SC0615);
URINATION, DISCHARGE OF URINE FROM BODY (SC0617). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). SEIZURE, CONVULSION (SC0149).
CARDIAC, PERTAINING TO HEART (SC0023);
ARRHYTHMIA, ABSENCE OF RHYTHM; IRREGULARITY (SC0010). COMA, STATE OF DEEP UNCONSCIOUSNESS (SC0583).
PERIPHERAL, OUTER LOCATION (SC0490);
VASCULAR, PERTAINING TO BLOOD VESSELS (SC0749).
COLLAPSE, EXTREME PROSTRATION (SC0029).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281).
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 4)
IF THIS CHEMICAL GETS INTO THE EYES, WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 4)

IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). IN CASE OF CHEMICAL BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 4)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 4)
IF THIS CHEMICAL HAS BEEN INGESTED, TREAT SYMPTOMATICALLY AND SUPPORTIVELY. IF PERSON IS CONSCIOUS AND ABLE TO SWALLOW, GIVE LARGE AMOUNTS OF WATER OR MILK TO DILUTE SUBSTANCE, GET MEDICAL ATTENTION IMMEDIATELY. GASTRIC LAVAGE PERFORMED BY QUALIFIED MEDICAL PERSONNEL MIGHT BE ADVISABLE IF THERE ARE NO SIGNS OF PERFORATION FROM THE INGESTION OF A CORROSIVE SUBSTANCE. IF VOMITING OCCURS, KEEP HEAD BELOW HIPS TO PREVENT ASPIRATION.

DT
SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
URINE LITHIUM.
SERUM LITHIUM.
ELECTROCARDIOGRAM.

RS
**********
RESPIRATORY PROTECTION.

(4 OF 28)
OSHA STANDARD 29.CFR1910.20 ACCESS TO EM.PLOYEE EXPOSURE AND MEDICAL RECORDS.

(5 OF 28)
OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT.

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AN ACCESSION NUMBER: 1171. 9112.
CN CHEMICAL NAME: ETHYL BENZENE.
SY SYNONYMS: PHENYLETHANE. ETHYLBENZOL. NCI-C56393. UN 1175.
ETHYLBENZENE. BENZENE, ETHYL. EB. ALPHA-METHYLTOLUENE. STCC 4909163.
RN CAS NUMBER: 100-41-4.

REG. TOXIC NUMBER: DA0700000.

CHEMICAL FORMULA: C8H10.

PD

PHYSICAL DESCRIPTION:
CLEAR, COLORLESS LIQUID WITH AN AROMATIC ODOR.

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|---|---|
| MOL WT: | 106.17 |
| BOILING PT: | 277 F (136 C) |
| SOLUBILITY: | 0.015% |
| FLASH PT: | 59 F (15 C) |
| VAPOR PRES: | 7.1 MMHG |
| MELT PT: | -139 F (-95 C) |
| UEL IN AIR: | 6.7% |
| LEL IN AIR: | 0.8% |
| MEC IN AIR: | 810 F (432 C) |
| SPEC GRAVITY: | 0.867 |
| VAPOR DENSITY: | 3.7 |
| ODOR THRESHOLD: | 140 PPM |
| OCTANOL/WATER CO-EFFICIENT: | 3.15. |

EL

PERMISSABLE EXPOSURE:
100 PPM OSHA TWA; 125 PPM OSHA STEL
100 PPM ACGIH TWA; 125 PPM ACGIH STEL
100 PPM NIOSH RECOMMENDED 10 HR TWA; 125 PPM NIOSH RECOMMENDED STEL
REPRODUCTIVE EFFECTS DATA (RTECS); MUTAGENIC DATA (RTECS)
AQUATIC TOXICITY RATING 2 (TLM96 10 - 100 PPM)
TLM96 - BLUEGILL 32 PPM (SOFT WATER), FATHEAD 48.51 PPM (SOFT WATER) - FATHEAD 42.33 PPM (HARD WATER)
CERCLA HAZARD RATINGS - TOXICITY 2 - IGNITABILITY 3 - REACTIVITY 0 - PERSISTENCE 3
TOXICOLOGY: ETHYL BENZENE IS A SKIN, EYE AND MUCOUS MEMBRANE IRRITANT. IT IS MODERATELY TOXIC BY INGESTION AND SLIGHTLY TOXIC BY SKIN ABSORPTION. ETHYL BENZENE IS A CENTRAL NERVOUS SYSTEM DEPRESSANT. POISONING MAY AFFECT THE LIVER. SYMPTOMS MAY INCLUDE A SENSE OF CHEST CONSTRICTION AND FUNCTIONAL NERVOUS DISORDERS. SKIN CONTACT MAY RESULT IN FIRST AND SECOND DEGREE BURNS.
THE ODOR CAN BE DETECTED AT 140 PPM AND IRRITATION OCCURS AT 200 PPM; THESE ARE CONSIDERED TO BE ADEQUATE WARNING PROPERTIES. THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT SKIN AND EYE IRRITATION. PERSONS WITH PRE-EXISTING SKIN DISORDERS OR IMPAIRED PULMONARY, KIDNEY OR LIVER FUNCTION MAY BE AT INCREASED RISK FROM EXPOSURE.

ETHYL BENZENE MAY CROSS THE PLACENTA.
IHL-HMN TCLO: 100 PPM/8H ORL-RAT LD50: 3500 MG/KG
SKN-RBT LD50: 17,800 MG/KG IPR-MUS LD50: 2272 MG/KG
IHL-RAT LCLO: 4000 PPM/4H IHL-MUS LDLO: 50 GM/M3/2H
IHL-GPG LCLO: 10,000 PPM
SKIN AND EYE IRRITATION DATA (RTECS)
SKN-RBT 15 MG/24H MLD EYE-RBT 100 MG

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
2000 PPM OSHA/NIOSH
CLEAR, COLORLESS LIQUID WITH A.

IC

INCOMPATIBILITIES:
ETHYL BENZENE: ACIDS (STRONG): POSSIBLE VIOLENT REACTION. AMMONIA: POSSIBLE VIOLENT REACTION. BASES (STRONG): POSSIBLE VIOLENT REACTION. OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD. PLASTICS: MAY BE ATTACKED. THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON. VAPOR-AIR MIXTURES ARE EXPLOSIVE. VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK. DUE TO LOW ELECTROCONDUCTIVITY OF THE SUBSTANCE, FLOW OR AGITATION MAY GENERATE ELECTROSTATIC CHARGES RESULTING IN SPARKS WITH POSSIBLE IGNITION.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING WET WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OPERATION OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
AROMATIC HYDROCARBONS: EXCELLENT/GOOD: VITON GOOD/FAIR: CHLORINATED POLYETHYLENE VITON/NEOPRENE POOR/FAIR: BUTYL/NEOPRENE POOR: NATURAL RUBBER NEOPRENE NITRILE+POLYVINYL CHLORIDE POLYETHYLENE POLYVINYL CHLORIDE *** THERE IS A WIDE VARIATION IN RATINGS FOR THE FOLLOWING MATERIALS *** BUTYL RUBBER NITRILE RUBBER POLYVINYL ALCOHOL.

WEAR EYE PROTECTION TO PREVENT:

FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE SPLASH-PROOF SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS LIQUID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.
EMPLOYERS SHALL ENSURE THAT ANY CLOTHING WHICH BECOMES WET WITH THIS FLAMMABLE LIQUID BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1000 PPM
- POWERED AIR-PURIFYING RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS
- CHEMICAL CARTRIDGE RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE

2000 PPM
- GAS MASK WITH AN ORGANIC VAPOR CANISTER (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE

ESCAPE
- GAS MASK WITH AN ORGANIC VAPOR CANISTER (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
OSHA: CHRONIC RESPIRATORY DISEASE.
KIDNEY FUNCTION.
LIVER FUNCTION.
SKIN DISEASE.
OTHER MEDICAL SURVEILLANCE RECOMMENDED: BLOOD DISEASE.
EYE DISEASE.
ACGIH BIOLOGICAL EXPOSURE INDICES FOR ETHYL BENZENE: 2 G/L MANDELIC ACID IN URINE / TIMING--END OF SHIFT AND END OF WORKWEEK 1.5 G/G CREAT. MANDELIC ACID IN URINE / TIMING -END OF SHIFT AND END OF WORKWEEK 2 PPM ETHYL BENZENE IN END-EXHALED AIR /TIMING--PRIOR TO NEXT SHIFT.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

R

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN ABSORPTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. CENTRAL NERVOUS SYSTEM. GASTROINTESTINAL. LIVER.

SP

SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). COUGHING, FORCEFUL EXPIRATION (SC0173). FATIGUE, TIREDNESS, SLUGGISH (SC0066). DEPRESSION DECREASE IN ACTIVITY/FUNCTION (SC0043). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). NARCOSIS, STUPOR OR SLEEP DUE TO NARCOTIC (SC0113). SLEEPINESS, DROWSINESS (SC0150). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091).
SKIN, COVERING OF BODY (SC0174);
INFLAMMATION, EXTREME INFLAMMATORY TISSUE REACTION (SC0086).
SKIN, COVERING OF BODY (SC0174);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). LACRIMATION, DISCHARGE OF TEARS (SC0096).
ABDOMINAL, SECTION BETWEEN THORAX AND PELVIS (SC0750);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166).
PULARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);

HEMORRHAGE, BLEEDING (SC0080).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181). COMA, STATE OF DEEP UNCONSCIOUSNESS (SC0583).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
PARALYSIS, LOSS OF POWER OF VOLUNTARY MOVEMENT (SC0124).
LIVER, BILE-SECRETING GLANDULAR ORGAN (SC0620);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
BLOOD, FLUID WHICH CARRIES NUTRIMENT AND OXYGEN TO BODY CELLS (SC0769);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 6)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 6)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). IN CASE OF CHEMICAL BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 6)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 6)
INGESTION OF PETROLEUM DISTILLATES/HYDROCARBONS: EMERGENCY TREATMENT - PREVENT ASPIRATION. IF AMOUNT INGESTED EXCEEDS 1 ML/KG, OR IF TOXIC INGREDIENT IS PRESENT, SUBSTANCE MUST BE REMOVED. GASTRIC LAVAGE WITH ACTIVATED CHARCOAL AND CUFFED ENDOTRACHEAL TUBE TO PREVENT ASPIRATION SHOULD BE PERFORMED 15 MINUTES. IN ABSENCE OF DEPRESSION, CONVULSIONS OR GAG REFLEX, IPECAC EMESIS CAN ALSO BE DONE WITHOUT INCREASING ASPIRATION HAZARD. WHEN VOMITING OCCURS, HOLD PATIENT WITH HEAD LOWER THAN HIPS TO PREVENT ASPIRATION. AFTER VOMITING CEASES, GIVE 30-60 ML OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. FURTHER TREATMENT: GIVE ARTIFICIAL RESPIRATION WITH OXYGEN IF NECESSARY. SPECIAL TREATMENT: TREAT BACTERIAL ASPIRATION PNEUMONIA BY ORGANISM SPECIFIC CHEMOTHERAPY. TREAT PULMONARY EDEMA. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(5 OF 6)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE.

AN ACCESSION NUMBER: 3305. 9112.
CN CHEMICAL NAME: XYLENE.
SY SYNONYMS: DIMETHYLBENZENE. BENZENE, DIMETHYL-. XYLOL. DILAN.
NCI-C55232. UN 1307. STCC 4904350. RCRA U239.
R CAS NUMBER: 1330-20-7.

REG. TOXIC NUMBER: ZE2100000.

CHEMICAL FORMULA: C8H10.
PD
PHYSICAL DESCRIPTION:
LIGHT-COLORED OR COLORLESS, MOBILE LIQUID WITH AN AROMATIC ODOR.

| | |
|---|---|
| MOL WT: | 106.16 |
| BOILING PT: | 280-291 F (138-144C) |
| SOLUBILITY: | 0.00003% |
| FLASH PT: | 81-90 F (27-32 C) |
| VAPOR PRES: | 7-9 MMHG |
| MELT PT: | -54-55 F (-48-13 C) |
| UEL IN AIR: | 7% |
| LEL IN AIR: | 1.0% |
| MEC IN AIR: | 867-984 F (464-529C) |
| SPEC GRAVITY: | 0.86 |

VAPOR DENSITY: 3.7
ODOR THRESHOLD: 0.5 PPM
OCTANOL/WATER CO-EFFICIENT:.

EL

PERMISSABLE EXPOSURE:
100 PPM OSHA TWA; 150 PPM OSHA STEL
100 PPM ACGIH TWA
150 PPM ACGIH STEL
100 PPM NIOSH RECOMMENDED TWA
150 PPM NIOSH RECOMMENDED STEL
REPRODUCTIVE EFFECTS DATA (RTECS)
AQUATIC TOXICITY RATING 2 (TLM96 10 - 100 PPM)
TLM96 - BLUEGILL 20.87 PPM, FATHEAD 26.7-28.77 PPM, GUPPIES 34.37 PPM
KILL, 1HR - LEPOMIS HUMILIS 47.48 PPM
TLM24 DAPHNIA MAGNA >100 - <1000 PPM
CERCLA HAZARD RATINGS - TOXICITY 2 - IGNITABILITY 3 - REACTIVITY 0 - PERSISTENCE 1
TOXICOLOGY: XYLENE IS AN EYE, SKIN AND MUCOUS MEMBRANE IRRITANT. IT IS MODERATELY TOXIC BY INHALATION AND INGESTION. IT IS A CENTRAL NERVOUS SYSTEM DEPRESSANT. POISONING MAY AFFECT THE LIVER AND KIDNEYS. CONCENTRATIONS OF 200 PPM MAY RESULT IN IRRITATION OF THE UPPER RESPIRATORY TRACT. INITIALLY, CENTRAL NERVOUS SYSTEM EXCITATION MAY OCCUR FOLLOWED BY DEPRESSION WITH TRANSIENT EUPHORIA, EMOTIONAL INSTABILITY, DROWSINESS AND ATAXIA. A GROUP OF SUBJECTS WHO INHALED 12.3 UMOL/L OF XYLENE WHILE EXERCISING BECAME SIGNIFICANTLY IMPAIRED ON 3 NEUROPSYCHOLOGICAL TESTS. PROLONGED EXPOSURE TO VAPORS ABOVE 200 PPM MAY LEAD TO NAUSEA, VOMITING, ABDOMINAL PAIN AND ANOREXIA. WOMEN MAY DEVELOP MENSTRUAL DISORDERS, INFERTILITY AND PATHOLOGICAL PREGNANCY CONDITIONS.
PREGNANT WOMEN MAY BE AT AN INCREASED RISK FROM EXPOSURE.
ALCOHOLIC BEVERAGES MAY ENHANCE THE TOXIC EFFECTS. STIMULANTS SUCH AS EPINEPHRINE OR EPHEDRINE MAY INCUDE VENTRICULAR FIBRILLATION.
IHL-MAN LCLO: 10,000 PPM/6 HR IHL-HMN TCLO: 200 PPM
ORL-HMN LDLO: 50 MG/KG ORL-RAT LD50: 4300 MG/KG
IHL-RAT LD50: 5000 PPM/4 HR SCU-RAT LD50: 1700 MG/KG
IPR-RAT LD50: 2459 MG/KG IPR-MUS LD50: 1548 MG/KG
SKIN AND EYE IRRITATION DATA (RTECS)
EYE-HMN 200 PPM SKN-RBT 100% MOD
SKN-RBT 500 MG/24 HR MOD EYE-RBT 87 MG MLD

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
1000 PPM OSHA/NIOSH
LIGHT-COLORED OR COLORLESS, MO.

IC

INCOMPATIBILITIES:
NITRIC ACID. STRONG OXIDIZERS. PLASTICS. RUBBER. HYDROGEN SULFIDE.
VAPOR-AIR MIXTURES ARE EXPLOSIVE ABOVE FLASH POINT!.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR

CHEMICAL HAZARDS":
MPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE ROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
XYLENE: EXCELLENT/GOOD: POLYVINYL ALCOHOL GOOD/FAIR: VITON/NEOPRENE VITON TEFLON POOR/FAIR: BUTYL CHLORINATED POLYETHYLENE BUTYL/NEOPRENE STYRENE-BUTADIENE RUBBER POOR: NATURAL RUBBER NEOPRENE NITRILE + POLYVINYL ALCOHOL NITRILE POLYETHYLENE POLYVINYL CHLORIDE NEOPRENE + NATURAL RUBBER NEOPRENE/NATURAL RUBBER.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
MPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE SPLASH-PROOF SAFETY OGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS LIQUID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ANY CLOTHING WHICH BECOMES WET WITH THIS FLAMMABLE LIQUID BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
O SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.
RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1000 PPM
- CHEMICAL CARTRIDGE RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE
- POWERED AIR-PURIFYING RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

ESCAPE
- GAS MASK WITH AN ORGANIC VAPOR CANISTER (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS
MEDICAL SURVEILLANCE:
GENERAL MEDICAL HISTORY.
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
OSHA: CENTRAL NERVOUS SYSTEM TESTS, PERIPHERAL NEUROPATHY.
VISION TEST.
EYE DISEASE.
GASTROINTESTINAL.
LIVER FUNCTION.
KIDNEY FUNCTION.
SKIN EXAM.
COMPLETE BLOOD COUNT.
URINALYSIS.
ACGIH BIOLOGICAL EXPOSURE INDICES FOR XYLENES: 1.5 G/G CREAT.
METHYLHIPPURIC ACIDS IN URINE /TIMING-END OF SHIFT 2 MG/MIN
METHYLHIPPURIC ACIDS IN URINE /TIMING--LAST 4 HRS OF SHIF.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE
ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO
TARGET ORGANS:
CENTRAL NERVOUS SYSTEM. EYES. GASTROINTESTINAL. BLOOD. LIVER. SKIN. KIDNEYS. RESPIRATORY SYSTEM.

SP
SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).

EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);
EXCITATION, CENTRAL NERVOUS SYSTEM STIMULATION (SC0289).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). EUPHORIA, AN EXAGGERATED FEELING OF WELL-BEING (SC0061). NYSTAGMUS, RHYTHMICAL OSCILLATION OF EYEBALLS (SC0443). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). ANOREXIA, DIMINISHED APPETITE (SC0006).
ABDOMINAL, SECTION BETWEEN THORAX AND PELVIS (SC0750);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). DROWSINESS, FALLING ASLEEP (SC0049). ATAXIA, MUSCULAR INCOORDINATION (SC0013). INCOORDINATION, LACK OF COORDINATION (SC0085). SALIVATION, EXCESS DISCHARGE OF SALIVA (SC0146). SPEECH DIFFICULTIES, TROUBLES WITH VERBAL EXPRESSION (SC0614). BLURRED VISION, (SC0015). ERYTHEMA, REDNESS, SPOTS ON SKIN (SC0060). TINNITUS, RINGING IN EARS (SC0308). TREMORS, TREMBLING, SHAKING (SC0197). CONFUSION, IN A BEWILDERED STATE (SC0030). FACE/NECK FLUSHED VASODILATION WITH HEAT OF FACE/NECK (SC0215). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). ANESTHESIA, LOSS OF SENSATION (SC0005). AMNESIA, LOSS OF MEMORY (SC0438). HYPOTHERMIA, LOWERED BODY TEMPERATURE (SC0211).
LUNG, RESPIRATORY ORGAN (SC0377);
CONGESTION, ACCUMULATON OF BLOOD OR FLUID (SC0607). FATIGUE, TIREDNESS, SLUGGISH (SC0066). LASSITUDE, A SENSE OF WEARINESS (SC0098). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). FLATULENCE, EXCESSIVE GAS IN STOMACH/INTESTINES (SC0751). PARESTHESIA, ABNORMAL SENSATION WITHOUT CAUSE (SC0125). APPREHENSION, FEELING OF UNEASINESS, FEAR, ANXIETY (SC0073). VESICULATION, BLISTERING (SC0164). PHOTOPHOBIA, INTOLERANCE TO LIGHT (SC0131).
TRANSIENT, PASSING QUICKLY (SC0731);
CORNEAL, TRANSPARENT MEMBRANE OVER EYE (SC0035).
DAMAGE, PERMANENT INJURY (SC0287).
MENSTRUAL DISORDERS, DISTURBANCE IN MENSES (SC0752). VENTRICULAR FIBRILLATION, RAPID CONTRACTIONS OF VENTRICLES (SC0162). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). THIRST, DESIRE FOR WATER (SC0210). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). UNCONSCIOUSNESS, NOT AWAKE; INSENSIBLE (SC0198). COMA, STATE OF DEEP UNCONSCIOUSNESS (SC0583). LIVER DAMAGE, INJURY TO THE LIVER (SC0221). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES

IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
BENZENE/TOLUENE/XYLENE INGESTION: REMOVE BY GASTRIC LAVAGE BEING CAREFUL TO AVOID ASPIRATION. GENERAL MEASURES - CONTROL EXCITEMENT OR CONVULSIONS WITH DIAZEPAM, 0.1 MG/KG SLOW INTRAVENOUSLY. KEEP AT COMPLETE BED REST UNTIL RESPIRATION IS NORMAL. DO NOT GIVE EPINEPHRINE OR EPHEDRINE OR RELATED DRUGS. THEY MAY INDUCE FATAL VENTRICULAR FIBRILLATION. MONITOR ECG TO DETECT VENTRICULAR ABNORMALITIES FORESHADOWING POSSIBLE CARDIAC ARREST. SPECIAL PROBLEMS - TREAT ANEMIA BY REPEATED BLOOD TRANSFUSIONS. TREAT RESPIRATORY OR PULMONARY PROBLEMS. TREAT KIDNEY OR LIVER DAMAGE. GET MEDICAL ATTENTION IMMEDIATELY. TREATMENT MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(5 OF 5)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

# MATERIAL SAFETY DATA SHEET

CORPORATE RESEARCH & DEVELOPMENT

SCHENECTADY, N. Y. 12305

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MATERIALS INFORMATION SERVICES

NO. 317

TOLUENE

Revision C

Date August 1979

## SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TOLUENE
OTHER DESIGNATIONS: Toluol, Methylbenzene, Phenylmethane, $CH_3C_6H_5$, GE Material D5B11, ASTM D362 and D841, CAS# 000 108 883
MANUFACTURER: Available from many suppliers, including Shell Chemical Co. and Sun Oil Co.

| SECTION II. INGREDIENTS AND HAZARDS | % | HAZARD DATA |
|---|---|---|
| Toluene | ca 100 | 8-hr TWA 100 ppm (skin)* or 375 mg/m$^3$<br>Human, inhalation TCLo 200 ppm (central nervous syst.)<br>Rat, inhalation LCLo 4000 ppm/4 hr<br>Rat, oral $LD_{50}$ 5000 mg/kg |

*ACGIH (1978); (skin) notation indicates a potential contribution to overall exposure via skin absorption. OSHA/NIOSH (1976) proposed an 8-hr TWA of 100 ppm, with a 15-minute ceiling of 200 ppm, and an action level of 50 ppm. Current OSHA TLV is 200 ppm.

## SECTION III. PHYSICAL DATA

| | | | |
|---|---|---|---|
| Boiling point, 1 atm, deg F (C) | 231 (110.6) | Specific gravity (Water=1) | 0.866 |
| Vapor pressure @ 25 C, mm Hg | 28 | Volatiles, % | 100 |
| Vapor density (Air=1) | 3.2 | Evaporation rate (BuAc=1) | 1.9 |
| Solubility in water, % | 0.05 | Molecular weight | 92.15 |

Appearance & Odor: Water white liquid with a characteristic aromatic odor, whose recognition threshold (unfatigued) is 2-5 ppm (100% ~~of test panel~~). Odor detection is unsatisfactory for safety because of fatigue.

## SECTION IV. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temp. | Flammability Limits In Air % by volume | LOWER | UPPER |
|---|---|---|---|---|
| 40 F (4.4 C) Closed cup | (536 C) 997 F | | 1.2 | 7 |

Extinguishing Media: Carbon dioxide, dry chemical, foam, and water fog. Water may be ineffective for putting out fire, but use spray to cool fire-exposed containers.

At room temperature, toluene emits vapors that can form flammable mixtures with air. It is a dangerous fire hazard and a moderate explosion hazard when exposed to heat and flame. Vapors can flow along surfaces to distant ignition sources, then flash back.

Firefighters should wear self-contained breathing apparatus and eye protection when fighting toluene fires.

## SECTION V. REACTIVITY DATA

Toluene is a stable material under normal storage and handling. It does not undergo hazardous polymerization.

Since toluene is a flammable liquid, avoid contact with heat, sparks or open flames. Avoid contact with strong oxidizing agents. Nitric acid and toluene, especially in combination with sulfuric acid, will produce nitrated compounds which are dangerously explosive.

Oxidation in air can form oxides of carbon and nitrogen.



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## SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm (skin) (See Sect. II)

Vapor inhalation can produce headache and slight drowsiness at 100 ppm, fatigue, nausea, and itching skin at 100-200 ppm, anesthetic effects and respiratory tract and eye irritation above 200 ppm. Absorption can occur through the skin, and liquid contact will cause defatting of the skin, with possible dermatitis from repeated or prolonged contact. Eye contact is irritating and can be damaging (corneal burns). Ingestion irritates the digestive tract and results in systemic effects from absorption.

FIRST AID:

Eye Contact: Immediately irrigate with water for 15 minutes. Get medical help.

Skin Contact: Wash area with soap & water; remove contaminated clothing promptly. Get medical help if irritation persists or if large areas of skin were exposed.

Inhalation: Remove to fresh air; restore breathing and give oxygen if needed. Get medical help!

Ingestion: Get medical help as soon as possible! When victim is conscious, give USP mineral oil to drink. (Aspiration is a potential hazard if vomiting occurs!)

## SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Report large spills to safety personnel. Remove ignition sources; provide explosion-proof ventilation. Those involved in clean-up must use protection again liquid contact and vapor inhalation. Pick as liquid when feasible, or absorb on vermiculite or sand and scoop up with nonsparking tools into a metal container with cover. Liquid can be flushed with a water spray to an open holding area for handling. Do not flush to sewer, to a confined space, or to a watercourse!

DISPOSAL: Consider reclaiming by distillation or disposal via a licensed waste disposal company. Scrap may be incinerated under properly controlled conditions. Follow Federal, State and local regulations.

## SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and exhaust ventilation to meet TLV requirements. Ventilation fans & other electrical service must be nonsparking and explosion proof. Exhaust hoods should have >100 lfm face velocity and be designed to capture heavy vapors. Exposure above the TLV for nonroutine and emergency situations requires use of an organic chemical cartridge respirator up to 200 ppm; above 200 ppm a full face piece is required with an approved canister-type gas mask or self-contained breathing equipment.

Safety goggles or glasses should be worn in areas of use. Impermeable (neoprene has been recommended) gloves and apron, face shield, and other protective clothing may be needed to prevent skin contact during use, especially where splashing may occur. An eyewash station should be available if splashing is possible. A safety shower and washing facilities should be available.

## SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in cool, clean, well-ventilated area away from sources of heat and ignition and away from oxidizing agents. Area must meet requirements of OSHA Class IB liquid. No smoking in areas of storage or use. Nonsparking tools should be used near toluene. Use safety cans for handling small amounts. Ground and bond metal containers for liquid transfers to prevent static sparks. Protect containers from physical damage.

Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart and blood should be provided. At least an annual exam is recommended for workers exposed above the action level (50 ppm). Use of alcohol can aggravate the narcotic effect and blood effects of toluene.

DATA SOURCE(S) CODE: 1-9,12,20,21,24,26

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, General Electric Company extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

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1
AN ACCESSION NUMBER: 1655. 9112.
CN CHEMICAL NAME: LEAD.
SY SYNONYMS: C.I. PIGMENT METAL 4. C.I. 77575. LEAD FLAKE. KS-4.
LEAD S2. SI. SO. S 1. PLUMBUM. PB-S 100. LEAD ELEMENT. L-18.
L-24. L-29. L-27. T-134.
RN CAS NUMBER: 7439-92-1.

REG. TOXIC NUMBER: OF7525000.

CHEMICAL FORMULA: PB.
PD
PHYSICAL DESCRIPTION:
BLUISH-WHITE, SILVERY GRAY, HEAVY MALLEABLE METAL.

| | |
|---|---|
| MOL WT: | 207.19 |
| BOILING PT: | 3164 F (1740 C) |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | NONCOMBUSTIBLE SOLID |
| VAPOR PRES: | 1.3 MMHG @ 970 C |
| MELT PT: | 622 F (328 C) |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | NOT AVAILABLE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 11.3 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
50 UG(PB)/M3 OSHA TWA; 30 UG(PB)/M3 OSHA TWA ACTION LEVEL
IF AN EMPLOYEE IS EXPOSED TO LEAD FOR MORE THAN 8 HOURS PER DAY THE
FOLLOWING FORMULA IS USED:
MAXIMUM PERMISSIBLE LIMIT (IN UG/M3)= 400 DIVIDED BY HOURS WORKED
0.15 MG(PB)/M3 ACGIH TWA
<0.10 MG(PB)/M3 NIOSH RECOMMENDED 10 HOUR TWA
HUMAN INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-2B)
ANIMAL SUFFICIENT EVIDENCE FOR CARCINOGENICITY (IARC GROUP-2B)
REPRODUCTIVE EFFECTS DATA (RTECS); MUTAGENIC DATA (RTECS)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 -
PERSISTENCE 3
TOXICOLOGY: LEAD MAY BE IRRITATING TO THE EYES AND SKIN. THERE IS
INSUFFICIENT DATA TO QUANTIFY THE TOXICITY. IT IS A NEUROTOXIN,
NEPHROTOXIN AND TERATOGEN. POISONING MAY ALSO AFFECT THE BLOOD, HEART,
ENDOCRINE AND IMMUNE SYSTEMS. THE FATAL DOSE OF ABSORBED LEAD IS
APPROXIMATELY 0.5 GRAMS. ACUTE EXPOSURES MAY RESULT IN METAL FUME FEVER
WHILE CHRONIC EXPOSURE MAY RESULT IN "PLUMBISM" AND AN ACCUMULATION IN
BODY TISSUES. REPRODUCTIVE EFFECTS HAVE BEEN EXHIBITED IN BOTH MALES
ND FEMALES. PATERNAL EFFECTS MAY INCLUDE DECREASED SEX DRIVE,
IMPOTENCE, STERILITY AND ADVERSE EFFECTS ON THE SPERM WHICH MAY
INCREASE THE RISK OF BIRTH DEFECTS. MATERNAL EFFECTS MAY INCLUDE
MISCARRIAGE AND STILLBIRTHS IN EXPOSED WOMEN OR WOMEN WHOSE HUSBANDS

WERE EXPOSED, ABORTION, STERILITY OR DECREASED FERTILITY, AND ABNORMAL MENSTRUAL CYCLES. RENAL TUMORS WERE PRODUCED IN ANIMALS BY LEAD ACETATE, SUBACETATE AND PHOSPHATE WHEN GIVEN ORALLY. NO EVALUATION COULD BE MADE OF THE CARCINOGENICITY OF POWDERED LEAD.
DUE TO THE LACK OF INFORMATION ON ODOR THRESHOLD AND EYE IRRITATION LEVELS, INORGANIC LEAD IS TREATED AS A MATERIAL WITH POOR WARNING PROPERTIES. THE THRESHOLD LIMIT VALUE WAS ESTABLISHED BASED ON SYSTEMIC EFFECTS.
PERSONS WITH NERVOUS SYSTEM OR GASTROINTESINAL DISRODERS, ANEMIA OR CHRONIC BRONCHITIS MAY BE AT AN INCREASED RISK FROM EXPOSURE. LEAD MAY CROSS THE PLACENTA AND AFFECT THE FETUS CAUSING BIRTH DEFECTS.
ORL-WMN TDLO: 450 MG/KG/6 Y IHL-HMN TDLO: 10 UG/M3

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
700 MG/M3 OSHA/NIOSH
BLUISH-WHITE, SILVERY GRAY, HE.

IC

INCOMPATIBILITIES:
LEAD: AMMONIUM NITRATE: VIOLENT OR EXPLOSIVE REACTION. CHLORINE TRIFLUORIDE: VIOLENT REACTION. DISODIUM ACETYLIDE: TRITURATION IN MORTAR MAY BE VIOLENT AND LIBERATE CARBON. HYDROGEN PEROXIDE (52% OR GREATER): VIOLENT DECOMPOSITION. HYDROGEN PEROXIDE (60% SOLUTION) AND TRIOXIANE: SPONTANEOUSLY DETONABLE. METALS (ACTIVE): INCOMPATIBLE. NITRIC ACID: LEAD-CONTAINING RUBBER MAY IGNITE. OXIDIZERS (STRONG): INCOMPATIBLE. SODIUM AZIDE: FORMS LEAD AZIDE AND COPPER AZIDE IN COPPER PIPE. SODIUM CARBIDE: VIGOROUS REACTION. SULFURIC ACID (HOT): REACTS. ZIRCONIUM-LEAD ALLOYS: IGNITION ON IMPACT.

CL

CLOTHING:
29CFR1910.1025 LEAD THE EMPLOYERS SHALL ASSURE THAT EMPLOYEES WHO ARE EXPOSED TO LEAD ABOVE THE PERMISSIBLE EXPOSURE LEVEL, WITHOUT REGARD TO THE USE OF RESPIRATORS OR WHERE THE POSSIBILITTY OF SKIN OR EYE IRRITATION EXISTS, BE PROVIDED WITH COVERALLS OR SIMILAR FULL-BODY WORK CLOTHING, GLOVES, HATS AND SHOES OR DISPOSABLE SHOE COVERLETS, FACESHIELDS, VENTED GOGGLES OR OTHER APPROPRIATE PROTECTIVE EQUIPMENT.

WEAR EYE PROTECTION TO PREVENT:
29CFR1910.1025 LEAD THE EMPLOYERS SHALL ASSURE THAT EMPLOYEES WEAR FACESHIELDS, VENTED GOGGLES OR OTHER APPROPRIATE PROTECTIVE EQUIPEMENT WHICH COMPLIES WITH 29CFR1910.133.

EMPLOYEE SHOULD WASH:
29CFR1910.1025 LEAD THE EMPLOYER SHALL ASSURE THAT EMPLOYEES WHO WORK IN AREAS WHERE THEIR AIRBORNE EXPOSURE TO LEAD IS ABOVE THE PERMISSIBLE EXPOSURE LEVEL, WITHOUT REGARD TO THE USE OF A RESPIRATOR, WASH THEIR HANDS AND FACE PRIOR TO EATING, DRINKIND OR APPLYING COSMETICS AND SHOWER AT THE END OF THE WORKSHIFT.

WORK CLOTHING SHOULD BE CHANGED DAILY:

29CFR1910.1025 LEAD THE EMPLOYER SHALL ASSURE THAT ALL PROTECTIVE CLOTHING IS REMOVED AT THE COMPLETION OF A WORKSHIFT ONLY IN CHANGE ROOMS PROVIDED FOR THAT PURPOSE.

REMOVE CLOTHING:
NO SPECIFIC REGULATIONS UNDER 29CFR1910.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
LEAD

THE FOLLOWING RESPIRATORS ARE THE MINIMUM LEGAL REQUIREMENTS AS SET FORTH BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION FOUND IN 29CFR1910, SUBPART Z. NOT IN EXCESS OF 0.5 MG/M3 (10X PEL) - HALF-MASK, AIR-PURIFYING RESPIRATOR EQUIPPED WITH HIGH-EFFICIENCY FILTERS NOT IN EXCESS OF 2.5 MG/M3 (50X PEL) - FULL FACEPIECE, AIR-PURIFYING RESPIRATOR WITH HIGH-EFFICIENCY FILTERS NOT IN EXCESS OF 50 MG/M3 - ANY POWERED AIR-PURIFYING RESPIRATOR WITH HIGH-EFFICIENCY FILTERS - HALF-MASK SUPPLIED-AIR RESPIRATOR OPERATED IN POSITIVE PRESSURE MODE NOT IN EXCESS OF 100 MG/MG (2000X PEL) - SUPPLIED-AIR RESPIRATORS WITH FULL FACEPIECE, HOOD OR HELMET OR SUIT, OPERATED IN POSITIVE PRESSURE MODE GREATER THAN 100 MG/M3, UNKNOWN CONCENTRATIONS OR FIREFIGHTING - FULL FACEPIECE, SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSUE MODE (RESPIRATORS SPECIFIED FOR HIGHER CONCENTRATIONS CAN BE USED A LOWER CONCENTRATIONS OF LEAD). (FULL FACEPIECE IS REQUIRED IF THE LEAD AEROSOLS CAUSE EYE AND SKIN IRRITATION AT THE USE CONCENTRATIONS.) (A HIGH EFFICIENCY PARTICULATE FILTER MEANS 99.97% EFFICIENT AGAINST 0.3 MICRON PARTICLES) THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS OR NIOSH CRITERIA DOCUMENTS.

0.5 MG(PB)/M3
- SUPPLIED-AIR RESPIRATOR
- AIR-PURIFYING RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS

1.25 MG(PB)/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND HIGH-EFFICIENCY PARTICULATE FILTER
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

2.5 MG(PB)/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND HIGH-EFFICIENCY PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE

- SUPPLIED-AIR RESPIRATOR WITH A TIGHT-FITTING FACEPIECE OPERATED IN A CONTINUOUS FLOW MODE

50 MG(PB)/M3
- SUPPLIED-AIR RESPIRATOR WITH HALF-MASK OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

100 MG(PB)/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.1025 THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIRES EMPLOYERS TO PROVIDE A MEDICAL SURVEILLANCE PROGRAM FOR ALL EMPLOYEES WHO ARE OR MAY BE EXPOSED TO LEAD ABOVE THE ACTION LEVEL FOR MORE THAN 30 DAYS PER YEAR THIS MEDICAL SURVEILLANCE PROGRAM SHALL CONSIST OF: (1) INITIAL MEDICAL EXAMINATION INCLUDING: (A) WORK HISTORY (B) MEDICAL HISTORY WITH PARTICULAR ATTENTION TO: (1) PAST LEAD EXPOSURE (OCCUPATIONAL AND NON-OCCUPATIONAL) (2) PERSONAL HABITS (SMOKING, HYGIENE) (3) PAST GASTROINTESTINAL, HEMATOLOGIC, RENAL, REPRODUCITVE, CARDIOVASCULAR AND NEUROLOGIC PROBLEMS (C) PHYSICAL EXAMINATION (1) WITH PARTICULAR ATTENTION TO: (A) TEETH AND GUMS (B) HEMATOLOGIC SYSTEM (C) GASTROINTESTINAL SYSTEM (D) KIDNEYS (E) CARDIOVASCULAR SYSTEM (F) NEUROLOGICAL SYSTEM (G) PULMONARY STATUS IF RESPIRATORY PROTECTION WILL BE USED (2) BLOOD PRESSURE MEASUREMENT (3) BLOOD SAMPLE AND ANALYSIS DETERMINING: (A) BLOOD LEAD LEVEL (B) HEMOGLOBIN AND HEMATOCRIT DETERMINATIONS, RED CELL INDICES, EXAM OF PERIPHERAL SMEAR MORPHOLOGY (C) ZINC PROTOPORPHYRIN (D) BLOOD UREA NITROGEN (E) SERUM CREATININE (4) URINALYSIS WITH MICROSCOPIC EXAM (5) ANY LABORATORY OR OTHER TEST DEEMED NECESSARY BY THE PHYSICIAN (2) PERIODIC EXAMINATIONS (A) BLOOD LEAD AND ZPP LEVEL TESTS AND ANALYSIS: (1) EVERY 6 MONTHS FOR EACH EMPLOYEE EXPOSED ABOVE THE ACTION LEVEL FOR MOR THAN 30 DAYS PER YEAR (2) AT LEAST EVERY 2 MONTHS FOR EACH EMPLOYEE WHOSE LAST BLOOD SAMPLING AND ANALYSIS INDICATED A BLOOD LEVEL AT OR ABOVE 40 UG/100 G OF WHOLE BLOOD. THIS FREQUENCY SHALL CONTINUE UNTIL 2 CONSECUTIVE BLOOD SAMPLES AND ANALYSES INDICATE A BLOOD LEAD LEVEL BELOW 40 UG/100 G OF WHOLE BLOOD (3) AT LEAST MONTHLY DURING THE REMOVAL PERIOD OF EACH EMPLOYEE REMOVED FROM EXPOSURE TO LEAD DUE TO AN ELEVATED BLOOD LEAD LEVEL (B) ALL TESTS CONDUCTED IN INITIAL EXAMINATION: (1) AT LEAST ANNUALLY FOR EACH EMPLOYEE FOR WHOM A BLOOD SAMPLING TEST CONDUCTED AT ANY TIME DURING THE PRECEDING 12 MONTHS INDICATED A BLOOD LEAD LEVEL AT OR ABOVE 400 UG/100 G (2) PRIOR TO ASSIGNMENT FOR EACH EMPLOYEE BEING ASSIGNED FOR THE FIRST TIME TO AN AREA IN WHICH AIRBORNE CONCENTRATIONS OF LEAD ARE AT OR ABOVE THE ACTION LEVEL (3) AS SOON AS POSSIBLE, UPON NOTIFICATION BY AN EMPLOYEE HAS DEVELOPED SIGNS OR SYMPTOMS ASSOCIATED WITH LEAD INTOXICATION, THAT THE EMPLOYEE DESIRES MEDICAL ADVICE CONCERNING THE EFFECTS OF CURRENT OR PAST EXPOSURE TO LEAD ON THE EMPLOYEES ABILITY TO PROVIDE A HEALTHY CHILD, OR THAT EMPLOYEE HAS DEMONSTRATED DIFFICULTY IN BREATHING DURING A RESPIRATORY FITTING TEST OR DURING USE (4) AS MEDICALLY APPROPRIATE FOR EACH EMPLOYEE

EITHER REMOVED FROM EXPOSURE TO LEAD DUE TO A RISK OF SUSTAINING MATERIAL IMPAIRMENT TO HEALTH, OR OTHERWISE LIMITED PURSUANT TO A FINAL MEDICAL DETERMINATION.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
OTHER MEDICAL SURVEILLANCE RECOMMENDED: ACGIH BIOLOGICAL EXPOSURE INDICES FOR LEAD: 50 UG/100 ML LEAD IN BLOOD / TIMING -NOT CRITICAL 150 UG/G CREATINE LEAD IN URINE / TIMING -NOT CRITICAL 250 UG/100 ML ERYTHROCYTES OF 100 UG/100 ML BLOOD ZINC PROTOPORPHYRIN IN BLOOD / TIMING -AFTER ONE MONTH EXPOSURE.

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
CENTRAL NERVOUS SYSTEM. CARDIOVASCULAR SYSTEM. GASTROINTESTINAL. KIDNEYS. REPRODUCTIVE SYSTEM. GINGIVAL TISSUE. BLOOD.

SP

SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). SALIVATION, EXCESS DISCHARGE OF SALIVA (SC0146). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). CONSTIPATION, DIFFICULT, INFREQUENT DEFECATION (SC0032). FATIGUE, TIREDNESS, SLUGGISH (SC0066). SLEEP DISORDERS, CHANGE IN NORMAL SLEEP PATTERNS (SC0599). IRRITABILITY QUICK EXCITABILITY TO ANNOYANCE (SC0091). MEMORY DEFECTS, IMPERFECTION IN RECOLLECTION ABILITY (SC0585). INABILITY TO CONCENTRATE, INABILITY TO FOCUS ONE'S THOUGHTS (SC0586). DELIRIUM, STATE OF DISORIENTATION, CONFUSION (SC0288). PARESTHESIA, ABNORMAL SENSATION WITHOUT CAUSE (SC0125).
MUSCLE, TISSUE RESPONSIBLE FOR MOTION (SC0623);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). WEAKNESS, LACK OF STRENGTH (SC0167).
LIVER, BILE-SECRETING GLANDULAR ORGAN (SC0620);
EFFECTS, SIGNS AND SYMPTOMS (SC0579). THIRST, DESIRE FOR WATER (SC0210). LETHARGY, SLUGGISHNESS (SC0595). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). SWEATING, EXCRETING MOISTURE THROUGH THE SKIN (SC0156). EXCESSIVE, SUPERFLUOUS (SC0737);
URINATION, DISCHARGE OF URINE FROM BODY (SC0617). PROSTRATION, MARKED LOSS OF STRENGTH, EXHAUSTION (SC0139). FEVER, BODY TEMPERATURE ABOVE NORMAL (SC0067). CHILLS, A SHIVERING OR SHAKING (SC0736). PALLOR, PALENESS, AS OF THE SKIN (SC0122). FATIGUE, TIREDNESS, SLUGGISH (SC0066). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104). APATHY, LACK OF FEELING OR EMOTION (SC0008). GINGIVAL BLACK LINE, BLACK LINE ON GUMS (SC0207). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). MYALGIA, MUSCLE PAIN OR TENDERNESS (SC0526).
ABDOMINAL, SECTION BETWEEN THORAX AND PELVIS (SC0750);

PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). ATAXIA, MUSCULAR INCOORDINATION (SC0013). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). VISUAL DISTURBANCE, UPSET IN SIGHT (SC0165). ENCEPHALOPATHY, BRAIN DYSFUNCTION; BRAIN DISEASE (SC0336). DELIRIUM, STATE OF DISORIENTATION, CONFUSION (SC0288). MENTAL DISORDER, PSYCHIC DISTURBANCE (SC0608). SEIZURE, CONVULSION (SC0149). HYPERTENSION, HIGH BLOOD PRESSURE (SC0177).
CRANIAL NERVE, NERVE ARISING FROM THE BRAIN (SC0342);
PARALYSIS, LOSS OF POWER OF VOLUNTARY MOVEMENT (SC0124). KIDNEY DAMAGE INJURY TO THE KIDNEY (SC0220). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
TUMORS, BENIGN OR CANCEROUS ENLARGEMENTS (SC0578).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
INGESTED LEAD COMPOUNDS: REMOVE INGESTED POISON BY GASTRIC LAVAGE WITH DILUTE MAGNESIUM SULFATE OR SODIUM SULFATE SOLUTION OR BY EMESIS. TREAT CEREBRAL EDEMA WITH MANNITOL AND PREDNISOLONE OR OTHER CORTICOSTEROID. GET MEDICAL ATTENTION IMMEDIATELY. ANTIDOTE: INITIATE URINE FLOW. GIVE 10% DEXTROSE IN WATER INTRAVENOUSLY, 10-20 ML/KG, FOR ONE TO TWO HOURS. IF URINE FLOW DOES NOT START, GIVE 20% SOLUTION OF MANNITOL, 5-10 ML/KG INTRAVENOUSLY, OVER TWENTY MINUTES. LIMIT FLUID TO REQUIREMENTS, AND CATHETERIZATION MAY BE NECESSARY IN COMA. DAILY URINE OUTPUT SHOULD BE 350-500 ML/M2/24 HOURS. EXCESSIVE FLUIDS FURTHER INCREASE CEREBRAL EDEMA. FOR ADULTS WITH ACUTE ENCEPHALOPATHY, GIVE DIMERCAPROL, 4 MG/KG, INTRAMUSCULARLY EVERY 4 HOURS FOR 30 DOSES. BEGINNING 4 HOURS LATER, GIVE CALCIUM DISODIUM EDETATE AT A SEPERATE INJECTION SITE, 12.5 MG/KG INTRAMUSCULARLY EVERY 4 HOURS AS A 20% SOLUTION, WITH 0.5% PROCAINE ADDED, FOR A TOTAL OF 30 DOSES. IF SIGNIFICANT IMPROVEMENT HAS NOT OCCURRED BY THE FOURTH DAY, INCREASE THE NUMBER OF INJECTIONS BY 10 FOR EACH DRUG. FOR SYMPTOMATIC ADULTS, THE COURSE OF DIMERCAPROL AND CALCIUM DISODIUM EDETATE CAN BE SHORTENED OR CALCIUM DISODIUM EDETATE ONLY CAN BE GIVIN IN A DOSAGE OF 50 MG/KG INTRAVENOUSLY AS 0.5% SOLUTION IN 5% DEXTROSE IN WATER OR NORMAL SAILINE BY INFUSION OVER NOT LESS THAN 8 HOURS FOR NOT MORE THAN 5 DAYS. FOLLOW WITH PENICILLAMINE, 500-750 MG/DAY, ORALLY FOR 1-2 MONTHS OR UNTIL URINE LEAD LEVELS DROPS BELOW 0.3 MG/24 HOURS. (DREISBACH, HANDBOOK OF POISONING, 12TH EDITION.) PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL.

(5 OF 5)
ASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH UBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

DT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
OMPLETE BLOOD COUNT.
RINALYSIS.
BLOOD LEAD.
URINE LEAD AS EXPOSURE INDEX.
BLOOD ERYTHROCYTE PROTOPORPHYRIN BLOOD ERYTHOCYTE GAMMA-AMINOLEVULINIC ACID DEHYDRATASE URINE LEAD EXCRETION >0.08 MG/DAY URINE COPROPORPHYRIN >0.8 MG/L URINE GAMMA-AMINOLEVULINIC ACID >6 MG/L.

RS

REGULATORY STATUS.

(1 OF 44)
**********
FEDERAL REGULATIONS
**********.

(2 OF 44)
OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

(3 OF 44)
OSHA STANDARD 29CFR1910.1025 LEAD.

(4 OF 44)
OSHA STANDARD 29CFR1910.252 WELDING, CUTTING, AND BRAZING.

1
AN ACCESSION NUMBER: 261. 9112.
CN CHEMICAL NAME: ARSENIC, SOLID.
SY SYNONYMS: UN 1558. ARSENIC. COLLOIDAL ARSENIC. ARSENIC BLACK. GREY ARSENIC. METALLIC ARSENIC. ARSENIC, METALLIC. ARSENICALS. ARSENIC-75. STCC 4923207.
RN CAS NUMBER: 7440-38-2.

REG. TOXIC NUMBER: CG0525000.

CHEMICAL FORMULA: AS.
PD
PHYSICAL DESCRIPTION:
SILVER-GRAY BRITTLE, CRYSTALLINE SOLID WITH AN ODOR OF GARLIC.

| | |
|---|---|
| MOL WT: | 74.92 |
| BOILING PT: | SUBLIMES AT 1135 F |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | NONCOMBUSTIBLE SOLID |
| VAPOR PRES: | NOT AVAILABLE |
| MELT PT: | 1503 F AT 28 ATM |
| UEL IN AIR: | NONCOMBUSTIBLE |
| LEL IN AIR: | NONCOMBUSTIBLE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 5.6 - 5.9 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
10 UG(AS)/M3 OSHA TWA
200 UG(AS)/M3 ACGIH TWA
2 UG(AS)/M3 NIOSH RECOMMENDED 15 MINUTE CEILING
HUMAN SUFFICIENT EVIDENCE FOR CARCINOGENICITY (IARC GROUP-1 ARSENICS)
ANIMAL LIMITED EVIDENCE FOR CARCINOGENICITY (IARC GROUP-1 ARSENICS)
OSHA CARCINOGEN; KNOWN HUMAN CARCINOGEN (NTP)
HUMAN CARCINOGEN (EPA - CATEGORY A)
TUMORIGENIC DATA (RTECS)
REPRODUCTIVE EFFECTS DATA (RTECS)
MUTAGENIC DATA (RTECS)
SURVEILLANCE INDEX CLASSIFICATION I: HIGH HEALTH HAZARD POTENTIAL
CERCLA HAZARD RATING - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 - PERSISTENCE 3
TOXICOLOGY: ARSENIC IS AN EYE, SKIN AND MUCOUS MEMBRANE IRRITANT AND A SKIN SENSITIZER. IT IS MODERATELY TOXIC BY INGESTION. ARSENIC IS A NEUROTOXIN. POISONING MAY AFFECT THE HEART, LIVER, KIDNEYS, AND THE HEMATOPOIETIC, GASTROINTESTINAL AND ENDOCRINE SYSTEMS. CHRONIC EXPOSURE TO ARSENIC COMPOUNDS MAY CAUSE GENERALIZED MUSCULAR WEAKNESS, BRONZING OF THE SKIN, MEE'S LINES IN THE FINGERNAILS AND A FEELING OF PINS AND NEEDLES IN THE EXTREMITIES. EVIDENCE FOR CARCINOGENICITY OF ARSENIC COMPOUNDS IN ANIMALS IS CONSIDERED LIMITED. THERE IS SUFFICIENT EVIDENCE THAT SKIN CANCER IS CAUSALLY ASSOCIATED WITH EXPOSURE TO INORGANIC ARSENIC COMPOUNDS IN THE OCCUPATIONAL

ENVIRONMENT. THE RISK OF LUNG CANCER INCREASED 4 TO 12 TIMES IN CERTAIN SMELTER WORKERS WHO INHALED HIGH LEVELS OF ARSENIC TRIOXIDE. HOWEVER, THE INFLUENCE OF OTHER CONSTITUENTS OF THE WORKING ENVIRONMENT CANNOT BE EXCLUDED. CASE REPORTS HAVE SUGGESTED AN ASSOCIATION BETWEEN EXPOSURE TO ARSENIC COMPOUNDS AND LIVER TUMORS AND BLOOD DISEASES.
THE THRESHOLD LIMIT VALUE WAS SET ON THE PROBABILITY THAT SOME ARSENIC COMPOUNDS, OR THE METAL ITSELF, IS CHRONICALLY LESS TOXIC THAN ARSENIC TRIOXIDE.
THERE IS EVIDENCE THAT ARSENIC MAY CROSS THE PLACENTAL BARRIER.
ORL-MAN TDLO: 7857 MG/KG/55Y ORL-RAT LD50: 763 MG/KG
ORL-MUS LD50: 145 MG/KG IPR-MUS LD50: 46,200 MG/KG
IPR-GPG LDLO: 10 MG/KG SCU-GPG LDLO: 300 MG/KG

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
100 MG(AS)/M3 POTENTIAL
CARCINOGENNIOSH
SILVER-GRAY BRITTLE, CRYSTALLI.

IC

INCOMPATIBILITIES:
ARSENIC, SOLID: BROMATES: REACT VIGOROUSLY. CHLORATES: REACT VIGOROUSLY. FLUORINE: REACTS VIGOROUSLY. LITHIUM: REACTS VIGOROUSLY. POTASSIUM: REACTS VIGOROUSLY: HYDROGEN GAS: REACTS VIGOROUSLY. OXIDIZING MATERIALS: REACT VIGOROUSLY. ACIDS: REACT VIGOROUSLY. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC.

CL

CLOTHING:
29CFR1910.1018 INORGANIC ARSENIC WHERE THE POSSIBILITY OF SKIN OR EYE IRRITATION FROM INORGANIC ARSENIC EXISTS, AND FOR ALL WORKERS WORKING IN REGULATED AREAS, THE EMPLOYER SHALL PROVIDE AT NO COST TO THE EMPLOYEE AND ASSURE THAT EMPLOYEES USE APPROPRIATE AND CLEAN PROTECTIVE WORK CLOTHING AND EQUIPMENT SUCH AS, BUT NOT LIMITED TO: COVERALLS OR SIMILAR FULL-BODY WORK CLOTHING; GLOVES, AND SHOES OR COVERLETS; FACE SHIELDS OR VENTED GOGGLES WHEN NECESSARY TO PREVENT EYE IRRITATION, WHICH COMPLY WITH THE REQUIREMENTS OF 29CFR1910.133(A) (2)-(A)(6); AND IMPERVIOUS CLOTHING FOR EMPLOYEES SUBJECT TO EXPOSURE TO ARSENIC TRICHLORIDE. THE EMPLOYER SHALL PROVIDE THE PROTECTIVE CLOTHING IN A FRESHLY LAUNDERED AND DRY CONDITION AT LEAST WEEKLY, AND DAILY IF THE EMPLOYEE WORKS IN AREAS WHERE EXPOSURES ARE OVER 100 UG/M3 OF INORGANIC ARSENIC OR IN AREAS WHERE MORE FREQUENT WASHING IS NEEDED TO PREVENT SKIN IRRITATION. THE EMPLOYER SHALL REPAIR OR REPLACE THE PROTECTIVE CLOTHING AND EQUIPMENT NEEDED TO MAINTAIN THEIR EFFECTIVENESS. THE EMPLOYER SHALL ASSURE THAT CONTAMINATED PROTECTIVE CLOTHING TO BE CLEANED, LAUNDERED, OR DISPOSED OF, IS PLACED IN A CLOSED CONTAINER IN THE CHANGE-ROOM WHICH PREVENTS DISPERSION OF INORGANIC ARSENIC OUTSIDE THE CONTAINER. THE EMPLOYER SHALL INFORM IN WRITING ANY PERSON WHO CLEANS OR LAUNDERS CLOTHING OF THE POTENTIALLY HARMFUL EFFECTS INCLUDING THE CARCINOGENIC EFFECTS OF EXPOSURE TO INORGANIC ARSENIC.

WEAR EYE PROTECTION TO PREVENT:

29CFR1910.1018 INORGANIC ARSENIC FACE SHIELDS OR VENTED GOGGLES WHEN NECESSARY TO PREVENT EYE IRRITATION, WHICH COMPLY WITH THE REQUIREMENTS F 29CFR1910.133(A)(2)-(A)(6).
OLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THERE IS ANY POSSIBILITY OF THIS SOLID CONTACTING THE EYES.

EMPLOYEE SHOULD WASH:
29CFR1910.1018 INORGANIC ARSENIC THE EMPLOYER SHALL ASSURE THAT EMPLOYEES WORKING IN THE REGULATED AREA OF SUBJECT TO THE POSSIBILITY OF SKIN OR EYE IRRITATION FROM EXPOSURE TO INORGANIC ARSENIC WASH THEIR HANDS AND FACE PRIOR TO EATING. THE EMPLOYER SHALL ASSURE THAT EMPLOYEES WORKING IN REGULATED AREAS OR SUBJECT TO THE POSSIBILITY OF SKIN OR EYE IRRITATION FROM INORGANIC ARSENIC SHOWER AT THE END OF THE WORK SHIFT. FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINGES FOR CHEMICAL HAZARDS": SKIN THAT BECOMES CONTAMINATED WITH INORGANIC ARSENIC SHOULD BE PROMPTLY WASHED WITH SOAP AND WATER. WORKERS WHO HANDLE INORGANIC ARSENIC SHOULD WASH THEIR FACES, HANDS, AND FOREARMS THOROUGHLY WITH SOAP AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
29CFR1910.1018 INORGANIC ARSENIC THE EMPLOYERS SHALL PROVIDE FOR EMPLOYEES WORKING IN REGULATED AREAS OR SUBJECT TO THE POSSIBILITY OF SKIN OR EYE IRRITATION FROM INORGANIC ARSENIC, CLEAN CHANGE ROOMS EQUIPPED WITH STORAGE FACILITIES FOR STREET CLOTHES AND SEPARATE STORAGE FACILITIES FOR PROTECTIVE CLOTHING AND EQUIPMENT IN ACCORDANCE WITH 9CFR1910.141(E). FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL EALTH GUIDELINES FOR CHEMICAL HAZARDS": EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
29CFR1910.1018 INORGANIC ARSENIC EMPLOYERS SHALL ASSURE THAT ALL PROTECTIVE CLOTHING IS REMOVED AT THE COMPLETION OF A WORK SHIFT ONLY IN APPROPRIATE CHANGE ROOMS. THE EMPLOYER SHALL PROHIBIT THE REMOVAL OF INORGANIC ARSENIC FROM PROTECTIVE CLOTHING OR EQUIPMENT BY BLOWING OR SHAKING. FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FROM CHEMICAL HAZARDS": CLOTHING WHICH IS CONTAMINATED WITH INORGANIC ARSENIC SHOULD BE REMOVED IMMEDIATELY AND PLACED IN SEALED CONTAINERS FOR STORAGE UNTIL IS CAN BE DISCARDED OR UNTIL PROVISION IS MADE FOR THE REMOVAL OF INORGANIC ARSENIC FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REGULATIONS UNDER 29CFR1910.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH ODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RI

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
SEND BACK AREA EXCEDED.

MS

MEDICAL SURVEILLANCE:
29CFR1910.1018 THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIRES EMPLOYERS TO PROVIDE A MEDICAL SURVEILLANCE PROGRAM FOR EMPLOYEES WHO ARE OR MAY BE EXPOSED TO LEVELS OF INORGANIC ARSENIC ABOVE THE ACTION LEVEL FOR AT LEAST 30 DAYS PER YEAR (WHICH WOULD INCLUDE AMONG OTHERS, ALL EMPLOYEES, WHO WORK IN REGULATED AREAS). EXAMINATIONS ARE ALSO TO BE PROVIDED TO ALL EMPLOYEES WHO HAVE HAD 10 YEARS OR MORE EXPOSURE ABOVE THE ACTION LEVEL FOR MORE THAN 30 DAYS PER YEAR WHILE WORKING FOR THE PRESENT OR PREDECESSOR EMPLOYER THOUGH THEY MAY NO LONGER BE EXPOSED ABOVE THE LEVEL. THIS MEDICAL SURVEILLANCE PROGRAM SHALL CONSIST OF: (1) AN INITIAL MEDICAL EXAMINATION INCLUDING: (A) WORK AND MEDICAL HISTORY (1) SMOKING HISTORY (2) PRESENCE AND DEGREE OF RESPIRATORY SYMPTOMS (B) A 14" BY 17" POSTERIOR-ANTERIOR CHEST X-RAY AND AN INTERNATIONAL LABOR OFFICE UICC/CINCINNATI (ILO U/C) RATING (C) A NASAL AND SKIN EXAM (D) A SPUTUM CYTOLOGY EXAM (E) OTHER EXAMS WHICH THE PHYSICIAN BELIEVES APPROPRIATE BECAUSE OF THE EMPLOYEE'S EXPOSURE TO INORGANIC ARSENIC OR BECAUSE OF REQUIRED RESPIRATOR USE (2) PERIODIC EXAMINATION (A) ANNUAL EXAMS FOR THOSE EXPLOYEES 45 YEARS OF AGE OR LESS WITH FEWER THAN 10 YEARS EMPLOYMENT WHERE EMPLOYEE EXPOSURE EXCEEDS THE ACTION LEVEL INCLUDING: (1) MEDICAL HISTORY UPDATE (2) NO SPUTUM CYTOLOGY (B) SEMI-ANNUAL EXAMS FOR OTHER COVERED EMPLOYEES INCLUDING: (1) ALL TESTS IN INITIAL EXAM (2) MEDICAL HISTORY UPDATE (3) ADDITIONAL EXAMINATIONS (A) LATERAL AND OBLIQUE X-RAYS (B) PULMONARY FUNCTION (C) PALPATION OF SUPERFICIAL LYMPH NODES AND COMPLETE BLOOD COUNT FOR WORKERS EXPOSED TO COPPER ACETOARSENITE, POTASSIUM ARSENITE OR SODIUM ARSENITE (D) IF EMPLOYEE FOR ANY REASON DEVELOPS SIGN AND SYMPTOMS COMMONLY ASSOCIATED WITH EXPOSURE TO INORGANIC ARSENIC THE EMPLOYER SHALL PROVIDE AN APPROPRIATE EXAM.
OTHER MEDICAL SURVEILLANCE RECOMMENDED: 40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS.
FOOD AND DRUG ADMINISTRATION (FDA) SURVEILLANCE INDEX CLASSIFICATION (SIC) - CLASS I: HIGH HEALTH/TOXICITY HAZARD. THIS HAZARD POTENTIAL WARRANTS IMMEDIATE INCLUSION OF THIS SUBSTANCE IN MEDICAL MONITORING PROGRAM ON A CONTINUOUS BASIS.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS.
NOTICE OF INTENT TO ESTABLISH ACGIH BIOLOGICAL EXPOSURE INDICIES FOR ARSENIC AND SOLUBLE COMPOUNDS INCLUDING ARSINE: 50 UG/G CREATININE INORGANIC ARSENIC METABOLITES IN URINE / TIMING-END OF WORKWEEK.

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
RESPIRATORY SYSTEM. SKIN. EYES. LYMPHATIC SYSTEM. CENTRAL NERVOUS SYSTEM. MUCOUS MEMBRANES. KIDNEYS. LIVER. BLOOD. PERIPHERAL NERVOUS SYSTEM.

SP

SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
SENSITIZATION, ALLERGIC REACTION (SC0148). FROTHY SPUTUM, FOAMY MIXTURE OF SALIVA AND MUCOUS (SC0627). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). LASSITUDE, A SENSE OF WEARINESS (SC0098). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). GIDDINESS, FRIVOLOUS, DIZZINESS (SC0071). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). WEAKNESS, LACK OF STRENGTH (SC0167). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046).
EXTREMITIES, ARMS OR LEGS (SC0062);
MYALGIA, MUSCLE PAIN OR TENDERNESS (SC0526). HYPOTENSION, LOW BLOOD PRESSURE (SC0180). ANOREXIA, DIMINISHED APPETITE (SC0006).
CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031). CORYZA, HEAD COLD (SC0431).
PERFORATION, OPENING IN HOLLOW ORGAN OR VISCUS (SC0127);
NASAL, PERTAINING TO THE NOSE (SC0114).
SEPTUM, WALL DIVIDING 2 CAVITIES OF NOSE (SC0202).
SKIN, COVERING OF BODY (SC0174).
LESIONS, DISCONTINUITY OF TISSUE (SC0416). PALMAR AND PLANTAR HYPERKERATOSIS, GROWTHS ON HANDS & SOLES OF FEET (SC0266). ALOPECIA, BALDNESS (SC0201). PERIPHERAL NEURITIS, INFLAMED NERVES OF EXTREMITIES (SC0129). BRONZING OF THE SKIN, GOLDEN-YELLOW SKIN PIGMENTATION (SC0126). KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094).
PHOTOPHOBIA, INTOLERANCE TO LIGHT (SC0131). DYSPHAGIA, DIFFICULTY IN SWALLOWING (SC0325). METALLIC TASTE, TASTE RESEMBLING METAL IN MOUTH (SC0216). THROMBOCYTOPENIA, DECREASE IN BLOOD PLATELETS (SC0329). BONE MARROW DEPRESSION, LOWERING OF BONE TISSUE BLOOD PRODUCT(SC0249).
POLYNEURITIS, INFLAMMATION OF MANY NERVES (SC0624). PARESTHESIA, ABNORMAL SENSATION WITHOUT CAUSE (SC0125). ANESTHESIA, LOSS OF SENSATION (SC0005). CIRRHOSIS, PROGRESSIVE DISEASE OF LIVER (SC0027). APLASTIC ANEMIA, ANEMIA FROM BONE MARROW DAMAGE (SC0285). ATAXIA, MUSCULAR INCOORDINATION (SC0013). TREMORS, TREMBLING, SHAKING (SC0197).
CONFUSION, IN A BEWILDERED STATE (SC0030). INCOORDINATION, LACK OF COORDINATION (SC0085). FEVER, BODY TEMPERATURE ABOVE NORMAL (SC0067).
ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104). WRIST DROP, WRIST WILL NOT EXTEND (SC0208).
BRITTLE FINGERNAILS, FINGERNAILS CRACKING AND SLOUGHING (SC0225).
CARDIAC, PERTAINING TO HEART (SC0023);
FAILURE, LOSS OF FUNCTION (SC0386). LIVER DAMAGE, INJURY TO THE LIVER (SC0221).
SKIN, COVERING OF BODY (SC0174);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
LUNG, RESPIRATORY ORGAN (SC0377);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA
IRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE

AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
INGESTED ARSENIC: REMOVE INGESTED ARSENIC BY GASTRIC LAVAGE OR EMESIS. FOLLOW WITH A SALINE CATHARTIC. MAINTAIN BLOOD PRESSURE, AIRWAY AND GIVE OXYGEN IF RESPIRATION IS DEPRESSED. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS IF VICTIM IS UNCONSCIOUS. GET MEDICAL ATTENTION IMMEDIATELY. ANTIDOTE: GIVE DIMERCAPROL, 3 MG/KG (OR 0.3 ML/KG) EVERY 4 HOURS FOR 2 DAYS AND THEN 2 MG/KG EVERY 2 HOURS FOR A TOTAL OF 10 DAYS. DIMERCAPROLIS AVAILABLE AS A 10% SOLUTION IN OIL FOR INTRAMUSCULAR ADMINISTRATION. NEXT, GIVE PENICILLAMINE, UP TO 100 MG/KG/DAY (MAXIMUM 1 G/DAY) DIVIDED INTO 4 DOSES FOR NO LONGER THAN 1 WEEK. IF A LONGER ADMINISTRATION PERIOD IS WARRENTED, DOSAGE SHOULD NOT EXCEED 40 MG/KG/DAY. GIVE THE DRUG ORALLY HALF AND HOUR BEFORE MEALS. (DREISBACH, HANDBOOKOF POISONING, 12TH ED.). ADMINISTRATION OF GASTRIC LAVAGE, OXYGEN AND/OR ANTIDOTE SHOULD BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL.

(5 OF 5)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

END OF REQUEST

BRS SEARCH MODE - ENTER QUERY
5_: ..PRINT ALL/DOC=1

1
ACCESSION NUMBER: 289. 9205.
CHEMICAL NAME: BARIUM.
SY SYNONYMS: BARIUM METAL. BARIUM, METALLIC. METALLIC BARIUM. BARIUM METAL, NON-PYROPHORIC. UN 1400. UN 1399.
RN CAS NUMBER: 7440-39-3.

REG. TOXIC NUMBER: CQ8370000.

CHEMICAL FORMULA: BA.
PD
PHYSICAL DESCRIPTION:
SILVERY-WHITE, SOFT METAL, TURNS YELLOW ON EXPOSURE TO AIR.

| | |
|---|---|
| MOL WT: | 137.36 |
| BOILING PT: | 2984 F |
| SOLUBILITY: | REACTS |
| FLASH PT: | FLAMMABLE SOLID |
| VAPOR PRES: | 10 MM AT 1920 F |
| MELT PT: | 1337 F |
| UEL IN AIR: | |
| LEL IN AIR: | |
| MEC IN AIR: | |
| SPEC GRAVITY: | 3.5 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

PERMISSABLE EXPOSURE:
0.5 MG/M3 OSHA TWA
0.5 MG/M3 ACGIH TWA
0.5 MG/M3 NIOSH RECOMMENDED 10 HR TWA
CERCLA HAZARD RATING - TOXICITY U - IGNITABILITY 0 - REACTIVITY 2 - PERSISTENCE 3
TOXICOLOGY: BARIUM IS AN EYE, SKIN AND MUCOUS MEMBRANE IRRITANT. THERE IS INSUFFICIENT DATA TO QUANTIFY THE TOXICITY. POISONING MAY AFFECT THE CENTRAL NERVOUS SYSTEM, GASTROINTESTINAL SYSTEM, BLOOD AND KIDNEYS. STIMULATION OF ALL MUSCLE TYPES MAY OCCUR, ESPECIALLY CARDIAC. CHRONIC INHALATION MAY RESULT IN A BENIGN RESPIRATORY AFFECTION KNOWN AS BARITOSIS, WHICH, AS A RULE, CAUSES NO SPECIFIC SYMPTOMS AND NO RESPIRATORY INCAPACITY. IT MAY PRODUCE SMALL CIRCUMSCRIBED NODULES THROUGHOUT THE LUNG FIELD. NODULATION DISAPPEARS WITH CESSATION OF EXPOSURE BUT THERE OFTEN REMAIN SOME SIGNS CHARACTERISTIC OF CHRONIC BRONCHICAL IRRITATION.
THE THRESHOLD LIMIT VALUE WAS SET AT 0.5 MG/M3.
PERSONS WITH A HISTORY OF CHRONIC RESPIRATORY, CARDIOVASCULAR OR SKIN DISEASE MAY BE AT AN INCREASED RISK FROM EXPOSURE.

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
1100 MG/M3 OSHA/NIOSH
SILVERY-WHITE, SOFT METAL, TUR.
IC
INCOMPATIBILITIES:

FLAMMABLE IN AIR. REACTS WITH WATER, RELEASING TOXIC AND/OR DANGEROUS GAS(ES). AMMONIA. OXYGEN. HALOGENS (BROMINE, CHLORINE, IODINE, FLUORINE). ACIDS. METAL IN POWDERED FORM IS EXPLOSIVE. CARBON TETRACHLORIDE. REACTS VIGOROUSLY WITH WATER. TRICHLOROTRIFLUOROETHANE. TRICHLOROFLUOROMETHANE. TETRACHLOROETHYLENE. 1,1,2-TRICHLOROETHYLENE. BROMINE PENTAFLUORIDE. IODINE HEPTAFLUORIDE.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROLONGED SKIN CONTACT WITH SOLUBLE BARIUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE BARIUM COMPOUNDS. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUSTAND SPLASHPROOF SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE SOLUBLE BARIUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE BARIUM COMPOUNDS MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES WET WITH THIS SUBSTANCE PROPMTLY WASH OR SHOWER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE SOLUBLE BARIUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE BARIUM COMPOUNDS WASH THEIR HANDS THOROUGHLY BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NOT REQUIRED.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES WET WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE SOLUBLE BARIUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE BARIUM COMPOUNDS ARE HANDLED, PROCESSED, OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
5 MG/M3
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS AND QUARTERMASK RESPIRATORS
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

12.5 MG/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A DUST AND MIST FILTER

25 MG/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND HIGH-EFFICIENCY PARTICULATE FILTER
- SUPPLIED-AIR RESPIRATOR WITH A TIGHT-FITTING FACEPIECE OPERATED IN A CONTINUOUS FLOW MODE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE

250 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS
MEDICAL SURVEILLANCE:
NO INFORMATION AVAILABLE FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS'; ADVISE: EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
CARDIOVASCULAR DISEASE.
CHRONIC RESPIRATORY DISEASE.
CENTRAL NERVOUS SYSTEM EXAMINATION.
SPECIAL ATTENTION TO SKIN.
14 BY 17 CHEST P.A. X-RAY.
PULMONARY FUNCTIONS.
RESPIRATORY HISTORY.
ELECTROCARDIOGRAM.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE
ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO
TARGET ORGANS:
HEART. LUNGS. CENTRAL NERVOUS SYSTEM. SKIN. RESPIRATORY SYSTEM. EYES.

SP
SYMPTOMS:

IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). COUGHING, FORCEFUL EXPIRATION (SC0173). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). TREMORS, TREMBLING, SHAKING (SC0197). DERMATITIS, INFLAMMATION OF SKIN (SC0044). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031). WEAKNESS, LACK OF STRENGTH (SC0167). ANXIETY, A TROUBLED FEELING (SC0009). ABDOMINAL CRAMPS, PAINFUL SPASMS OF ABDOMINAL AREA (SC0218). GASTROENTERITIS, STOMACH AND INTESTINAL INFLAMMATION (SC0551). GIDDINESS, FRIVOLOUS, DIZZINESS (SC0071). TINNITUS, RINGING IN EARS (SC0308). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). CONFUSION, IN A BEWILDERED STATE (SC0030). SOMNOLENCE, PROLONGED SLEEPINESS (SC0152). SLOW PULSE, DECREASED HEARTBEAT (SC0437). HYPOKALEMIA, DEPLETION OF BLOOD POTASSIUM (SC0472). ARRHYTHMIA, ABSENCE OF RHYTHM; IRREGULARITY (SC0010).
MUSCLE, TISSUE RESPONSIBLE FOR MOTION (SC0623);
STIMULATION, TO EXCITE (SC0279). PARALYSIS, LOSS OF POWER OF VOLUNTARY MOVEMENT (SC0124). HEMOLYSIS, BLOOD DISSOLUTION, DESTRUCTION (SC0195). HEMORRHAGE, BLEEDING (SC0080). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220).
CARDIAC, PERTAINING TO HEART (SC0023);
FAILURE, LOSS OF FUNCTION (SC0386).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
FAILURE, LOSS OF FUNCTION (SC0386).

FA

FIRST AID.

(1 OF 4)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 4)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 4)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 4)
SOLUBLE BARIUM COMPOUNDS INGESTION: INDUCE VOMITING IMMEDIATELY WHEN SOLUBLE BARIUM COMPOUNDS ARE INGESTED. TREAT SYMPTOMATICALLY AND SUPPORTIVELY (PARMEGGIANI, ENCYCLOPEDIA OF OCCUPATIONAL HEALTH AND SAFETY, 3RD ED). GET MEDICAL ATTENTION IMMEDIATELY. ANTIDOTE: GIVE 30 GRAMS OF SODIUM SULFATE IN 250 ML OF WATER ORALLY AND REPEAT IN ONE HOUR. GIVE BY GASTRIC TUBE IF SYMPTOMS HAVE APPEARED. THE ADMINISTRATION OF SULFATE SALTS INTRAVENOUSLY IS HAZARDOUS, SINCE THEY INDUCE THE PRECIPITATION OF BARIUM SULFATE IN THE KIDNEY, WITH SUBSEQUENT RENAL FAILURE. IF SYMPTOMS ARE SEVERE AND OTHERWISE UNCONTROLLABLE, GIVE 10 ML OF 10% SODIUM SULFATE SLOWLY INTRAVENOUSLY WHILE MAINTAINING MAXIMUM DIURESIS (DREISBACH, HANDBOOK OF POISONING, 11TH ED.). ANTIDOTE SHOULD BE ADMINISTED BY QUALIFIED MEDICAL PERSONNEL.

DT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
ELECTROCARDIOGRAM.
COMPLETE BLOOD COUNT.

AN ACCESSION NUMBER: [illegible]

CN CHEMICAL NAME: CADMIUM.

SY SYNONYMS: C.I. 77180. CADMIUM DUST. CADMIUM ELEMENT.

RN CAS NUMBER: 7440-43-9.

REG. TOXIC NUMBER: EU9800000.

CHEMICAL FORMULA: CD.

PD

PHYSICAL DESCRIPTION:

SOFT, DUCTILE, MALLEABLE SILVER-WHITE, LUSTROUS METAL OR POWDER.

| | |
|---|---|
| MOL WT: | 112.41 |
| BOILING PT: | 1409 F (765 C) |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | NOT AVAILABLE |
| VAPOR PRES: | 1 MMHG @ 349 C |
| MELT PT: | 610 F (321 C) |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | NOT AVAILABLE |
| MEC IN AIR: | 482 F (LAYER) |
| SPEC GRAVITY: | 8.642 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL

PERMISSABLE EXPOSURE:
* OSHA EXPOSURE LIMIT REMOVED AS PER OSHA INSTRUCTION PUB 8-1.4
(NOTICE OF INTENDED CHANGES 1990-91)
ACGIH A2 - SUSPECTED HUMAN CARCINOGEN
LOWEST FEASIBLE LIMIT NIOSH RECOMMENDED EXPOSURE CRITERIA
HUMAN LIMITED EVIDENCE FOR CARCINOGENICITY (IARC GROUP-2A CADMIUM)
ANIMAL SUFFICIENT EVIDENCE FOR CARCINOGENICITY (IARC GROUP-2A CADMIUM)
ANTICIPATED HUMAN CARCINOGEN (NTP)
PROBABLE HUMAN CARCINOGEN (EPA-CATEGORY B)
MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS)
REPRODUCTIVE EFFECTS DATA (RTECS)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 0
PERSISTENCE 3
TOXICOLOGY: CADMIUM IS A MUCOUS MEMBRANE IRRITANT AND MAY BE A SKIN AND EYE IRRITANT. IT IS HIGHLY TOXIC BY INHALATION AND TOXIC BY INGESTION. CADMIUM IS ALSO A NEPHROTOXIN. POISONING MAY AFFECT THE LIVER, BONE, BLOOD, LUNGS AND NERVOUS SYSTEM. EARLY SYMPTOMS OF RHINITIS AND VERTIGO MAY BE FOLLOWED BY A LATENT PERIOD OF 1 TO 10 HOURS WHICH MAY PROCEED THE ONSET OF SUBSTERNAL OR PRECORDIAL CHEST PAIN, A FLU-LIKE SYNDROME AND MUSCULAR PAIN IN THE BACK AND LIMBS. CADMIUM IS HIGHLY CUMULATIVE. REPEATED OR PROLONGED EXPOSURE MAY CAUSE IRREVERSIBLE LUNG INJURY, YELLOW DISCOLORATION OF THE TEETH AND SEVERE KIDNEY EFFECTS. CADMIUM HAS PRODUCED LOCAL SARCOMAS IN RATS FOLLOWING INTRAMUSCULAR ADMINISTRATION. OCCUPATIONAL EXPOSURE TO CADMIUM IS IMPLICATED IN A SIGNIFICANT INCREASE IN THE INCIDENCE OF PROSTATIC AND RESPIRATORY CANCERS.
THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT PROTEINURIA, PULMONARY EDEMA AND EMPHYSEMA.
DEFICIENCIES IN IRON, CALCIUM, ZINC, PROTEIN AND VITAMINS C AND D MAY ENHANCE THE TOXIC EFFECTS. ALTERATIONS OF DRUG METABOLIZING ACTIVITY HAVE BEEN INDICATED IN ANIMALS.
IHL-HMN LCLO: 39 MG/M3/20M IHL-MAN TCLO: 88 UG/M3/8.6Y
IHL-RAT LC50: 25 MG/M3/30M ORL-RAT LD50: 225 MG/KG
ORL-MUS LD50: 890 MG/KG SCU-RAT LD50: 9 MG/KG
IPR-RAT LD50: 4 MG/KG IVN-RAT LD50: 1800 UG/KG
IHL-MUS LCLO: 170 MG/M3 ORL-RBT LCLO: 70 MG/KG

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
50 MG/M3 POTENTIAL
RCINOGENNIOSH
SOFT, DUCTILE, MALLEABLE SILVE.

IC

INCOMPATIBILITIES:
CADMIUM: AMMONIUM NITRATE (FUSED): VIOLENT OR EXPLOSIVE REACTION HYDRAZOIC ACID: MAY EXPLODE VIOLENTLY NITRYL FLUORIDE: INCANDESCENT REACTION WHEN HEATED SLIGHTLY OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD SELENIUM: EXOTHERMIC REACTION SULFUR: FIRE AND EXPLOSION HAZARD TELLURIUM: INCANDESCENT REACTION IN HYDROGEN ATMOSPHERE ZINC: INTENSE EXOTHERMIC REACTION.

CL

CLOTHING:
NO SPECIFIC REQUIREMENT. USE APPROPRIATE PROTECTIVE CLOTHING AS INDICATED BY THE NATURE OF THE CONTAMINANT AND PROBABILITY OF EXPOSURE.

WEAR EYE PROTECTION TO PREVENT:
NO SPECIFIC REQUIREMENT. USE APPROPRIATE SAFETY GOGGLES, AS INDICATED BY THE NATURE OF THE CONTAMINANT AND THE LIKELIHOOD OF EXPOSURE.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK Y.
MPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING OR SMOKING.

WORK CLOTHING SHOULD BE CHANGED DAILY:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, REMOVE CLOTHING AND DO NOT WEAR AGAIN UNTIL SUBSTANCE HAS BEEN REMOVED FROM CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1 MG/M3
- DUST MASK
EXCEPT SINGLE-USE RESPIRATORS

2 MG/M3
- DUST MASK
EXCEPT SINGLE-USE RESPIRATORS

AND QUARTER-MASK RESPIRATORS
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

10 MG/M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE

40 MG/M3
- POWERED AIR-PURIFYING RESPIRATOR
WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE

ESCAPE
- DUST MASK
EXCEPT SINGLE-USE RESPIRATORS
- SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
OSHA: URINALYSIS.
14 BY 17 CHEST P.A. X-RAY.
LIVER FUNCTION.
FORCED VITAL CAPACITY.
FORCED EXPIRATORY VOLUME (1 SECOND).
NOTICE OF INTENT TO ESTABLISH ACGIH BIOLOGICAL EXPOSURE INDICIES FOR CADMIUM: 5 UG/G CREATININE CADMIUM IN URINE / TIMING-NOT CRITICAL 5 UG/L CADMIUM IN BLOOD / TIMING-NOT CRITICAL.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS.

RE

ROUTE OF ENTRY:

INHALATION. INGESTION. SKIN OR EYE CONTACT.
TO
RGET ORGANS:
ES. SKIN. RESPIRATORY SYSTEM. CENTRAL NERVOUS SYSTEM.
CARDIOVASCULAR SYSTEM. KIDNEYS. LIVER. SKELETAL. PROSTATE. BLOOD.
SP
SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). RHINITIS, INFLAMMATION OF NASAL MUCOSA (SC0236). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). METALLIC TASTE, TASTE RESEMBLING METAL IN MOUTH (SC0216). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038).
CHEST, THE THORAX (SC0754);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). WEAKNESS, LACK OF STRENGTH (SC0167). MALAISE, UNEASINESS, DISCOMFORT, FEELING BAD (SC0106). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). FEVER, BODY TEMPERATURE ABOVE NORMAL (SC0067). CHILLS, A SHIVERING OR SHAKING (SC0736). SWEATING, EXCRETING MOISTURE THROUGH THE SKIN (SC0156). COUGHING, FORCEFUL EXPIRATION (SC0173). FROTHY SPUTUM, FOAMY MIXTURE OF SALIVA AND MUCOUS (SC0627). DERMATITIS, INFLAMMATION OF SKIN (SC0044). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031). PULMONARY RALES, ABNORMAL RESPIRATORY SOUNDS (SC0206).
ULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
DEMA, FLUID RETENTION WITH SWELLING (SC0181). PNEUMONITIS, LOCALIZED INFLAMMATION OF LUNG (SC0137). PULMONARY FIBROSIS, FIBROUS TISSUE INVOLVING LUNGS (SC0244). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). TESTICULAR ATROPHY, WASTING, REDUCTION OF MALE GONADS (SC0268).
NASAL, PERTAINING TO THE NOSE (SC0114);
SEPTUM, WALL DIVIDING 2 CAVITIES OF NOSE (SC0202).
NEUROSARCOMA, SARCOMA WITH NERVE CELL COMPONENTS (SC0373).
KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
STONES, HARDENED MINERAL MATTER (SC0603).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
FAILURE, LOSS OF FUNCTION (SC0386). OSTEOPOROSIS, DEMINERALIZATION OF BONE (SC0763). LIVER DAMAGE, INJURY TO THE LIVER (SC0221). TENESMUS, INVOLUNTARY DEFECATION/URINATION (SC0261). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). BLURRED VISION, (SC0015). SHOCK, SUDDEN PHYSICAL OR MENTAL DISTURBANCE(SC0228).
CARDIOPULMONARY, PERTAINING TO THE HEART AND LUNGS (SC0764);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043).
CARDIOVASCULAR, PERTAINING TO HEART & BLOOD VESSELS (SC0037);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
ROSTATE, SEMEN PRODUCING GLAND OF MALE (SC0203);
ANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FIRST AID.

(1 OF 6)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 6)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 6)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 6)
INGESTED CADMIUM AND COMPOUNDS: GIVE MILK OR BEATEN EGGS EVERY 4 HOURS TO REVIEVE GASTROINTESTINAL IRRITATION. REMOVE UNABSORBED CADMIUM BY CATHARSIS WITH FLEET'S PHOSPHO-SODA, 30-60 ML DILUTED 1:4 IN WATER. GET MEDICAL ATTENTION IMMEDIATELY. ANTIDOTE: DO NOT GIVE DIMERCAPROL (BAL). IF SYMPTOMS PERSIST, THE ADMINISTRATION OF CALCIUM DISODIUM EDETATE IS RECOMMENDED. GIVE 15-25 MG/KG (0.08-0.125 ML OF 20% SOLUTION PER KILOGRAM OF BODY WEIGHT) IN 250-500 ML OF 5% DEXTROSE INTRAVENOUSLY OVER A 1 TO 2 HOUR PERIOD, TWICE DAILY. THE MAXIMUM DOSE SHOULD NOT EXCEED 50 MG/KG/DAY. THE DRUG SHOULD BE GIVEN IN 5-DAY COURSES WITH A REST PERIOD OF AT LEAST 2 DAYS BETWEEN COURSES. AFTER THE FIRST COURSE, SUBSEQUENT COURSES SHOULD NOT EXCEED 50 MG/KG/DAY. DAILY URINALYSIS SHOULD BE DONE DURING THE TREATMENT PERIOD. THE DOSAGE SHUOLD BE REDUCED IF ANY UNUSUAL URINARY FINDINGS APPEAR. FOR INTRAMUSCULAR ADMINISTRATION, GIVE 20% SOLUTION (200 MG/ML), 12.5 MG/KG BODY WEIGHT EVERY 4-6 HOURS. DILUTE EACH DOSE WITH AN EQUAL VOLUME OF 1% PROCAINE. DOSE LIMITATION IS THE SAME AS THAT GIVEN ABOVE. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). PROCEDURES MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL.

(5 OF 6)
ACUTE RENAL FAILURE - TREAT SHOCK. FOR HEMOLYTIC REACTIONS, GIVE SODIUM BICARBONATE, 5 G EVERY 1-2 HOURS AS NECESSARY TO MAINTAIN AN ALKALINE URINE.GET MEDICAL ATTENTION IMMEDIATELY. (MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL) (DREISBACH, HANDBOOK OF POISONING, 12TH ED.)
.

(6 OF 6)
LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY, DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK

1

AN ACCESSION NUMBER: 675. 9204.
CN CHEMICAL NAME: CHROMIUM.
SY SYNONYMS: CHROME. CHROMIUM ELEMENT. CHROMIUM METAL. METALLIC
ROMIUM.
RN CAS NUMBER: 7440-47-3.

REG. TOXIC NUMBER: GB4200000.

CHEMICAL FORMULA: CR.

PD
PHYSICAL DESCRIPTION:
ODORLESS, STEEL-GRAY, LUSTROUS METAL OR POWDER.

| | |
|---|---|
| MOL WT: | 51.996 |
| BOILING PT: | 4842 F (2672 C) |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | FLAMMABLE DUST |
| VAPOR PRES: | 1 MMHG @ 1616 C |
| MELT PT: | 3339-3411 F |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | 0.230 OZ/FT3 |
| MEC IN AIR: | 752 F (LAYER) |
| SPEC GRAVITY: | 7.20 @ 28 C |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
1 MG/M3 OSHA TWA
.5 MG/M3 ACGIH TWA
0.5 MG(CR)/M3 NIOSH RECOMMENDED 8 HR TWA
HUMAN INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-3)
ANIMAL INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-3)
TUMORIGENIC DATA (RTECS)
AQUATIC TOXICITY RATING 1 (TLM96 100 - 1000 MG/L)
BLUEGILL - 113 MG/L
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 0 -
PERSISTENCE 3
TOXICOLOGY: CHROMIUM MAY BE IRRITATING TO THE EYES, SKIN AND MUCOUS
MEMBRANES IN THE DUST FORM. THERE IS INSUFFICIENT DATA TO QUANTIFY
THE TOXICITY. POISONING BY CHROMIUM COMPOUNDS MAY AFFECT THE LIVER
AND KIDNEYS. REPEATED EXPOSURE TO CHROMIUM COMPOUNDS HAS BEEN
REPORTED TO RESULT IN ULCERATION AND PERFORATION OF THE NASAL SEPTUM,
GASTROINTESTINAL DISTURBANCES AND BLOOD CHANGES. PROLONGED CONTACT
WITH THE SKIN HAS BEEN REPORTED TO CAUSE VARIOUS TYPES OF DERMATITIS,
INCLUDING ECZEMA, 'CHROME HOLES', AND SENSITIZATION.
THE THRESHOLD LIMIT VALUE WAS ESTABLISHED TO PREVENT PULMONARY
DISEASE OR OTHER TOXIC EFFECTS.
CHROMIUM MAY CROSS THE PLACENTA AND BE EXCRETED IN BREAST MILK.

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL
MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY
PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR
EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD
COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY
DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO
TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NOT REQUIRED
ODORLESS, STEEL-GRAY, LUSTROUS.

TC

AMMONIUM NITRATE (FUSED): VIOLENT OR EXPLOSIVE REACTION. BROMINE PENTAFLUORIDE: VIOLENT REACTION AND POSSIBLE IGNITION. HYDROGEN PEROXIDE: VIOLENT DECOMPOSITION REACTION. LITHIUM (MOLTEN): VIGOROUS REACTION AT ELEVATED TEMPERATURES. NITROGEN OXIDE: INCANDESCENT REACTION. OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD. POTASSIUM CHLORATE (FUSED): VIGOROUS INCANDESCENT REACTION. SULFUR DIOXIDE: INCANDESCENT REACTION. THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC CHROMIC OXIDE. FINELY DIVIDED MATERIAL MAY IGNITE ON EXPOSURE TO AIR.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS SOLID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
2.5 MG(CR)/M3
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS

5 MG(CR)/M3
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS AND QUARTERMASK RESPIRATORS
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

12.5 MG(CR)/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A DUST AND MIST FILTER
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

25 MG(CR)/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER

- POWERED AIR-PURIFYING RESPIRATOR
PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE

0 MG(CR)/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN
PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY
PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN
PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY
SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS
MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH
PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA
ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO
EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC
SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS
AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP
RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30
YEARS.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR
CHEMICAL HAZARDS".
GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
RESPIRATORY HISTORY.
14 BY 17 CHEST P.A. X-RAY.
FORCED VITAL CAPACITY.
FORCED EXPIRATORY VOLUME (1 SECOND).

RE
ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO
TARGET ORGANS:
SKIN. RESPIRATORY SYSTEM. GASTROINTESTINAL. KIDNEYS. LIVER.

SP
SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
NASAL, PERTAINING TO THE NOSE (SC0114);
SEPTUM, WALL DIVIDING 2 CAVITIES OF NOSE (SC0202).
PERFORATION, OPENING IN HOLLOW ORGAN OR VISCUS (SC0127).
GASTROINTESTINAL, PERTAINING TO STOMACH & INTESTINE (SC0070).
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). BLOOD CHANGES,
CHANGES IN BLOOD CELLS OR MORPHOLOGY (SC0227).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
SENSITIZATION, ALLERGIC REACTION (SC0148). DERMATITIS, INFLAMMATION OF
SKIN (SC0044). ECZEMA, CHRONIC DERMATITIS (SC0053).

OF EYES (SC0031). LACRIMATION, DISCHARGE OF TEARS (SC0096). DIZZINESS
FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048).
EXCESSIVE, SUPERFLUOUS (SC0737);
THIRST, DESIRE FOR WATER (SC0210).
ABDOMINAL, SECTION BETWEEN THORAX AND PELVIS (SC0750);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). VOMITING,
PERTAINING TO NAUSEA (SC0166). SHOCK, SUDDEN PHYSICAL OR MENTAL
DISTURBANCE(SC0228). OLIGURIA, DECREASED URINATION (SC0323). ANURIA,
COMPLETE LACK OF URINATION (SC0304). UREMIA, NITROGEN IN BLOOD FROM
RENAL FAILURE (SC0310).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
LIVER, BILE-SECRETING GLANDULAR ORGAN (SC0620);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
IF THIS CHEMICAL IS INGESTED, TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION.

(5 OF 5)
CHROMIUM INGESTION: USE OF DIMERCAPTOL HAS BEEN SUGGESTED ON THE BASIS OF FINDINGS IN ANIMALS. GIVE 3 MG/KG (OR 0.3 ML/10 KG) EVERY 4 HOURS, INTRAMUSCULARLY FOR THE FIRST 2 DAYS AND THE 2 MG/KG EVERY 12 HOURS FOR A TOTAL OF 10 DAYS (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

IT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
URINE CHROMIUM LEVEL.
BLOOD CHEMISTRY.
LIVER PROFILE BLOOD TESTS.
(1 OF 42)
**********
NTER DOCUMENT SELECTION._: ..OFF

CONNECT TIME 0:02:32 HH:MM:SS 0.042 DEC HRS SESSION 155
SIGN OFF 14:40:53 05/20/92708 154B DISCONNECTED 00 40 00:00:02:5 34

MERCURY, INORGANIC. QUICKSILVER. NA 2809. COLLOIDOL MERCURY. NCI-C60399. QUICK SILVER. HYDRARGYRUM. RCRA U151. UN 2809. ELEMENTAL MERCURY.

CAS NUMBER: 7439-97-6.

REG. TOXIC NUMBER: OV4550000.

CHEMICAL FORMULA: HG.

PD

PHYSICAL DESCRIPTION:
ODORLESS, SILVERY LIQUID WITH A METALLIC LUSTER.

| | |
|---|---|
| MOL WT: | 200.59 |
| BOILING PT: | 674 F (357 C) |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | NONCOMBUSTIBLE SOLID |
| VAPOR PRES: | 0.002 MMHG @ 25 C |
| MELT PT: | -38 F (-39 C) |
| UEL IN AIR: | |
| LEL IN AIR: | NOT APPLICABLE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 13.5939 |
| VAPOR DENSITY: | 7.0 |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL

PERMISSABLE EXPOSURE:
0.05 MG(HG)/M3 OSHA TWA (VAPOR); 0.1 MG(HG)/M3 OSHA CEILING (SKIN)
0.05 MG(HG)/M3 ACGIH TWA (VAPOR); 0.1 MG(HG)/M3 ACGIH TWA (SKIN)
0.05 MG(HG)/M3 NIOSH RECOMMENDED 10 HR TWA (SKIN)
TUMORIGENIC DATA (RTECS)
REPRODUCTIVE EFFECTS DATA (RTECS)
MUTAGENIC DATA (RTECS)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 - PERSISTENCE 3
TOXICOLOGY: MERCURY IS A MUCOUS MEMBRANE IRRITANT AND A SKIN AND PULMONARY SENSITIZER. THERE IS INSUFFICIENT DATA TO FULLY QUANTIFY THE TOXICITY. IT IS A NEUROTOXIN AND NEPHROTOXIN. POISONING MAY ALSO AFFECT THE RESPIRATORY AND GASTROINTESTINAL SYSTEMS. METAL FUME FEVER, AN INFLUENZA-LIKE ILLNESS, MAY OCCUR DUE TO THE INHALATION OF FRESHLY FORMED METAL OXIDE PARTICLES SIZED USUALLY BETWEEN 0.02-0.05 MICRONS. SYMPTOMS MAY BE DELAYED 4-12 HOURS AND BEGIN WITH A SUDDEN ONSET. REPEATED EXPOSURE MAY CAUSE MERCURIALISM, WHICH IS CHARACTERIZED BY FINE TREMORS AND ERETHISM. TREMORS MAY AFFECT THE HANDS FIRST, BUT THEN BECOME EVIDENT IN THE FACE, ARMS AND LEGS. ERETHISM MAY BE MANIFESTED BY ABNORMAL SHYNESS, BLUSHING, RESENTMENT OF CRITICISM AND IRRITABILITY OR EXCITABILITY.
THE THRESHOLD LIMIT VALUE WAS ESTABLISHED BASED ON THE ABILITY OF MERCURY ABSORBED IN THE BRAIN TO REMAIN.
PERSONS WITH NERVOUS SYSTEM DISORDERS, CHRONIC RESPIRATORY DISEASE AND KIDNEYS DISEASE MAY BE AT AN INCREASED RISK FROM EXPOSURE.
IHL-WMN TCLO: 1500 UG/M3/46 D IHL-MAN TCLO: 44,300 UG/M3/8 HR
SKN-MAN TDLO: 129 MG/KG/5 HR C IHL-RBT LCLO: 29 MG/M3/30 HR

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD

COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
28 MG/M3 OSHA/NIOSH
ODORLESS, SILVERY LIQUID WITH.

IC

INCOMPATIBILITIES:
SEND BACK AREA EXCEDED. ACETYLENE: FORMATION OF EXPLOSIVE COMPOUND. ACETYLINIC COMPOUNDS: FORMATION OF EXPLOSIVE COMPOUND. ALUMINUM: CORRODES. AMINES: MAY FORM EXPLOSIVE COMPOUNDS. AMMONIA + MOISTURE: FORMS EXPLOSIVE COMPOUND. BORON DIIODOPHOSPHIDE: IGNITES ON CONTACT WITH MERCURY VAPORS. BROMINE: VIOLENT REACTION. 3-BROMOPROPYNE: EXPLOSION HAZARD. CALCIUM: AMALGAM FORMATION @ 390 C IS VIOLENT. CHLORINE: IGNITES @ 200-300 C. CHLORINE DIOXIDE: EXPLODES. COPPER (AND ALLOYS): MAY BE ATTACKED. ETHYLENE OXIDE + TRACES OF ACETYLENE: MAY FORM EXPLOSIVE ACETYLIDES. LITHIUM: AMALGAM FORMATION IS VIOLENTLY EXOTHERMIC AND MAY BE EXPLOSIVE. METHYL AZIDE: PRODUCES SHOCK SENSITIVE MIXTURE. METHYLSILANE + OXYGEN: PRODUCES SHOCK SENSITIVE MIXTURE. NITRIC ACID + ALCOHOLS: FORMS FULMINATES CAPABLE OF DETONATION. OXALIC ACID: FORMS SHOCK SENSITIVE COMPOUND. OXIDANTS: VIOLENT REACTION. PEROXYFORMIC ACID: EXPLOSIVE REACTION. POTASSIUM: AMALGAM FORMATION IS VIGOROUSLY EXOTHERMIC AND MAY BE EXPLOSIVE.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
NO SPECIFIC REQUIREMENT. USE APPROPRIATE SAFETY GOGGLES, AS INDICATED BY THE NATURE OF THE CONTAMINANT AND THE LIKELIHOOD OF EXPOSURE.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:

FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
0.5 MG/M3
- CHEMICAL CARTRIDGE RESPIRATOR PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

1.25 MG/M3
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE
- POWERED AIR-PURIFYING RESPIRATOR WITH CARTRIDGE PROVIDING PROTECTION AGAINST THE COMPOUND OF CONCERN

2.5 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR WITH A TIGHT-FITTING FACEPIECE OPERATED IN A CONTINUOUS FLOW MODE
- CHEMICAL CARTRIDGE RESPIRATOR PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN WITH A FULL FACE-PIECE
- GAS MASK WITH A CANISTER PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND CARTRIDGE PROVIDING PROTECTION AGAINST COMPOUND OF CONCERN

28 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH HALF-MASK OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- GAS MASK WITH A CANISTER PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY

SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.
MS
MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS".
GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
HISTORY OF ASTHMA OR ALLERGIES.
RESPIRATORY HISTORY.
PULMONARY FUNCTIONS.
CENTRAL NERVOUS SYSTEM TESTS, PERIPHERAL NEUROPATHY.
KIDNEY FUNCTION.
URINALYSIS.
NOTICE OF INTENT TO ESTABLISH: ACGIH BIOLOGICAL EXPOSURE INDICIES FOR MERCURY: 35 UG/G CREATININE TOTAL INORGANIC MERCURY IN URINE / TIMING -PRE-SHIFT 15 UG/L TOTAL INORGANIC MERCURY IN BLOOD / TIMING -END OF SHIFT AT END OF WORKWEEK.
RE
ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.
TO
TARGET ORGANS:
SKIN. RESPIRATORY SYSTEM. CENTRAL NERVOUS SYSTEM. KIDNEYS. EYES.
SP
SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). COUGHING, FORCEFUL EXPIRATION (SC0173). FEVER, BODY TEMPERATURE ABOVE NORMAL (SC0067). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). STOMATITIS, INFLAMMATION OF THE MOUTH (SC0395). SALIVATION, EXCESS DISCHARGE OF SALIVA (SC0146). METALLIC TASTE, TASTE RESEMBLING METAL IN MOUTH (SC0216).
SKIN, COVERING OF BODY (SC0174);
SENSITIZATION, ALLERGIC REACTION (SC0148). DERMATITIS, INFLAMMATION OF SKIN (SC0044).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
SENSITIZATION, ALLERGIC REACTION (SC0148). BRONCHITIS, INFLAMED BRONCHIAL MUCOUS MEMBRANES (SC0017). PNEUMONITIS, LOCALIZED INFLAMMATION OF LUNG (SC0137). ENCEPHALITIS, INFLAMMATION OF THE BRAIN (SC0307). TREMORS, TREMBLING, SHAKING (SC0197). ERETHISM, EXCESSIVE SENSIBILITY TO STIMULATION (SC0729). MENTAL DEPRESSION, ABSENCE OF CHEERFULNESS (SC0280). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091). EXCITABILITY, SENSITIVITY TO EMOTIONAL STIMULATION (SC0592). FATIGUE,

TIREDNESS, SLUGGISH (SC0066). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). HALLUCINATIONS, PERCEPTIONS OF WHAT DOES NOT EXIST (SC0074). MEMORY DEFECTS, IMPERFECTION IN RECOLLECTION ABILITY (SC0585). MENTAL DISORDER, PSYCHIC DISTURBANCE (SC0608). PROTEINURIA, PROTEIN IN URINE, OFTEN ALBUMIN (SC0140). ALBUMINURIA, ALBUMIN (PROTEIN) IN URINE (SC0002). ANURIA, COMPLETE LACK OF URINATION (SC0304). GINGIVITIS, GUM INFLAMMATION (SC0515). GINGIVAL BLUE LINE, BLUE LINE ON GUMS (SC0575).
EXTREMITIES, ARMS OR LEGS (SC0062);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182).
EXTREMITIES, ARMS OR LEGS (SC0062);
NUMBNESS, COMBINED ANESTHESIA AND PARESTHESIA (SC0120). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104). ANOREXIA, DIMINISHED APPETITE (SC0006). SPEECH DIFFICULTIES, TROUBLES WITH VERBAL EXPRESSION (SC0614). ACIDOSIS ACID IMBALANCE (SC0290).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). INCOORDINATION, LACK OF COORDINATION (SC0085). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220).
NERVE, BUNDLE OF NERVE FIBERS (SC0726);
DAMAGE, PERMANENT INJURY (SC0287).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212). HEMATURIA, RED BLOOD CELLS IN URINE (SC0076). ALBUMINURIA, ALBUMIN (PROTEIN) IN URINE (SC0002). FEVER, BODY TEMPERATURE ABOVE NORMAL (SC0067).
BLINDNESS, INABILITY TO SEE (SC0223);.

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
INGESTED MERCURY: REMOVE BY GASTRIC LAVAGE OR EMESIS. MAINTAIN BLOOD PRESSURE AND AIRWAY. GIVE OXYGEN IF RESPIRATION IS DEPRESSED. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS IF VICTIM IS UNCONSCIOUSS. GET MEDICAL ATTENTION IMMEDIATELY. ADMINISTRATION OF GASTRIC LAVAGE OR OXYGEN SHOULD BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. ANTIDOTE: GIVE DIMERCAPROL, 3 MG/KG (OR 0.3 ML/KG) EVERY 4 HOURS FOR THE FIRST 2 DAYS AND THEN 2 MG/KG EVERY 12 HOURS FOR A TOTAL OF 10 DAYS. DIMERCAPTROL IS AVAILABLE AS A 10% SOLUTION IN OIL FOR INTRAMUSCULAR ADMINISTRATION. HEMODIALYSIS WILL SPEED THE REMOVAL OF THE MERCURY-DIMERCAPROL COMPLEX. PENICILLAMINE IS ALSO EFFECTIVE. GIVE UP TO 100 MG/KG/DAY (MAXIMUM 1 GM/DAY) DIVIDED

..PRINT ALL/DOC=1

1
AN ACCESSION NUMBER: 2773. 9205.
CN CHEMICAL NAME: SELENIUM.
SY SYNONYMS: SELENIUM, METALLIC. SELENIUM, ELEMENTAL. C.I. 77805. UN 658. ELEMENTAL SELENIUM. SELENIUM METAL.
RN CAS NUMBER: 7782-49-2.

REG. TOXIC NUMBER: VS7700000.

CHEMICAL FORMULA: SE.

PD
PHYSICAL DESCRIPTION:
ODORLESS, BLUISH-GRAY, BLACK OR RED SOLID.

| | |
|---|---|
| MOL WT: | 78.96 |
| BOILING PT: | 1261-1265 F |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | NONCOMBUSTIBLE SOLID |
| VAPOR PRES: | 10 MMHG @ 29 C |
| MELT PT: | 423 F (217 C) |
| UEL IN AIR: | N/A |
| LEL IN AIR: | N/A |
| MEC IN AIR: | |
| SPEC GRAVITY: | 4.81 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
0.2 MG/M3 OSHA TWA
0.2 MG/M3 ACGIH TWA
0.2 MG/M3 NIOSH RECOMMENDED 10 HR TWA
HUMAN INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-3)
ANIMAL INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-3)
TUMORIGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 - PERSISTENCE 3
TOXICOLOGY: SELENIUM IS AN EYE, SKIN AND MUCOUS MEMBRANE IRRITANT. IT IS SLIGHTLY TOXIC BY INGESTION. POISONING MAY AFFECT THE LIVER, KIDNEYS AND RESPIRATORY SYSTEM. METAL FUME FEVER, AN INFLUENZA-LIKE ILLNESS MAY OCCUR DUE TO THE INHALATION OF FRESHLY FORMED METAL OXIDES AND RESULT IN SYMPTOMS INCLUDING A SWEET, METALLIC OR FOUL TASTE IN THE MOUTH, EXAGGERATED MENTAL ACTIVITY AND PROSTRATION. REPEATED OR PROLONGED EXPOSURE MAY CAUSE A GARLIC ODOR ON THE BREATH AND SWEAT, PALLOR, COATED TONGUE AND GASTROINTESTINAL DISTURBANCES.
TOLERANCE TO THE FUMES DEVELOPS RAPIDLY, BUT IS QUICKLY LOST AND, THEREFORE, DOES NOT HAVE ADEQUATE WARNING PROPERTIES. THE THRESHOLD LIMIT VALUE WAS ESTABLISHED TO BE LOW ENOUGH TO PREVENT SYSTEMIC TOXICITY AND MINIMIZE IRRITATION OF THE EYES AND RESPIRATORY PASSAGES.
PERSONS WITH A HISTORY OF CHRONIC RESPIRATORY DISEASE, GASTROINTESTINAL DISTURBANCES, ALLERGIES, LIVER OR KIDNEY DISEASE OR RECURRENT DERMATITIS MAY BE AT AN INCREASED RISK FROM EXPOSURE.
ORL-RAT LD50: 6700 MG/KG IHL-RAT LDLO: 33 MG/KG/8 HR
INV-RAT LD50: 6 MG/KG INV-RBT LDLO: 2500 UG/KG

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

NONE SPECIFIED
ODORLESS, BLUISH-GRAY, BLACK O.

IC

INCOMPATIBILITIES:
SEND BACK AREA EXCEDED. ALKALI METAL AMIDES: PRODUCES EXPLOSIVE PRODUCTS ALKALINE EARTH METAL AMIDES: PRODUCES EXPLOSIVE PRODUCTS BARIUM PEROXIDE: IGNITES AT 265 C BROMINE PENTAFLUORIDE: VIOLENT REACTION AND POSSIBLE IGNITION CADMIUM: POSSIBLE EXPLOSION WHEN HEATED CHLORINE TRIFLUORIDE: REACTS VIOLENTLY, IGNITION OFTEN OCCURRING CHROMIC ANHYDRIDE: VIOLENT REACTION FLUORINE: IGNITES ON CONTACT LITHIUM SILICIDE: INCANDESCENT REACTION METAL ACETYLIDES: INCANDESCENT REACTION ON HEATING METAL CARBIDES: INCANDESCENT REACTION ON HEATING METAL CHLORATES (EXCEPT ALKALI): INCANDESCENT REACTION IN THE PRESENCE OF WATER. METALS: CONTACT OF MANY METALS WITH SELENIUM RESULTS IN INCANDESCENCE NITROGEN TRICHLORIDE: EXPLODES ON CONTACT OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD) PHOSPHOROUS: INCANDESCENT REACTION WHEN HEATED POTASSIUM: INCANDESCENCE REACTION WITH POSSIBLE EXPLOSION POTASSIUM BROMATE: VIOLENT, EXPLOSIVE REACTION SILVER BROMATE: VIOLENT EXPLOSIVE REACTION SILVER OXIDE: IGNITION ON GRINDING SODIUM PEROXIDE: FORMS EXPLOSIVE MIXTURE TIN (POWDERED): EXTREMELY EXOTHERMIC, INCANDESCENT REACTION.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).

WEAR EYE PROTECTION TO PREVENT:
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS SOLID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE IMMEDIATELY WASH OR SHOWER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
2 MG/M3
- DUST AND MIST RESPIRATOR WITH A FULL FACEPIECE
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

5 MG(SE)/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A DUST AND MIST FILTER
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

10 MG/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY ARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE

100 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
3FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS'.
GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
EYE DISEASE.
RESPIRATORY HISTORY.
LIVER FUNCTION.
KIDNEY FUNCTION.
BLOOD CHEMISTRY.
SKIN EXAM.
URINALYSIS.
HISTORY OF ASTHMA OR ALLERGIES.

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
RESPIRATORY SYSTEM. EYES. SKIN. KIDNEYS. LIVER. BLOOD. GASTROINTESTINAL.

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);

EXPIRATION OF AIR (SC0151). COUGHING, FORCEFUL EXPIRATION (SC0173).
HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). ANOSMIA, LACKING SENSE OF SMELL (SC0007). EPISTAXIS NOSEBLEED (SC0057). PNEUMONITIS, LOCALIZED INFLAMMATION OF LUNG (SC0137). THIRST, DESIRE FOR WATER (SC0210). METALLIC TASTE, TASTE RESEMBLING METAL IN MOUTH (SC0216). LASSITUDE, A SENSE OF WEARINESS (SC0098). MALAISE, UNEASINESS, DISCOMFORT, FEELING BAD (SC0106). FEVE BODY TEMPERATURE ABOVE NORMAL (SC0067). CHILLS, A SHIVERING OR SHAKING (SC0736).
MUSCULAR, ORGAN RESPONSIBLE FOR MOTION (SC0110);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). SWEATING EXCRETING MOISTURE THROUGH THE SKIN (SC0156).
EXCESSIVE, SUPERFLUOUS (SC0737);
URINATION, DISCHARGE OF URINE FROM BODY (SC0617). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). PROSTRATION, MARKED LOSS OF STRENGTH, EXHAUSTION (SC0139). HALITOSIS, OFFENSIVE BREATH (SC0333). PALLOR, PALENESS, AS OF THE SKIN (SC0122). NERVOUSNESS, STATE OF UNREST, UNEASINESS (SC0118).
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043).
GASTROINTESTINAL, PERTAINING TO STOMACH & INTESTINE (SC0070);
DISTURBANCE, INTERRUPTION OF A NORMAL STATE (SC0047). FATIGUE, TIREDNESS, SLUGGISH (SC0066). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). LIVER DAMAGE, INJURY TO THE LIVER (SC0221).
CARDIAC, PERTAINING TO HEART (SC0023);
DAMAGE, PERMANENT INJURY (SC0287).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
SELENIUM DERIVATIVES: REMOVE INGESTED POISON BY GASTRIC LAVAGE OR EMESIS. FOLLOW WITH A SALINE CATHARTIC. MAINTAIN BLOOD PRESSURE, AIRWAY, AND GIVE OXYGEN IF VICTIM IS UNCONSCIOUS. GET MEDICAL ATTENTION IMMEDIATELY. (GOSSELIN, CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, 5TH EDITION). ADMINISTRATION OF GASTRIC LAVAGE OR OXYGEN SHOULD BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL.

(5 OF 5)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH,

TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

DT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
URINE SELENIUM AS EXPOSURE INDEX.
DIFFERENTIAL WHITE BLOOD CELL COUNT.

RS

REGULATORY STATUS.

(1 OF 42)
**********
FEDERAL REGULATIONS
**********.

P096 THE REQUEST YOU MADE WAS AGAINST A ZERO RESULT LIST. PLEASE TRY AGAIN._:

P096 THE REQUEST YOU MADE WAS AGAINST A ZERO RESULT LIST. PLEASE TRY AGAIN._:

1
AN ACCESSION NUMBER: 2799. 9205.
CN CHEMICAL NAME: SILVER.
SY SYNONYMS: ARGENTUM. C.I. 77820. L-3. SHELL SILVER. SILVER ATOM.
SILVER, METAL. SILFLAKE 135. V 9. SILVER METAL. SR 999.
RN CAS NUMBER: 7440-22-4.

REG. TOXIC NUMBER: VW3500000.

CHEMICAL FORMULA: AG.
PD
PHYSICAL DESCRIPTION:
SOFT, DUCTILE, LUSTROUS WHITE SOLID.

| | |
|---|---|
| MOL WT: | 107.9 |
| BOILING PT: | 4014 F |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | INCOMBUSTABLE |
| VAPOR PRES: | NEGLIGIBLE |
| MELT PT: | 1763 F |
| UEL IN AIR: | INCOMBUSTABLE |
| LEL IN AIR: | INCOMBUSTABLE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 10.5 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
0.01 MG/M3 OSHA TWA
0.1 MG/M3 ACGIH TWA (DUST, FUME)
0.01 MG/M3 NIOSH RECOMMENDED 10 HR TWA
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 -
PERSISTENCE 3
TOXICOLOGY: SILVER IS AN EYE AND MUCOUS MEMBRANE IRRITANT AND PRIMARY
SKIN IRRITANT.
ACUTE INGESTION OF SOLUBLE SILVER COMPOUNDS CAUSES ORAL PAIN, MUCOUS
MEMBRANE PIGMENTATION, SALIVATION, BLACK VOMITUS, DIARRHEA, ANURIA,
COLLAPSE AND SHOCK. TERMINAL SIGNS ARE CONVULSIONS OR COMA.
CHRONIC SKIN CONTACT WILL RESULT IN ARGYRIA.
THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT ARGYRIA.

OSHA STANDARD 1910.1200 HAZARD COMMUNICATION REQUIRES CHEMICAL
MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY
PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR
EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD
COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY
DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO
TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NOT REQUIRED
SOFT, DUCTILE, LUSTROUS WHITE.
IC
INCOMPATIBILITIES:
ACETYLENE GAS. AMMONIA. HYDROGEN. PEROXIDES. METAL IN POWDERED FORM
IS EXPLOSIVE.
CL
CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR

CHEMICAL HAZARDS :
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT SKIN CONTACT WITH THIS SUBSTANCE WHERE SKIN CONTACT MAY OCCUR. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THERE IS ANY POSSIBILITY OF THIS SOLID CONTACTING THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
0.25 MG(AG)/M3
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE
- POWERED AIR-PURIFYING RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER

0.5 MG(AG)/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE

20 MG(AG)/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
GENERAL MEDICAL HISTORY.
RESPIRATORY HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
NASAL SEPTUM.
VISION TEST.
EYE DISEASE.
SKIN EXAM.
SPECIAL ATTENTION TO SKIN.
SKIN EXAMINATION FOR EVIDENCE OF PIGMENTATION.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PERIODIC EXAM FOLLOWING EXPOSURE.
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
ACGIH BIOLOGICAL EXPOSURE INDICIES FOR METHEMOGLOBIN INDUCERS: 1.5% OF HEMOGLOBIN METHEMOGLOBIN IN BLOOD / TIMING -DURING OR END OF SHIFT.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. NASAL SEPTUM.

SP

SYMPTOMS:
CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). THIRST, DESIRE FOR WATER (SC0210). SKIN BURNS, INJURY OF SKIN CAUSED BY HEAT (SC0176).
EYE, ORGAN OF SIGHT (SC0170);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). GASTROENTERITIS, STOMACH AND INTESTINAL INFLAMMATION (SC0551). SHOCK, SUDDEN PHYSICAL OR MENTAL DISTURBANCE(SC0228). CHEMOSIS, EDEMA OF CONJUNCTIVA AROUND CORNEA (SC0450). ARGYRIA, BLUISH OR BLACK SKIN DISCOLORATION (SC0552).

FA

FIRST AID.

(1 OF 6)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 6)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOE IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 6)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR

KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 6)
INGESTED SILVER SALTS: EMERGENCY TREATMENT - DILUTE WITH WATER CONTAINING SODIUM CHLORIDE, 10 GRAMS/LITER, REPEATEDLY TO PRECIPITATE SILVER ION. FOLLOW WITH CATHARSIS USING 30-60 ML FLEET'S PHOSPHOSODA DILUTED 1:4 IN WATER CONTAINING 5 GRAMS SODIUM CHLORIDE TO PRECIPITATE AND REMOVE SILVER FROM INTESTINES. TREAT SHOCK AND METHEMOGLOBINEMIA. FURTHER TREATMENT - GIVE MILK TO REDUCE GASTRIC IRRITATION. GIVE MEPERIDINE, 100 MG, OR CODEINE, 60 MG, TO RELIEVE PAIN. (MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL) (DREISBACH, HANDBOOK OF POISONING, 11TH ED.).

(5 OF 6)
CIRCULATORY FAILURE/SHOCK - PLACE PATIENT IN SUPINE POSITION WITH FEET ELEVATED. ESTABLISH AND MAINTAIN AN ADEQUATE AIRWAY. MAINTAIN BODY WARMTH BY APPLICATION OF BLANKETS, BUT DO NOT APPLY EXTERNAL HEAT. RELIEVE PAIN WITH MORPHINE SULFATE, 10 MG/70 KG SUBCUTANEOUSLY OR INTRAVENOUSLY, FOR OTHERWISE UNCONTROLLABLE PAIN. DO NOT GIVE MORPHINE TO UNCONSCIOUS OR STUPOROUS PATIENTS. PATIENTS WITH DEPRESSED RESPIRATION SHOULD NOT BE GIVEN MORPHINE UNLESS PERSONNEL AND EQUIPMENT TO MAINTAIN RESPIRATION ARE IMMEDIATELY AVAILABLE. RESTORE AND MAINTAIN ADEQUATE BLOOD VOLUME. PROCEDURE MUST PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(6 OF 6)
METHEMOGLOBINEMIA: (WHEN METHEMOGLOBIN CONCENTRATION IS OVER 25-40% OR IN THE PRESENCE OF SYMPTOMS). GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG INTRAVENOUSLY OVER A 10 MINUTE PERIOD. CYANOSIS MAY DISAPPEAR WITHIN MINUTES OR PERSIST LONGER DEPENDING ON DEGREE OF METHEMOGLOBINEMIA. INTRAVENOUS ADMINISTRATION OF THERAPEUTIC DOSES OF METHYLENE BLUE MAY CAUSE A RISE IN BLOOD PRESSURE, NAUSEA, AND DIZZINESS. LARGER DOSES (>500 MG) CAUSE VOMITING, DIARRHEA, CHEST PAIN, MENTAL CONFUSION, CYANOSIS, AND SWEATING. HEMOLYTIC ANEMIA HAS ALSO OCCURRED SEVERAL DAYS AFTER ADMINISTRATION. THESE EFFECTS ARE TEMPORARY, AND FATALITIES HAVE NOT BEEN REPORTED. IF METHYLENE BLUE IS NOT AVAILABLE, GIVE ASCORBIC ACID, 1 GRAM SLOWLY INTRAVENOUSLY. WITHOUT TREATMENT, METHEMOGLOBINEMIA LEVELS OF 20-30% REVERT TO NORMAL WITHIN 3 DAYS. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERD BY QUALIFIED MEDICAL PERSONNEL.

DT
SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
NONE IN COMMON USE.

RS
REGULATORY STATUS.

(1 OF 320 HAZARD COMMUNICATION REQUIRES CHEMICAL
ENTER DOCUMENT SELECTION._: 7440-39-3

P002 INVALID...ENTER DOCUMENT SELECTION (DOC=)._:

1
AN ACCESSION NUMBER: 2799. 9205.
CN CHEMICAL NAME: SILVER.
SY SYNONYMS: ARGENTUM. C.I. 77820. L-3. SHELL SILVER. SILVER ATOM. SILVER, METAL. SILFLAKE 135. V 9. SILVER METAL. SR 999.
CAS NUMBER: 7440-22-4.

REG. TOXIC NUMBER: VW3500000.

CHEMICAL FORMULA: AG.

PD
PHYSICAL DESCRIPTION:
SOFT, DUCTILE, LUSTROUS WHITE SOLID.

..PRINT 1 ALL/DOC=1

1

AN ACCESSION NUMBER: 3315. 9207.
CN CHEMICAL NAME: TRINITROTOLUENE.
SY SYNONYMS: TNT. 2,4,6-TRINITROTOLUENE. NCI-C56155. UN 0209. TRITON. TOLITE. TOLUENE, 2,4,6-TRINITRO-. UN 1356. BENZENE, 2-METHYL-1,3,5-TRINITRO-. ENTSUFON. ALPHA-TNT. TNT-TOLITE. TOLIT. TRINITROTOLUENE, DRY. S-TRINITROTOLUENE. SYM-TRINITROTOLUOL. 2,4,6-TRINITROTOLUOL. TRITOL. TROTYL. TROTYL OIL.
RN CAS NUMBER: 118-96-7.

REG. TOXIC NUMBER: XU0175000.

CHEMICAL FORMULA: C7H5N3O6.
PD
PHYSICAL DESCRIPTION:
COLORLESS TO PALE YELLOW, ODORLESS SOLID.

| | |
|---|---|
| MOL WT: | 227 |
| BOILING PT: | EXPLODES 464 F |
| SOLUBILITY: | 0.013 G |
| FLASH PT: | EXPLODES |
| VAPOR PRES: | 0.05 MM |
| MELT PT: | 178 F |
| UEL IN AIR: | N/A |
| LEL IN AIR: | N/A |
| MEC IN AIR: | 887 F |
| SPEC GRAVITY: | 1.654 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
0.5 MG/M3 OSHA TWA (SKIN)
0.5 MG/M3 ACGIH TWA (SKIN NOTATION)
0.5 MG/M3 NIOSH RECOMMENDED 10 HR TWA (SKIN)
MUTAGENIC DATA (RTEC)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 3 - PERSISTENCE 2
TOXICOLOGY: TNT IS A PRIMARY SKIN IRRITANT, SKIN SENSITIZER, NUERO-TOXIN, NEPHROTOXIN, HEPATOTOXIN, AND BONE MARROW DEPRESSANT.
ACUTE POISONING RESULTS IN CYANOSIS, NAUSEA, APLASTIC OR HEMOLYTIC ANEMIA,JAUNDICE, AND POSSIBLY OLIGURIA OR ANURIA. IN EXTREME CASES, PERIPHERAL NEURITIS, CONVULSIONS AND COMA MAY OCCUR.
VAPORS AND DUSTS IRRITATE THE EYES AND MUCOUS MEMBRANES. EXPOSURE MAY DISCOLOR THE SKIN, HAIR, AND NAILS. SEVERE DERMATITIS IS PRODUCED IN MANY WORKERS EXPOSED TO TNT. CASES OF SENSITIZATION HAVE BEEN REPORTED.
INFORMATION IS NOT AVAILABLE ON WARNING PROPERTIES OF TRINITROTOLUENE.
THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT SYSTEMIC POISONING.
ORL-RAT LD50: 820 MG/KG
ORL-MUS LD50:1009 MG/KG
ORL-CAT LDLO:1850 MG/KG
ORL-RBT LDLO: 500 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NOT REQUIRED

IC

INCOMPATIBILITIES:
STRONG OXIDIZERS. AMMONIA. STRONG ALKALIES. EXPLOSIVE HAZARD AT HIGH TEMPERATURES. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC. SHOCK MAY DETONATE OR EXPLODE. REDUCING AGENTS.

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
UNSUBSTITUTED NITRO COMPOUNDS: EXCELLENT/GOOD: POLYVINYL ALCOHOL FAIR/POOR: NATURAL RUBBER NITRILE RUBBER FAIR/GOOD: CHLORINATED POLYETHYLENE POLYURETHANE POLYVINYL CHLORIDE VITON A WIDE VARIATION IN RATINGS IS INDICATED FOR THE FOLLOWING MATERIALS: BUTYL RUBBER NEOPRENE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS SOLID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
5 MG/M3
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

12.5 MG/M3
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

25 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE

1000 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONTOR BACK-MOUNTED ORGANIC VAPOR CANISTER HAVING A HIGH EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
RESPIRATORY HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
HISTORY OF ASTHMA OR ALLERGIES.
BLOOD DISEASE.
BLOOD CHEMISTRY.
RENAL AND LIVER FUNCTIONS.
LIVER FUNCTION.
VISION TEST.
EYE DISEASE.
CHRONIC RESPIRATORY DISEASE.
CENTRAL NERVOUS SYSTEM EXAMINATION.
KIDNEY FUNCTION.
URINALYSIS.
COMPLETE BLOOD COUNT.
HEMATOLOGY.
SGOT.
SGPT.
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
PRE-PLACEMENT AND UP TO SEMI-ANNUAL UNDER SPECIFIC CONDITIONS.
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO

EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HAZARDOUS PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. BLOOD. CENTRAL NERVOUS SYSTEM. CARDIOVASCULAR SYSTEM. GASTROINTESTINAL. KIDNEYS. LIVER.

SP

SYMPTOMS:
LIVER DAMAGE, INJURY TO THE LIVER (SC0221). JAUNDICE, YELLOWING OF SKIN, EYES (SC0092). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). SNEEZING FORCABLE EXPIRATION OF AIR (SC0151). COUGHING, FORCEFUL EXPIRATION (SC0173). THIRST, DESIRE FOR WATER (SC0210). PERIPHERAL NEURITIS, INFLAMED NERVES OF EXTREMITIES (SC0129).
MUSCULAR, ORGAN RESPONSIBLE FOR MOTION (SC0110);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). DERMATITIS, INFLAMMATION OF SKIN (SC0044). LEUKOCYTOSIS, INCREASED WHITE BLOOD CELLS (SC0099). TOXIC HEPATITIS, INFLAMED LIVER OF TOXIC ORIGIN (SC0257).
CARDIOVASCULAR, PERTAINING TO HEART & BLOOD VESSELS (SC0037);
DISTURBANCE, INTERRUPTION OF A NORMAL STATE (SC0047). ALBUMINURIA, ALBUMIN (PROTEIN) IN URINE (SC0002). SEIZURE, CONVULSION (SC0149). NEPHRITIS, INFLAMMATION OF THE KIDNEYS (SC0117). PALLOR, PALENESS, AS OF THE SKIN (SC0122). NAUSEA, SICKNESS AT THE STOMACH (SC0115). ANOREXIA DIMINISHED APPETITE (SC0006). BONE MARROW DEPRESSION, LOWERING OF BONE TISSUE BLOOD PRODUCT(SC0249). APLASTIC ANEMIA, ANEMIA FROM BONE MARROW DAMAGE (SC0285). HEMOLYTIC ANEMIA, BREAKDOWN OF RED BLOOD CELLS (SC0233). OLIGURIA, DECREASED URINATION (SC0323). ANURIA, COMPLETE LACK OF URINATION (SC0304). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). COMATOSE, STATE OF DEEP UNCONSCIOUSNESS (SC0186). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). METHEMOGLOBINEMIA, BLOOD CONDITION FOLLOWING SOME POSION(SC0230).
SKIN, COVERING OF BODY (SC0174);
SENSITIZATION, ALLERGIC REACTION (SC0148).
GASTROINTESTINAL, PERTAINING TO STOMACH & INTESTINE (SC0070);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). LEUKOPENIA, DECREASED WHITE BLOOD CELLS (SC0101). CATARACTS, LOSS OF TRANSPARENCY OF EYE LENS (SC0409). ECZEMA, CHRONIC DERMATITIS (SC0053). ERYTHEMA, REDNESS, SPOTS ON SKIN (SC0060). ICTERUS, DISCOLORATION OF TISSUE (SC0084). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). ANGINA, SENSE OF SUFFOCATION (SC0209). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA UNCONTROLLED LOOSE BOWELS (SC0046).
HEPATIC, PERTAINING TO THE LIVER (SC0081);
ENLARGEMENT, BEING LARGER (SC0055).

FA

FIRST AID.

(1 OF 8)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 8)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

IF THIS CHEMICAL HAS BEEN INHALED, REMOVE PAT[illegible]
IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 8)
WHEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING. REMOVE B[illegible] GASTRIC LAVAGE AND CATHARSIS.

(5 OF 8)
INGESTED TRINITROTOLUENE/TRINITROBENZENE: EMERGENCY TREATMENT - REMOVE BY GASTRIC LAVAGE OR EMESIS. FURTHER TREATMENT - TREAT LIVER FAILURE AND HEMOLYTIC REACTIONS. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.).

(6 OF 8)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVIN LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(7 OF 8)
LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY, DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(8 OF 8)
HEMOLYTIC REACTION - IN THE PRESENCE OF HEMOGLOBINURIA WITH NORMAL KIDNEY FUNCTION, MAINTAIN URINE OUTPUT AT 2-3 ML/KG/HOUR. FUROSEMIDE, 20-80 MG ORALLY OR INTRAVENOUSLY EVERY 4-8 HOURS, MAY BE HELPFUL. ALKALINIZE THE URINE BY GIVING SODIUM BICARBONATE, 1-2 MEQ/KG EVERY 12 HOURS. MONITOR CENTRAL VENOUS PRESSURE AND ELECTROLYTES. MANNITOL ADMINISTRATION HAS BEEN USED TO MAINTAIN URINE OUTPUT. IF SERUM HEMOGLOBIN EXCEEDS 1.5 GM/DL, TOTAL EXCHANGE TRANSFUSION MAY PREVENT RENAL FAILURE. IN THE PRESENCE OF METHEMOGLOBINEMIA WITH HEMOLYSIS, TREAT METHEMOGLOBINEMIA BY GIVING METHYLENE BLUE, 1 MG/KG. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

DT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:

..PRINT 1 ALL/DOC=1

1

AN ACCESSION NUMBER: 3881. 9207.
CHEMICAL NAME: 2,4-DINITROTOLUENE.
SYNONYMS: DNT. 2,4-DNT. NCI-C01865. 1-METHYL-2,4-DINITROBENZENE.
2,4-DINITROTOLUOL. O,P-DINITROTOLUENE. UN 2038. BENZENE,
1-METHYL-2,4-DINITRO-. RCRA U105.
RN CAS NUMBER: 121-14-2.

REG. TOXIC NUMBER: XT1575000.

CHEMICAL FORMULA: C7H6N2O4.
PD
PHYSICAL DESCRIPTION:
YELLOW CRYSTALS.

| | |
|---|---|
| MOL WT: | 182.15 |
| BOILING PT: | DECOMPOSES 572 F |
| SOLUBILITY: | 300 PPM |
| FLASH PT: | 404 F |
| VAPOR PRES: | 1 MM |
| MELT PT: | 160 F |
| UEL IN AIR: | EXPLODES |
| LEL IN AIR: | EXPLODES |
| MEC IN AIR: | |
| SPEC GRAVITY: | 1.3208 AT 160 F |
| VAPOR DENSITY: | 6.3 |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

PERMISSABLE EXPOSURE:
1.5 MG/M3 OSHA TWA (SKIN NOTATION)
1.5 MG/M3 ACGIH TWA (SKIN NOTATION)
LOWEST FEASIBLE LIMIT NIOSH RECOMMENDED EXPOSURE CRITERIA
PROBABLE HUMAN CARCINOGEN (EPA - CATEGORY B)
NEGATIVE CARCINOGEN IN MICE (NCI)
MUTAGENIC DATA (RTEC)
TUMORIGENIC DATA (RTEC)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 1 - REACTIVITY 3 -
PERSISTENCE 2
TOXICOLOGY: SEE DINITROTOLUENE.
ORL-RAT LD50: 268 MG/KG
ORL-RAT LD50: 268 MG/KG
ORL-MUS LD50: 790 MG/KG
ORL-GPG LD50:1300 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
YELLOW CRYSTALS.
IC
INCOMPATIBILITIES:
HEAT. EXPLOSIVE HAZARD AT HIGH TEMPERATURES. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC. STRONG OXIDIZERS. CAUSTICS. ACTIVE METALS. TIN. ZINC.

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH MOLTEN DINITROTOLUENE;
PREVENT SKIN CONTACT WITH DINITROTOLUENE OR LIQUIDS CONTAINING DINITROTOLUENE, WHERE SKIN CONTACT MAY OCCUR
WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)
PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED
IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES
-ACGIH 'GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING' INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A '+' DESIGNATES A BLEND OF MATERIALS, WHILE A '/' DESIGNATES A COATED OR LAMINATED MATERIAL.) -
UNSUBSTITUTED NITRO COMPOUNDS: EXCELLENT/GOOD: POLYVINYL ALCOHOL FAIR/POOR: NATURAL RUBBER NITRILE RUBBER FAIR/GOOD: CHLORINATED POLYETHYLENE POLYURETHANE POLYVINYL CHLORIDE VITON A WIDE VARIATION IN RATINGS IS INDICATED FOR THE FOLLOWING MATERIALS: BUTYL RUBBER NEOPRENE.

WEAR EYE PROTECTION TO PREVENT:
PREVENT ANY POSSIBILITY OF EYE CONTACT.

EMPLOYEE SHOULD WASH:
IMMEDIATELY WHEN SKIN BECOMES CONTAMINATED AND AT THE END OF WORK SHIFT.

WORK CLOTHING SHOULD BE CHANGED DAILY:
AFTER WORK SHIFT.

REMOVE CLOTHING:
PROMPTLY IF IT IS NON-IMPERVIOUS AND CONTAMINATED.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE.

RP
RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
15 MG/M3
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

75 MG/M3
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE

200 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE, HELMENT, OR HOOD
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

ESCAPE
- GAS MASK
WITH AN ORGANIC VAPOR CANISTER
(CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
WITH A HIGH EFFICIENCY PARTICULATE FILTER

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
RESPIRATORY HISTORY.
BLOOD CHEMISTRY.
GGTP.
LDH.
SGOT.
SGPT.
COMPLETE BLOOD COUNT.
RENAL AND LIVER FUNCTIONS.
WITH EMPHASIS ON: MORPHOLOGICAL BLOOD SLIDES.
SKIN EXAM.
VISION TEST.
PULMONARY FUNCTIONS.
URINALYSIS.
ACGIH BIOLOGICAL EXPOSURE INDICIES FOR METHEMOGLOBIN INDUCERS: 1.5% OF HEMOGLOBIN METHEMOGLOBIN IN BLOOD / TIMING -DURING OR END OF SHIFT.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. BLOOD. CENTRAL NERVOUS SYSTEM. CARDIOVASCULAR SYSTEM. KIDNEYS. LIVER.

SP

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). DERMATITIS, INFLAMMATION OF SKIN (SC0044).
SKIN, COVERING OF BODY (SC0174);
PIGMENTATION, COLORATION (SC0132).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). METHEMOGLOBINEMIA BLOOD CONDITION FOLLOWING SOME POSION(SC0230). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). ASPHYXIA, SUFFOCATION (SC0011). RESPIRATORY DISTRESS, DIFFICULTY BREATHING (SC0219). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091). DROWSINESS, FALLING ASLEEP (SC0049). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). VERTIGO, FEELING OF WHIRLING MOTION (SC0163). DIZZINESS, FEELING FAINT, LIGHT-HEADED,

CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0035).
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). HEMOLYTIC ANEMIA, BREAKDOWN OF RED BLOOD CELLS (SC0233). HYPOTENSION, LOW BLOOD PRESSURE (SC0180). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). COMATOSE, STATE OF DEEP UNCONSCIOUSNESS (SC0186). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034).
BLADDER, URINE RESERVOIR VESICLE (SC0259);
ULCERATION, LESION OF TISSUE (SC0313). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). JAUNDICE, YELLOWING OF SKIN, EYES (SC0092). LIVER DAMAGE, INJURY TO THE LIVER (SC0221). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). ARTHRALGIA, JOINT PAIN (SC0417).

FA

FIRST AID.

(1 OF 7)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 7)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 7)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 7)
WHEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING. REMOVE BY GASTRIC LAVAGE AND CATHARSIS.

(5 OF 7)
INGESTED NITRO/AMINO COMPOUNDS: REMOVE BY GASTRIC LAVAGE OR EMESIS AND CONSIDER USING ACTIVATED CHARCOAL. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS ON AN UNCONSCIOUS PERSON. MAINTAIN BLOOD PRESSURE AND RESPIRATION. GIVE OXYGEN IF RESPIRATION IS SHALLOW OR ANOXIA IS PRESENT. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE AND OXYGEN MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. ANTIDOTE: FOR SEVERE METHEMOGLOBINEMIA, GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG (1 MG/KG) SLOWLY INTRAVENOUSLY. ALL ANTIDOTES MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(6 OF 7)
METHEMOGLOBINEMIA: (WHEN METHEMOGLOBIN CONCENTRATION IS OVER 25-40% OR IN THE PRESENCE OF SYMPTOMS). GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG INTRAVENOUSLY OVER A 10 MINUTE PERIOD. CYANOSIS MAY DISAPPEAR WITHIN MINUTES OR PERSIST LONGER DEPENDING ON DEGREE OF METHEMOGLOBINEMIA. INTRAVENOUS ADMINISTRATION OF THERAPEUTIC DOSES OF METHYLENE BLUE MAY CAUSE A RISE IN BLOOD PRESSURE, NAUSEA, AND DIZZINESS. LARGER DOSES (>500 MG) CAUSE VOMITING, DIARRHEA, CHEST PAIN, MENTAL CONFUSION, CYANOSIS, AND SWEATING. HEMOLYTIC ANEMIA HAS ALSO OCCURRED SEVERAL DAYS AFTER ADMINISTRATION. THESE EFFECTS ARE TEMPORARY, AND FATALITIES HAVE NOT BEEN REPORTED. IF METHYLENE BLUE IS NOT AVAILABLE, GIVE ASCORBIC ACID, 1 GRAM SLOWLY INTRAVENOUSLY. WITHOUT TREATMENT, METHEMOGLOBINEMIA LEVELS OF 20-30% REVERT TO NORMAL WITHIN 3 DAYS. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERD BY QUALIFIED MEDICAL PERSONNEL.

(7 OF 7)

LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE
BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR
OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED,
REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N
SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY,
DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT
CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO
CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG
DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE
MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK
OF POISONING, 12TH ED.).

DT

SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
METHEMOGLOBIN DETERMINATION.
ELECTROCARDIOGRAM.
CONVULSIONS - BLOOD ANALYSIS FOR GLUCOSE, CALCIUM, UREA NTROGEN AND
CARBON DIOXIDE.

RS

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BRS SEARCH MODE - ENTER QUERY

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1
AN ACCESSION NUMBER: 851. 9207.
CN CHEMICAL NAME: CYCLOTRIMETHYLENETRINITRAMINE.
SY SYNONYMS: UN 0072. CYCLOTRIMETHYLENENITRAMINE. HEXOLITE. UN 0118.
CYCLONITE. HEXOGEN. RDX. S-TRIAZINE, HEXAHYDRO-1,3,5-TRINITRO-.
HEXAHYDRO-1,3,5-TRINITRO-S-TRIAZINE.
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE. HEXOGEN (EXPLOSIVE). HEXOGEN
5W. PBX(AF) 108. T4. TRIMETHYLENETRINITRAMINE.
SYM-TRIMETHYLENETRINITRAMINE. TRINITROCYCLOTRIMETHYLENE TRIAMINE.
1,3,5-TRINITRO-1,3,5-TRIAZACYCLOHEXANE.
RN CAS NUMBER: 121-82-4.

REG. TOXIC NUMBER: XY9450000.

CHEMICAL FORMULA: C3H6N6O6.
PD
PHYSICAL DESCRIPTION:
COLORLESS OR WHITE CRYSTALLINE POWDER.

| | |
|---|---|
| MOL WT: | 222.15 |
| BOILING PT: | EXPLOSIVE |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | EXPLODES |
| VAPOR PRES: | 0.0004 MM AT 230 F |
| MELT PT: | 399 F |
| UEL IN AIR: | EXPLOSIVE |
| LEL IN AIR: | EXPLOSIVE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 1.82 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
1.5 MG/M3 OSHA TWA (SKIN)
1.5 MG/M3 ACGIH TWA (SKIN)
3 MG/M3 ACGIH STEL (NOTICE OF INTENDED CHANGES 1988-89)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 3 -
PERSISTENCE 0
TOXICOLOGY: TRINITROTRIAZINE IS TOXIC TO THE NERVOUS SYSTEM, LIVER AND
KIDNEYS. POISONING WILL RESULT IN NAUSEA, VOMITING, CONVULSIONS, UNCON-
SCIOUSNESS, ANEMIA, LIVER AND KIDNEY DAMAGE.
THE THRESHOLD LIMIT VALUE WAS SET BY ANALOGY WITH TRINITROTOLUENE TO
PREVENT SYSTEMIC INJURY.
ORL-RAT LD50:100 MG/KG
ORL-MUS LD50: 59 MG/KG
ORL-CAT LDLO:100 MG/KG
ORL-RBT LDLO:500 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL
MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY
PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR
EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD
COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFE
DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO
TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
COLORLESS OR WHITE CRYSTALLINE.

INCOMPATIBILITIES:
EXPLOSIVE HAZARD AT HIGH TEMPERATURES. SHOCK MAY DETONATE OR EXPLODE. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC. REDUCING AGENTS. ALUMINUM POWDER. CYANIDES. ESTERS. PHOSPHOROUS. THIOCYANATES. KETONES. CAUSTICS. AMMONIA. AMINES.

CL

CLOTHING:
NO NIOSH/OSHA DATA; RECOMMEND
PREVENT ANY POSSIBILITY OF SKIN CONTACT
WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)
PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED
IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES.

WEAR EYE PROTECTION TO PREVENT:
NO STANDARD REQUIREMENT, BUT ADVISE EYE PROTECTION TO PREVENT ANY POSSIBILITY OF EYE CONTACT
WEAR FACE SHIELD OR VENTED GOGGLES.

EMPLOYEE SHOULD WASH:
NO STANDARD REQUIREMENT, BUT ADVISE WASHING IMMEDIATELY WHEN SKIN BECOMES CONTAMINATED.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO STANDARD REQUIREMENT, BUT ADVISE CHANGING
IF THERE IS ANY POSSIBILITY THAT CLOTHING MAY BE CONTAMINATED
LEAVE CLOTHING & EQUIPMENT FOR DECONTAMINATION & DISPOSAL.

REMOVE CLOTHING:
NO STANDARD REQUIREMENT, BUT ADVISE REMOVING
EMPLOYERS SHALL ENSURE THAT CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO NIOSH/OSHA DATA, ADVISE:
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
HIGH LEVELS
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE, HELMENT, OR HOOD

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
NO INFORMATION AVAILABLE FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS"; ADVISE: EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.

CENTRAL NERVOUS SYSTEM EXAMINATION.
CONVULSIVE DISORDER.
GASTROINTESTINAL.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INGESTION. SKIN ABSORPTION. SKIN OR EYE CONTACT. INHALATION.

TO

TARGET ORGANS:
EYES. RESPIRATORY SYSTEM. SKIN. MUCOUS MEMBRANES. CENTRAL NERVOUS SYSTEM. KIDNEYS. LIVER.

SP

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
ULCERATION, LESION OF TISSUE (SC0313). DERMATITIS, INFLAMMATION OF SKIN (SC0044).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). NAUSEA, SICKNESS AT THE STOMACH (SC0115). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). VOMITING, PERTAINING TO NAUSEA (SC0166). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). SALIVATION, EXCESS DISCHARGE OF SALIVA (SC0146). IRRITABILITY, QUICK EXCITABILITY TO ANNOYANCE (SC0091). UNCONSCIOUSNESS, NOT AWAKE; INSENSIBLE (SC0198). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). ANOREXIA, DIMINISHED APPETITE (SC0006). ASTHENIA, LOSS OF STRENGTH (SC0430). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). LIVER DAMAGE, INJURY TO THE LIVER (SC0221).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 4)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 4)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 4)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 4)
IF THIS SUBSTANCE IS INGESTED AND EXTENSIVE VOMITING HAS NOT OCCURED, THIS SUBSTANCE SHOULD BE REMOVED BY EMESIS OR GASTRIC LAVAGE PROVIDED THAT THE PATIENT IS CONSCIOUS AND CONVULSIONS ARE NOT PRESENT. DO NOT ATTEMPT TO MAKE AN UNCONSCIOUS PERSON VOMIT. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY (DREISBACH, HANDBOOK OF
TREATMENT SHOULD BE PERFORMED BY QUALIFIED MEDICAL

1
AN ACCESSION NUMBER: 3324. 9208.
CN CHEMICAL NAME: TRINITROBENZENE.
SY SYNONYMS: TNB. 1,3,5-TRINITROBENZENE. UN 0214. TRINITROBENZENE, DRY. TRINITROBENZENE, WET. DC3860000. BENZENITE. UN 1354. BENZENE, 1,3,5-TRINITRO-. S-TRINITROBENZENE. SYM-TRINITROBENZENE. SYMMETRIC TRINITROBENZENE. RCRA U234.
RN CAS NUMBER: 99-35-4.

REG. TOXIC NUMBER: DC3850000.

CHEMICAL FORMULA: C6H3N3O6.
PD
PHYSICAL DESCRIPTION:
LIGHT GREENISH-YELLOW CRYSTALS.

| | |
|---|---|
| MOL WT: | 213.12 |
| BOILING PT: | DECOMPOSES |
| SOLUBILITY: | 0.035 G |
| FLASH PT: | EXPLODES |
| VAPOR PRES: | 0.3846 MM AT 252 F |
| MELT PT: | 254 F |
| UEL IN AIR: | EXPLOSIVE |
| LEL IN AIR: | EXPLOSIVE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 1.76 |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
NONE ESTABLISHED
MUTAGENIC DATA (RTEC)
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 3 - PERSISTENCE 2
TOXICOLOGY: SEE TRINITROTOLUENE.
ORL-RAT LD50:450 MG/KG
ORL-MUS LD50:572 MG/KG
ORL-GPG LD50:730 MG/KG
IVN-MUS LD50: 32 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
LIGHT GREENISH-YELLOW CRYSTALS.
IC
INCOMPATIBILITIES:

EXPLOSIVE HAZARD AT HIGH TEMPERATURES. SHOCK MAY DETONATE OR EXPLODE. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC. REDUCING AGENTS.

CL

CLOTHING:
NO NIOSH/OSHA DATA; RECOMMEND
PREVENT ANY POSSIBILITY OF SKIN CONTACT
WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)
PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED
IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
UNSUBSTITUTED NITRO COMPOUNDS: EXCELLENT/GOOD: POLYVINYL ALCOHOL FAIR/POOR: NATURAL RUBBER NITRILE RUBBER FAIR/GOOD: CHLORINATED POLYETHYLENE POLYURETHANE POLYVINYL CHLORIDE VITON A WIDE VARIATION IN RATINGS IS INDICATED FOR THE FOLLOWING MATERIALS: BUTYL RUBBER NEOPRENE.

WEAR EYE PROTECTION TO PREVENT:
NO STANDARD REQUIREMENT, BUT ADVISE EYE PROTECTION TO PREVENT ANY POSSIBILITY OF EYE CONTACT
WEAR FACE SHIELD OR VENTED GOGGLES.

EMPLOYEE SHOULD WASH:
NO STANDARD REQUIREMENT, BUT ADVISE WASHING IMMEDIATELY WHEN SKIN BECOMES CONTAMINATED.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO STANDARD REQUIREMENT, BUT ADVISE CHANGING IF THERE IS ANY POSSIBILITY THAT CLOTHING MAY BE CONTAMINATED.

REMOVE CLOTHING:
NO STANDARD REQUIREMENT, BUT ADVISE REMOVING IMMEDIATELY IF IT BECOMES WET.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO NIOSH/OSHA DATA, ADVISE:
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
NO SPEC ADVISE
- DUST MASK
EXCEPT SINGLE-USE RESPIRATORS
AND QUARTER-MASK RESPIRATORS
- FUME OR HIGH-EFFICIENCY PARTICULATE RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS
- SUPPLIED-AIR RESPIRATOR

HIGH LEVELS
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE, HELMENT, OR HOOD

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
NO INFORMATION AVAILABLE FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS"; ADVISE: EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
BLOOD CHEMISTRY.
SKIN EXAM.
WEIGHT.
GASTROINTESTINAL.
CENTRAL NERVOUS SYSTEM EXAMINATION.
LIVER FUNCTION.
URINALYSIS.
KIDNEY FUNCTION.
RENAL AND LIVER FUNCTIONS.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN ABSORPTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. RESPIRATORY SYSTEM. SKIN. BLOOD. CENTRAL NERVOUS SYSTEM. GASTROINTESTINAL. KIDNEYS. LIVER. BONE MARROW.

SP

SYMPTOMS:
NASAL, OLFACTORY ORGAN (SC0171);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
PIGMENTATION, COLORATION (SC0132). FATIGUE, TIREDNESS, SLUGGISH (SC0066). WEAKNESS, LACK OF STRENGTH (SC0167). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088).
HEMOLYSIS, BLOOD DISSOLUTION, DESTRUCTION (SC0195). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);

DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). LIVER DAMAGE, INJURY TO THE LIVER (SC0221). TOXIC HEPATITIS, INFLAMED LIVER OF TOXIC ORIGIN (SC0257). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). JAUNDICE, YELLOWING OF SKIN, EYES (SC0092). DERMATITIS, INFLAMMATION OF SKIN (SC0044). ANOREXIA, DIMINISHED APPETITE (SC0006). ANURIA, COMPLETE LACK OF URINATION (SC0304). OLIGURIA, DECREASED URINATION (SC0323). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). COMATOSE, STATE OF DEEP UNCONSCIOUSNESS (SC0186). HEMATURIA, RED BLOOD CELLS IN URINE (SC0076).
BONE MARROW, SOFT, BLOOD-FORMING TISSUE (SC0381);
DAMAGE, PERMANENT INJURY (SC0287). METHEMOGLOBINEMIA, BLOOD CONDITION FOLLOWING SOME POSION(SC0230). DYSPNEA, DIFFICULTY IN BREATHING (SC0052).

FA

FIRST AID.

(1 OF 4)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 4)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 4)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 4)
INGESTED NITRO/AMINO COMPOUNDS: REMOVE BY GASTRIC LAVAGE OR EMESIS AND CONSIDER USING ACTIVATED CHARCOAL. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS ON AN UNCONSCIOUS PERSON. MAINTAIN BLOOD PRESSURE AND RESPIRATION. GIVE OXYGEN IF RESPIRATION IS SHALLOW OR ANOXIA IS PRESENT. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE AND OXYGEN MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. ANTIDOTE: FOR SEVERE METHEMOGLOBINEMIA, GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG (1 MG/KG) SLOWLY INTRAVENOUSLY. ALL ANTIDOTES MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

END OF REQUEST

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1
AN ACCESSION NUMBER: 2339. 9208.
CN CHEMICAL NAME: O-DINITROBENZENE.
SY SYNONYMS: 1,2-DINITROBENZENE. ORTHO-DINITROBENZENE. UN 1597.
BENZENE, O-DINITRO-.
RN CAS NUMBER: 528-29-0.

REG. TOXIC NUMBER: CZ7450000.

CHEMICAL FORMULA: C6H4N2O4.
PD
PHYSICAL DESCRIPTION:
PALE YELLOW LIQUID.

| | |
|---|---|
| MOL WT: | 168 |
| BOILING PT: | 606 F AT 775 MM |
| SOLUBILITY: | 0.015 G |
| FLASH PT: | EXPLODES |
| VAPOR PRES: | <1 MM |
| MELT PT: | 245 F |
| UEL IN AIR: | N/A |
| LEL IN AIR: | N/A |
| MEC IN AIR: | |
| SPEC GRAVITY: | 1.565 AT 63 F |
| VAPOR DENSITY: | 5.8 |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT: | 1.58. |

EL
PERMISSABLE EXPOSURE:
1 MG/M3 OSHA TWA (SKIN NOTATION)
1 MG/M3 ACGIH TWA (SKIN)
1 MG/M3 NIOSH RECOMMENDED 10 HR TWA
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 3 - PERSISTENCE 2
TOXICOLOGY: O-DINITROBENZENE IS A METHEMOGLOBIN FORMER.
SEE DINITROBENZENE.

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
200 MG/M3 OSHA/NIOSH
PALE YELLOW LIQUID.
IC
INCOMPATIBILITIES:
STRONG OXIDIZERS. CAUSTICS. ACTIVE METALS.
CL
CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR

CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT SKIN CONTACT WITH THIS SUBSTANCE WHERE SKIN CONTACT MAY OCCUR. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
UNSUBSTITUTED NITRO COMPOUNDS: EXCELLENT/GOOD: POLYVINYL ALCOHOL FAIR/POOR: NATURAL RUBBER NITRILE RUBBER FAIR/GOOD: CHLORINATED POLYETHYLENE POLYURETHANE POLYVINYL CHLORIDE VITON A WIDE VARIATION IN RATINGS IS INDICATED FOR THE FOLLOWING MATERIALS: BUTYL RUBBER NEOPRENE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS SOLID MAY CONTACT THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
WHERE EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE MAY OCCUR, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
5 MG/M3
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS

10 MG/M3
- DUST AND MIST RESPIRATOR EXCEPT SINGLE-USE RESPIRATORS AND QUARTERMASK RESPIRATORS
- SUPPLIED-AIR RESPIRATOR
- AIR-PURIFYING RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS

25 MG/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A DUST AND MIST FILTER
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

50 MG/M3
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND HIGH-EFFICIENCY PARTICULATE FILTER
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR WITH A TIGHT-FITTING FACEPIECE OPERATED IN A CONTINUOUS FLOW MODE

200 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH HALF-MASK OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.

RESPIRATORY HISTORY.
COMPLETE BLOOD COUNT.
BLOOD CHEMISTRY.
WITH EMPHASIS ON: GGTP.
LDH.
SGOT.
SGPT.
PULMONARY FUNCTIONS.
VISION TEST.
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
URINALYSIS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
ACGIH BIOLOGICAL EXPOSURE INDICIES FOR METHEMOGLOBIN INDUCERS: 1.5% OF HEMOGLOBIN METHEMOGLOBIN IN BLOOD / TIMING -DURING OR END OF SHIFT.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. BLOOD. CENTRAL NERVOUS SYSTEM. CARDIOVASCULAR SYSTEM. GASTROINTESTINAL. KIDNEYS. LIVER.

SP

SYMPTOMS:
VISUAL DISTURBANCE, UPSET IN SIGHT (SC0165). SCOTOMA, BLIND GAP IN VISUAL FIELD (SC0147).
SKIN, COVERING OF BODY (SC0174);
PIGMENTATION, COLORATION (SC0132). METHEMOGLOBINEMIA, BLOOD CONDITION FOLLOWING SOME POSION(SC0230). HYPOXEMIA, INSUFFICIENT OXYGENATION OF BLOOD (SC0083). ASPHYXIA, SUFFOCATION (SC0011). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). CONFUSION, IN A BEWILDERED STATE (SC0030). WEAKNESS, LACK OF STRENGTH (SC0167). HEMOLYTIC ANEMIA, BREAKDOWN OF RED BLOOD CELLS (SC0233). THIRST, DESIRE FOR WATER (SC0210). NAUSEA, SICKNESS AT THE STOMACH (SC0115).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028); DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). HYPOTENSION, LOW BLOOD PRESSURE (SC0180). WEIGHT LOSS, DROP IN BODY WEIGHT (SC0104). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). COMATOSE, STATE OF DEEP UNCONSCIOUSNESS (SC0186).
BLADDER, URINE RESERVOIR VESICLE (SC0259);
ULCERATION, LESION OF TISSUE (SC0313). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). JAUNDICE, YELLOWING OF SKIN, EYES (SC0092). LIVER DAMAGE, INJURY TO THE LIVER (SC0221).
SPLEEN, SUBSTERNAL ORGAN; BLOOD FILTER (SC0258);
DAMAGE, PERMANENT INJURY (SC0287). BONE MARROW DEPRESSION, LOWERING OF BONE TISSUE BLOOD PRODUCT(SC0249). VOMITING, PERTAINING TO NAUSEA (SC0166). ATAXIA, MUSCULAR INCOORDINATION (SC0013). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). TACHYCARDIA, ABNORMAL RAPID HEARTBEAT (SC0158). LIGHTHEADEDNESS, DIZZY (SC0102). EUPHORIA, AN EXAGGERATED FEELING OF WELL-BEING (SC0061).

FA

FIRST AID.

(1 OF 7)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 7)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 7)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 7)
WHEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING. REMOVE BY GASTRIC LAVAGE AND CATHARSIS.

(5 OF 7)
INGESTED NITRO/AMINO COMPOUNDS: REMOVE BY GASTRIC LAVAGE OR EMESIS AND CONSIDER USING ACTIVATED CHARCOAL. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS ON AN UNCONSCIOUS PERSON. MAINTAIN BLOOD PRESSURE AND RESPIRATION. GIVE OXYGEN IF RESPIRATION IS SHALLOW OR ANOXIA IS PRESENT. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE AND OXYGEN MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. ANTIDOTE: FOR SEVERE METHEMOGLOBINEMIA, GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG (1 MG/KG) SLOWLY INTRAVENOUSLY. ALL ANTIDOTES MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(6 OF 7)
METHEMOGLOBINEMIA: (WHEN METHEMOGLOBIN CONCENTRATION IS OVER 25-40% OR IN THE PRESENCE OF SYMPTOMS). GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG INTRAVENOUSLY OVER A 10 MINUTE PERIOD. CYANOSIS MAY DISAPPEAR WITHIN MINUTES OR PERSIST LONGER DEPENDING ON DEGREE OF METHEMOGLOBINEMIA. INTRAVENOUS ADMINISTRATION OF THERAPEUTIC DOSES OF METHYLENE BLUE MAY CAUSE A RISE IN BLOOD PRESSURE, NAUSEA, AND DIZZINESS. LARGER DOSES (>500 MG) CAUSE VOMITING, DIARRHEA, CHEST PAIN, MENTAL CONFUSION, CYANOSIS, AND SWEATING. HEMOLYTIC ANEMIA HAS ALSO OCCURRED SEVERAL DAYS AFTER ADMINISTRATION. THESE EFFECTS ARE TEMPORARY, AND FATALITIES HAVE NOT BEEN REPORTED. IF METHYLENE BLUE IS NOT AVAILABLE, GIVE ASCORBIC ACID, 1 GRAM SLOWLY INTRAVENOUSLY. WITHOUT TREATMENT, METHEMOGLOBINEMIA LEVELS OF 20-30% REVERT TO NORMAL WITHIN 3 DAYS. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERD BY QUALIFIED MEDICAL PERSONNEL.

(7 OF 7)
LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY, DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT

CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

END OF REQUEST

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HMX
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1
AN ACCESSION NUMBER: 856. 9208.
CN CHEMICAL NAME: CYCLOTETRAMETHYLENETETRANITRAMINE.
SY SYNONYMS: CYCLOTETRAMETHYLENE TETRANITRAMINE. HMX. UN 0226. OCTOGEN. 1,3,5,7-TETRAZOCINE, OCTAHYDRO, 1,3,5,7-TETRANITRO-. BETA-HMX. 1,3,5,7-TETRANITROPERHYDRO-1,3,5,7-TETRAZOCINE. CYCLOTETRAMETHYLENE TETRANITRAMINE, WET WITH NOT LESS THAN 10% WATER. STCC 4901548. OCTAHYDRO-1,3,5,7-TETRANITRO-1,3,5,7-TETRAZOCINE. HOMOCYCTONITE. TETRAMETHYLENETETRANITRAMINE.
RN CAS NUMBER: 2691-41-0.

REG. TOXIC NUMBER: XF7450000.

CHEMICAL FORMULA: C4H8N8O8.
PD
PHYSICAL DESCRIPTION:
COLORLESS TO WHITE CRYSTALS WETTED WITH WATER.

| | |
|---|---|
| MOL WT: | 296.20 |
| BOILING PT: | NOT AVAILABLE |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | FLAMMABLE SOLID |
| VAPOR PRES: | NOT AVAILABLE |
| MELT PT: | 527 F (275 C) |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | NOT AVAILABLE |
| MEC IN AIR: | NOT AVAILABLE |
| SPEC GRAVITY: | NOT AVAILABLE |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT: | |

EL
PERMISSABLE EXPOSURE:
NO OCCUPATIONAL EXPOSURE LIMITS ESTABLISHED BY OSHA, ACGIH OR NIOSH
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 3 - PERSISTENCE 2
TOXICOLOGY: CYCLOTETRAMETHYLENETETRANITRAMINE MAY BE IRRITATING TO THE EYES. IT IS TOXIC BY SKIN ABSORPTION AND SLIGHTLY TOXIC BY INGESTION. INGESTION MAY CAUSE NARCOSIS. DERMATITIS AND CIRCULATORY COLLAPSE WITH CENTRAL NERVOUS SYSTEM DISTURBANCES HAVE BEEN REPORTED IN ANIMALS.
ORL-RAT LD50: 6490 MG/KG ORL-GPG LD50: 300 MG/KG
ORL-MUS LD50: 1500 MG/KG ORL-RBT LD50: 50 MG/KG
SKN-RBT LD50: 630 MG/KG INV-RAT LD50: 25 MG/KG
INV-RBT LD50: 10 MG/KG INV-GPG LD50: 28 MG/KG
INV-DOG LD50: 40 MG/KG
SKIN AND EYE IRRITATION DATA (RTECS)
SKN-RBT 500 MG MLD

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY

DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
COLORLESS TO WHITE CRYSTALS WE.

IC

INCOMPATIBILITIES:
CYCLOTETRAMETHYLENETETRANITRAMINE: MERCURY FULMINATE: MAY EASILY INITIATE AN EXPLOSION. METAL AZIDES: MAY INITIATE DETONATION. OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD. EXPOSURE TO HEAT, FRICTION OR SHOCK MAY INITIATE DETONATION. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC.

CL

CLOTHING:
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING WHICH HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE OPERATION OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
NO SPECIFIC REQUIREMENT. USE APPROPRIATE SAFETY GOGGLES, AS INDICATED BY THE NATURE OF THE CONTAMINANT AND THE LIKELIHOOD OF EXPOSURE.

EMPLOYEE SHOULD WASH:
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE IMMEDIATELY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

WORK CLOTHING SHOULD BE CHANGED DAILY:
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING HAS HAD ANY POSSIBILITY OF BEING CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THIS SUBSTANCE BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
HIGH LEVELS
- TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE OPERATED

IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE WITH A FULL FACE-PIECE, HELMET, OR HOOD OPERATED IN CONTINUOUS-FLOW MODE
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS. 53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
NO INFORMATION AVAILABLE FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS"; ADVISE: GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
NO DATA.

SP

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). NARCOSIS, STUPOR OR SLEEP DUE TO NARCOTIC (SC0113).
DERMATITIS, INFLAMMATION OF SKIN (SC0044);
IN EXPERIMENTAL ANIMALS, (SC0212).
CIRCULATORY, PERTAINING TO CIRCULATION (SC0613);
COLLAPSE, EXTREME PROSTRATION (SC0029).
IN EXPERIMENTAL ANIMALS, (SC0212).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028).
DISTURBANCE, INTERRUPTION OF A NORMAL STATE (SC0047).
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 4)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 4)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE

AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 4)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 4)
IF THIS CHEMICAL IS INGESTED, TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION.

END OF REQUEST

**********

1
AN ACCESSION NUMBER: 3953. 9208.
CN CHEMICAL NAME: 2,6-DINITROTOLUENE.
SY SYNONYMS: 2,6-DNT. 2-METHYL-1,3-DINITROBENZENE. UN 2038. TOLUENE, 2,6-DINITRO-. BENZENE, 2-METHYL-1,3-DINITRO-. STCC 4963120. RCRA U016.
RN CAS NUMBER: 606-20-2.

REG. TOXIC NUMBER: XT1925000.

CHEMICAL FORMULA: C7H6N2O4.
PD
PHYSICAL DESCRIPTION:
COLORLESS TO YELLOW CRYSTALS.

| | |
|---|---|
| MOL WT: | 182.14 |
| BOILING PT: | 545 F (285 C) |
| SOLUBILITY: | 180 PPM |
| FLASH PT: | 404 F (2,4-ISOMER) |
| VAPOR PRES: | 0.018 MMHG |
| MELT PT: | 151 F (66 C) |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | NOT AVAILABLE |
| MEC IN AIR: | |
| SPEC GRAVITY: | 1.2933 @ 111 C |
| VAPOR DENSITY: | |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
1.5 MG/M3 OSHA TWA (SKIN)
1.5 MG/M3 ACGIH TWA (SKIN)
1.5 MG/M3 NIOSH RECOMMENDED 10 HR TWA (SKIN)
TUMORIGENIC DATA (RTECS)
MUTAGENIC DATA (RTECS)
AQUATIC TOXICITY (LC50 96HR): FATHEAD MINNOW - 19.8 MG/L
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 1 - REACTIVITY 3 - PERSISTENCE 2
TOXICOLOGY: 2,6-DINITROTOLUENE MAY BE MILDLY IRRITATING TO THE SKIN. CONTACT WITH THE MOLTEN MATERIAL MAY CAUSE THERMAL BURNS TO THE SKIN AND EYES. IT IS TOXIC BY INGESTION. IT IS A METHEMOGLOBIN FORMER. POISONING MAY ALSO AFFECT THE CARDIOVASCULAR AND NERVOUS SYSTEMS AND THE LIVER AND KIDNEYS. METHEMOGLOBIN FORMATION AT 15% MAY RESULT IN OBSERVABLE CYANOSIS OF THE LIPS, NOSE AND EARLOBES. ABOVE 60% METHEMOGLOBIN, DYSPNEA, TACHYCARDIA, CONVULSIONS AND COMA MAY OCCUR. PROLONGED EXPOSURE TO DINITROTOLUENE MAY CAUSE ANEMIA ALONG WITH OTHER BLOOD CHANGES. WORKERS EXPOSED TO TECHNICAL GRADE DINITROTOLUENE FOR MORE THAN 15 YEARS EXPERIENCED A SIGNIFICANT INCREASE IN THE DEATH RATE DUE TO ISCHEMIC HEART DISEASE AND OTHER RESIDUAL DISEASES OF THE CIRCULATORY SYSTEM. THERE HAVE BEEN EQUIVOCAL REPORTS OF REPRODUCTIVE EFFECTS OCCURRING IN WORKERS WHO HAVE BEEN OCCUPATIONALLY EXPOSED. RATS FED FOR A YEAR DEVELOPED HEPATOCELLULAR CARCINOMAS.
THE THRESHOLD LIMIT VALUE FOR THE MIXED ISOMERS OF DINITROTOLUENE WAS BASED ON TOXICITY.
ALCOHOLIC BEVERAGES MAY ENHANCE THE TOXIC EFFECTS. HIGH AMBIENT

TEMPERATURES INCREASE THE SUSCEPTIBILITY TO CYANOSIS.
ORL-RAT LD50: 177 MG/KG ORL-MUS LD50: 621 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
200 MG/M3 POTENTIAL
CARCINOGENNIOSH
COLORLESS TO YELLOW CRYSTALS.

IC

INCOMPATIBILITIES:
CAUSTICS. ACTIVE METALS. NITRIC ACID. STRONG OXIDIZERS. REDUCING AGENTS. SODIUM PEROXIDE. EXPLOSIVE HAZARD AT HIGH TEMPERATURES.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES BE PROVIDED WITH AND REQUIRED TO USE IMPERVIOUS CLOTHING, GLOVES, FACE SHIELDS (EIGHT-INCH MINIMUM), AND OTHER APPROPRIATE PROTECTIVE CLOTHING NECESSARY TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS MOLTEN SUBSTANCE OR REPEATED PROBABILITY OF SKIN CONTACT WITH THE LIQUID OR SOLID.
EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES BE PROVIDED WITH AND REQUIRED TO USE SPLASH-PROOF SAFETY GOGGLES WHERE THERE IS ANY POSSIBILITY OF EYE CONTACT WITH THIS SUBSTANCE IN A MOLTEN FORM AND REASONABLE PROBABILITY OF EYE CONTACT WITH LIQUID OR SOLID CONTAINING THE SUBSTANCE.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WASH IMMEDIATELY WHEN THE SKIN BECOMES WET, PROMPTLY WHEN THE SKIN BECOMES CONTAMINATED AND AT THE END OF EACH WORK SHIFT.

WORK CLOTHING SHOULD BE CHANGED DAILY:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:

FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE NON-IMPERVIOUS CLOTHING BECOMES WET WITH THIS SUBSTANCE BE REMOVED IMMEDIATELY AND NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH THE SUBSTANCE BE REMOVED PROMPTLY AND SUCH CLOTHING NOT BE REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
ANY DETECTABLE CONC.
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONTOR BACK-MOUNTED ORGANIC VAPOR CANISTER HAVING A HIGH EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS".
GENERAL MEDICAL HISTORY.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
BLOOD CHEMISTRY.
LIVER FUNCTION.
CARDIOVASCULAR DISEASE.
COMPLETE BLOOD COUNT.
ACGIH BIOLOGICAL EXPOSURE INDICIES FOR METHEMOGLOBIN INDUCERS: 1.5% OF HEMOGLOBIN METHEMOGLOBIN IN BLOOD / TIMING -DURING OR END OF SHIFT.

RE

ROUTE OF ENTRY:
INHALATION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
BLOOD. CENTRAL NERVOUS SYSTEM. CARDIOVASCULAR SYSTEM. KIDNEYS. LIVER.

SP

SYMPTOMS:
CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). EUPHORIA, AN EXAGGERATED FEELING OF WELL-BEING (SC0061). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). WEAKNESS, LACK OF STRENGTH (SC0167). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). LIGHTHEADEDNESS, DIZZY (SC0102). ATAXIA, MUSCULAR INCOORDINATION (SC0013). DROWSINESS, FALLING ASLEEP (SC0049). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). CONFUSION, IN A BEWILDERED STATE (SC0030). LETHARGY, SLUGGISHNESS (SC0595). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). DYSPNEA, DIFFICULTY IN BREATHING (SC0052). TACHYCARDIA, ABNORMAL RAPID HEARTBEAT (SC0158). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). PALLOR, PALENESS, AS OF THE SKIN (SC0122). DERMATITIS, INFLAMMATION OF SKIN (SC0044). HEMATURIA, RED BLOOD CELLS IN URINE (SC0076). METHEMOGLOBINEMIA, BLOOD CONDITION FOLLOWING SOME POSION(SC0230).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
EFFECTS, SIGNS AND SYMPTOMS (SC0579). BLOOD CHANGES, CHANGES IN BLOOD CELLS OR MORPHOLOGY (SC0227). ARTHRALGIA, JOINT PAIN (SC0417). ANOREXIA DIMINISHED APPETITE (SC0006). GIDDINESS, FRIVOLOUS, DIZZINESS (SC0071). FATIGUE, TIREDNESS, SLUGGISH (SC0066). INSOMNIA, INABILITY TO OBTAIN NORMAL SLEEP (SC0088). NYSTAGMUS, RHYTHMICAL OSCILLATION OF EYEBALLS (SC0443). TREMORS, TREMBLING, SHAKING (SC0197).
CIRCULATORY, PERTAINING TO CIRCULATION (SC0613);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
SKIN, COVERING OF BODY (SC0174);
YELLOW DISCOLORATION, ABNORMAL PIGMENTATION OF TISSUE (SC0383).
SKIN, COVERING OF BODY (SC0174);
SENSITIZATION, ALLERGIC REACTION (SC0148).
SKIN, COVERING OF BODY (SC0174);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175).
EYE, ORGAN OF SIGHT (SC0170);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). INCOORDINATION, LACK OF COORDINATION (SC0085).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). PARALYSIS, LOSS OF POWER OF VOLUNTARY MOVEMENT (SC0124). REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281). LIVER DAMAGE, INJURY TO THE LIVER (SC0221).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)

IF CONTACT WITH THE SKIN IS NOT WITH MOLTEN MATERIAL, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY. BURNS FROM CONTACT WITH MOLTEN MATERIAL SHOULD BE TREATED LIKE THERMAL BURNS. COOL AFFECTED AREAS AS QUICKLY AS POSSIBLE BY DRENCHING OR IMMERSING IN WATER UNTIL MATERIAL SOLIDIFIES. DO NOT ATTEMPT TO REMOVE SOLIDIFIED MATERIAL. COVER AREA WITH STERILE, DRY DRESSING. GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
INGESTED NITRO/AMINO COMPOUNDS: REMOVE BY GASTRIC LAVAGE OR EMESIS AND CONSIDER USING ACTIVATED CHARCOAL. DO NOT PERFORM GASTRIC LAVAGE OR EMESIS ON AN UNCONSCIOUS PERSON. MAINTAIN BLOOD PRESSURE AND RESPIRATION. GIVE OXYGEN IF RESPIRATION IS SHALLOW OR ANOXIA IS PRESENT. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE AND OXYGEN MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. ANTIDOTE: FOR SEVERE METHEMOGLOBINEMIA, GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG (1 MG/KG) SLOWLY INTRAVENOUSLY. ALL ANTIDOTES MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(5 OF 5)
METHEMOGLOBINEMIA: (WHEN METHEMOGLOBIN CONCENTRATION IS OVER 25-40% OR IN THE PRESENCE OF SYMPTOMS). GIVE METHYLENE BLUE, 1% SOLUTION, 0.1 ML/KG INTRAVENOUSLY OVER A 10 MINUTE PERIOD. CYANOSIS MAY DISAPPEAR WITHIN MINUTES OR PERSIST LONGER DEPENDING ON DEGREE OF METHEMOGLOBINEMIA. INTRAVENOUS ADMINISTRATION OF THERAPEUTIC DOSES OF METHYLENE BLUE MAY CAUSE A RISE IN BLOOD PRESSURE, NAUSEA, AND DIZZINESS. LARGER DOSES (>500 MG) CAUSE VOMITING, DIARRHEA, CHEST PAIN, MENTAL CONFUSION, CYANOSIS, AND SWEATING. HEMOLYTIC ANEMIA HAS ALSO OCCURRED SEVERAL DAYS AFTER ADMINISTRATION. THESE EFFECTS ARE TEMPORARY, AND FATALITIES HAVE NOT BEEN REPORTED. IF METHYLENE BLUE IS NOT AVAILABLE, GIVE ASCORBIC ACID, 1 GRAM SLOWLY INTRAVENOUSLY. WITHOUT TREATMENT, METHEMOGLOBINEMIA LEVELS OF 20-30% REVERT TO NORMAL WITHIN 3 DAYS. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERD BY QUALIFIED MEDICAL PERSONNEL.

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1
AN ACCESSION NUMBER: 2580. 9208.
CN CHEMICAL NAME: PHOSPHORUS, RED.
SY SYNONYMS: RED PHOSPHOROUS. PHOSPHORUS. PHORPHOROUS. PHOSPHORUS, AMORPHOUS, RED. UN 1338. PHOSPHORUS (RED). PHOSPHORUS-31.
RN CAS NUMBER: 7723-14-0.

REG. TOXIC NUMBER: TH3495000.

CHEMICAL FORMULA: P.
PD
PHYSICAL DESCRIPTION:
DARK RED TO VIOLET POLYMORPHIC POWDER,HIGHLY TOXIC.

| | |
|---|---|
| MOL WT: | 124.08 |
| BOILING PT: | 536 F |
| SOLUBILITY: | INSOLUBLE |
| FLASH PT: | FLAMMABLE |
| VAPOR PRES: | N/A |
| MELT PT: | 1094 F AT 43 ATM |
| UEL IN AIR: | FLAMMABLE |
| LEL IN AIR: | FLAMMABLE |
| MEC IN AIR: | 500 F |
| SPEC GRAVITY: | 2.34 |
| VAPOR DENSITY: | 4.3 |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL
PERMISSABLE EXPOSURE:
NONE ESTABLISHED
CERCLA HAZARD RATINGS - TOXICITY 1 - IGNITABILITY 1 - REACTIVITY 1 - PERSISTENCE 3

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED
DARK RED TO VIOLET POLYMORPHIC.
IC
INCOMPATIBILITIES:
POTASSIUM CHLORATE. PERMANGANATES. PEROXIDES. OXYGEN. SHOCK MAY DETONATE OR EXPLODE. ORGANIC MATTER. THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC. REDUCING AGENTS.
CL
CLOTHING:
NO NIOSH/OSHA DATA; RECOMMEND
PREVENT ANY POSSIBILITY OF SKIN CONTACT
WEAR FLAME RESISTANT CLOTHING
WEAR IMPERVIOUS CLOTHING

WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)
PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED
IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES.

WEAR EYE PROTECTION TO PREVENT:
NO STANDARD REQUIREMENT, BUT ADVISE EYE PROTECTION TO PREVENT REASONABLE PROBABILITY OF EYE CONTACT.

EMPLOYEE SHOULD WASH:
NO STANDARD REQUIREMENT, BUT ADVISE WASHING PROMPTLY WHEN SKIN BECOMES CONTAMINATED.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO STANDARD REQUIREMENT, BUT ADVISE CHANGING IF IT IS REASONABLY PROBABLE THAT CLOTHING IS CONTAMINATED.

REMOVE CLOTHING:
NO STANDARD REQUIREMENT, BUT ADVISE REMOVING PROMPTLY IF IT IS NON-IMPERVIOUS AND CONTAMINATED.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO NIOSH/OSHA DATA, ADVISE:
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEE'S EYES MAY BE EXPOSED TO SUBSTANCE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1 MG/M3
- DUST AND MIST RESPIRATOR WITH A FULL FACEPIECE

2.5 MG/M3
- POWERED AIR-PURIFYING RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

5 MG/M3
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER

200 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

FIREFIGHTING

- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE.

MD

MEDICAL SURVEILLANCE:
NO INFORMATION AVAILABLE FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS"; ADVISE: CENTRAL NERVOUS SYSTEM TESTS, PERIPHERAL NEUROPATHY.
GENERAL MEDICAL HISTORY.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
PULMONARY FUNCTIONS.
RESPIRATORY HISTORY.
SKIN EXAM.
VISION TEST.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. MUCOUS MEMBRANES.

SP

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181).

FA

FIRST AID.

(1 OF 9)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 9)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 9)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 9)
WHEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING. REMOVE BY GASTRIC LAVAGE AND CATHARSIS.

(5 OF 9)
PHOSPHORUS/PHOSPHINE/PHOSPHIDE EXPOSURE: EMERGENCY TREATMENT - REMOVE POISON BY GASTRIC LAVAGE WITH 5-10 L OF TAP WATER. IF A GASTRIC TUBE IS NOT IMMEDIATELY AVAILABLE, INDUCE EMESIS. TREATMENT MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. FURTHER TREATMENT - TREAT PULMONARY EDEMA AND SHOCK. GIVE 10% CALCIUM GLUCONATE, 10 ML INTRAVENOUSLY, TO MAINTAIN SERUM CALCIUM. GIVE 1-4 LITERS OF 5% GLUCOSE IN WATER OR 10% INVERT SUGAR IN WATER INTRAVENOUSLY DAILY UNTIL A HIGH CARBOHYDRATE DIET CAN BE GIVEN ORALLY. TREAT HEPATIC FAILURE. GET MEDICAL ATTENTION IMMEDIATELY. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(6 OF 9)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(7 OF 9)
PULMONARY EDEMA - RELIEVE ANXIETY. GIVE MORPHINE SULFATE, 10 MG, TO DECREASE RATE OF RAPID, INEFFICIENT RESPIRATION. GIVE 40% OXYGEN BY FACE MASK. USE INTERMITTENT POSITIVE-PRESSURE OXYGEN RESUSCITATOR FOR SHORT PERIODS. GIVE AMINOPHYLLINE, 0.5 G, INTRAVENOUSLY, TO RELIEVE ASSOCIATED BRONCHIAL CONSTRICTION. TREAT EDEMA CAUSED BY MORPHINE OR MORPHINE ANALOGS BY GIVING NALOXONE AND OXYGEN. GENERAL MEASURES - DIURESIS WITH ETHACRYNIC ACID (EDECRIN), 25 MG ORALLY OR INTRAVENOUSLY, OR FLUROSEMIDE, 20-80 MG ORALLY OR INTRAVENOUSLY, IS HELPFUL BECAUSE IT REDUCES FLUID VOLUME. DO NOT INJECT AT A RATE FASTER THAN 10 MG/MIN. GIVE

CORTICOSTEROID ANTI-INFLAMMATORY AGENT IN MAXIMUM DOSES. IF PULMONARY EDEMA IS THE RESULT OF HEART FAILURE, DIGITALIZE THE PATIENT. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(8 OF 9)
CIRCULATORY FAILURE/SHOCK - PLACE PATIENT IN SUPINE POSITION WITH FEET ELEVATED. ESTABLISH AND MAINTAIN AN ADEQUATE AIRWAY. MAINTAIN BODY WARMTH BY APPLICATION OF BLANKETS, BUT DO NOT APPLY EXTERNAL HEAT. RELIEVE PAIN WITH MORPHINE SULFATE, 10 MG/70 KG SUBCUTANEOUSLY OR INTRAVENOUSLY, FOR OTHERWISE UNCONTROLLABLE PAIN. DO NOT GIVE MORPHINE TO UNCONSCIOUS OR STUPOROUS PATIENTS. PATIENTS WITH DEPRESSED RESPIRATION SHOULD NOT BE GIVEN MORPHINE UNLESS PERSONNEL AND EQUIPMENT TO MAINTAIN RESPIRATION ARE IMMEDIATELY AVAILABLE. RESTORE AND MAINTAIN ADEQUATE BLOOD VOLUME. PROCEDURE MUST PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(9 OF 9)
LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY, DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

2
AN ACCESSION NUMBER: 2581. 9208.
CN CHEMICAL NAME: PHOSPHORUS, WHITE.
SY SYNONYMS: WHITE PHOSPHOROUS. YELLOW PHOSPHORUS. YELLOW PHOSPHOROUS. PHOSPHOROUS. PHOSPHORUS. UN 1381. CRYSTALLINE PHOSPHORUS. PHOSPHORUS YELLOW. PHOSPHORUS (WHITE). PHOSPHOROUS WHITE DRY. WHITE PHOSPHORUS. PHOSPHORUS (YELLOW). PHOSPHORUS, ELEMENTAL, WHITE. PHOSPHORUS YELLOW DRY. RAT-NIP. STCC 4916140. WP.
RN CAS NUMBER: 7723-14-0.

REG. TOXIC NUMBER: TH3500000.

CHEMICAL FORMULA: P4.

PHYSICAL DESCRIPTION:
WHITE, YELLOW, OR COLORLESS, TRANSPARENT, SOFT, WAXY, CUBIC, CRYSTALLINE SOLID WITH A PUNGENT, GARLIC-LIKE ODOR; DARKENS UPON EXPOSURE TO LIGHT; GLOWS IN THE DARK WITH A GREENISH LIGHT.

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|---|---|
| MOL WT: | 123.89 |
| BOILING PT: | 536 F (280 C) |
| SOLUBILITY: | NEGLIGIBLE |
| FLASH PT: | FLAMMABLE SOLID |
| VAPOR PRES: | 0.028 MMHG @ 21 C |
| MELT PT: | 111 F (44 C) |
| UEL IN AIR: | NOT AVAILABLE |
| LEL IN AIR: | NOT AVAILABLE |
| MEC IN AIR: | 86 F (30 C) |
| SPEC GRAVITY: | 1.82 |
| VAPOR DENSITY: | 4.4 |
| ODOR THRESHOLD: | |
| OCTANOL/WATER CO-EFFICIENT:. | |

EL

PERMISSABLE EXPOSURE:
0.1 MG/M3 OSHA TWA
0.1 MG/M3 ACGIH TWA
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA
REPRODUCTIVE EFFECTS DATA (RTECS)
AQUATIC TOXICITY RATING 4/+ (TLM96 <1 PPM)
LEPMOIS MACROCHIRUS 0.072 PPM
CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 2
PERSISTENCE 3
TOXICOLOGY: PHOSPHORUS, WHITE IS CORROSIVE TO THE SKIN, EYES AND MUCOUS MEMBRANES. IT IS HIGHLY TOXIC BY INGESTION. POISONING MAY AFFECT THE LIVER, KIDNEYS, BRAIN, TEETH AND BONES. SOLID PHOSPHORUS MAY IGNITE AND PRODUCE SEVERE YELLOWISH NECROTIC THERMAL BURNS. THEY MAY FLUORESCE UNDER ULTRAVIOLET LIGHT AND HAVE A GARLIC LIKE ODOR. SYMPTOMS MAY INCLUDE PHOTOPHOBIA, INTENSE THIRST, FUMING OF BREATH OR EXCRETA AND CARDIAC ARRHYTHMIA WITHIN 1 TO 2 HOURS. DEATH FROM PERIPHERAL VASCULAR COLLAPSE OR CARDIAC ARREST MAY OCCUR IN 24 TO 48 HOURS OR SYMPTOMS MAY SUBSIDE AND RECUR IN SEVERAL DAYS WITH GREATER INTENSITY. A FEW MILLIGRAMS MAY CAUSE ACUTE HEPATIC DAMAGE WITH RENAL PATHOLOGIC CHANGES, HEPATIC ENCEPHALOPATHY OR DEATH DUE TO ACUTE YELLOW ATROPHY OF THE LIVER. PHOSPHORUS ACTS AS A SOLVENT ON THE TEETH CAUSING CHANGES WHICH LEAD TO BONE DESTRUCTION RESULTING IN A SEVERE DEFORMITY KNOWN AS "PHOSSY JAW". THE SHORTEST PERIOD OF EXPOSURE RESULTING IN PHOSSY JAW WAS 10 MONTHS.
THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT ACUTE POISONING BUT MAY NOT PROVIDE A WIDE MARGIN OF SAFETY FROM UNDESIRABLE EFFECTS. PERSONS WITH CARIOUS TEETH AND POOR DENTAL HYGIENE MAY BE AT AN INCREASED RISK FROM EXPOSURE. INGESTION OF ALCOHOL, DIGESTIBLE FATS AND OILS MAY ENHANCE THE TOXIC EFFECTS.
ORL-HMN LDLO: 1400 UG/KG ORL-WMN LDLO: 22 MG/KG
ORL-WMN TDLO: 11 MG/KG ORL-WMN LDLO: 4600 UG/KG
ORL-WMN TDLO: 2600 UG/KG ORL-RAT LD50: 3030 UG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
NONE SPECIFIED

WHITE, YELLOW, OR COLORLESS, T.

IC

INCOMPATIBILITIES:
ACIDS. BROMATES. CHLORATES. HALOGENS (BROMINE, CHLORINE, IODINE, FLUORINE). HYPOCHLORITES. IODATES. METAL ACETYLIDES OR CARBIDES. METALS. OXIDIZERS. ALKALI METAL NITRIDES. METAL FUME FEVER CAUSED BY EXPOSURE TO SOME METAL OXIDES; CHILLS,FEVER,MUSCULAR PAIN. INTERHALOGENS. HALOGEN AZIDES. REACTS WITH WATER TO FORM AN ACID. POLYMERIZES AT HIGH TEMPERATURES. SPONTANEOUSLY FLAMMABLE IN AIR.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE FLAME-RETARDANT PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH SOLID OR LIQUID PHOSPHORUS. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6). EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH PHOSPHORUS IS PLACED UNDERWATER IN CLOSED CONTAINERS FOR STORAGE UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF PHOSPHORUS FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE PHOSPHORUS, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE OPERATION OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST-RESISTANT SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THERE IS ANY POSSIBILITY OF THIS SOLID CONTACTING THE EYES.

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE IMMEDIATELY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.
EMPLOYERS SHALL ENSURE THAT ALL EMPLOYEES SUBJECT TO SKIN CONTACT WITH THIS SUBSTANCE WASH WITH SOAP OR MILD DETERGENT AND WATER ANY AREAS OF THE BODY WHICH MAY HAVE CONTACTED THE SUBSTANCE AT THE END OF EACH WORK DAY.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL ENSURE THAT ANY CLOTHING WHICH BECOMES WET WITH THIS FLAMMABLE LIQUID BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:

FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
WHERE THERE IS ANY POSSIBILITY OF EXPOSURE OF AN EMPLOYEE'S BODY TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE FACILITIES FOR QUICK DRENCHING OF TH BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, EMPLOYERS SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.
EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE THIS SUBSTANCE IS HANDLED, PROCESSED OR STORED.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1 MG/M3
- SUPPLIED-AIR RESPIRATOR

2.5 MG/M3
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

5 MG/M3
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE-PIECE

200 MG/M3
- SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE

ESCAPE
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS".
VISION TEST.
CHRONIC RESPIRATORY DISEASE.
RENAL AND LIVER FUNCTIONS.
DENTAL X-RAY.
EYE DISEASE.
PULMONARY FUNCTIONS.
SKIN EXAM.

RESPIRATORY HISTORY.
COMPLETE BLOOD COUNT.
BLOOD CHEMISTRY.
WITH EMPHASIS ON: GUMS AND TEETH.

RE

ROUTE OF ENTRY:
INHALATION. SKIN ABSORPTION. INGESTION. SKIN OR EYE CONTACT.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. EYES. CARDIOVASCULAR SYSTEM.
KIDNEYS. LIVER. TEETH. JAW. BLOOD.

SP

SYMPTOMS:
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). COUGHING, FORCEFUL EXPIRATION (SC0173). DYSPNEA, DIFFICULTY IN BREATHING (SC0052).
HALITOSIS, OFFENSIVE BREATH (SC0333).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181). ABDOMINAL CRAMPS, PAINFUL SPASMS OF ABDOMINAL AREA (SC0218). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). DIARRHEA, UNCONTROLLED LOOSE BOWELS (SC0046). UNCONSCIOUSNESS, NOT AWAKE; INSENSIBLE (SC0198).
BONE, PART OF THE SKELETON (SC0185);
NECROSIS, DEAD TISSUE SURROUNDED BY WELL TISSUE(SC0116). WEAKNESS, LACK OF STRENGTH (SC0167). ANEMIA, RED BLOOD CELLS LESS THAN NORMAL (SC0004). ANOREXIA, DIMINISHED APPETITE (SC0006). BRONCHITIS, INFLAMED BRONCHIAL MUCOUS MEMBRANES (SC0017). TOOTHACHE, PAIN IN A TOOTH (SC0461). VESICULATION, BLISTERING (SC0164). PHOTOPHOBIA, INTOLERANCE TO LIGHT (SC0131). SHOCK, SUDDEN PHYSICAL OR MENTAL DISTURBANCE(SC0228).
BLEPHAROSPASM, SPASMODIC WINKING (SC0449).
SKIN, COVERING OF BODY (SC0174);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175).
EYE, ORGAN OF SIGHT (SC0170);
BURNS, TISSUE DAMAGE FROM HEAT (SC0175). THIRST, DESIRE FOR WATER (SC0210). HEMATEMESIS, BLOODY VOMITUS (SC0273). OLIGURIA, DECREASED URINATION (SC0323). ALBUMINURIA, ALBUMIN (PROTEIN) IN URINE (SC0002).
ANURIA, COMPLETE LACK OF URINATION (SC0304).
CARDIAC, PERTAINING TO HEART (SC0023);
ARRHYTHMIA, ABSENCE OF RHYTHM; IRREGULARITY (SC0010).
SKIN, COVERING OF BODY (SC0174);
ERUPTION, A RASH OR LESION (SC0602). DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). DELIRIUM, STATE OF DISORIENTATION, CONFUSION (SC0288). HYPOTENSION, LOW BLOOD PRESSURE (SC0180). CYANOSIS, DARK BLUE/PURPLE SKIN COLOR (SC0038). HYPOGLYCEMIA, ABNORMALLY LOW BLOOD SUGAR (SC0321). KIDNEY DAMAGE, INJURY TO THE KIDNEY (SC0220). LIVER DAMAGE, INJURY TO THE LIVER (SC0221). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031). STOMATITIS, INFLAMMATION OF THE MOUTH (SC0395).
LACRIMATION, DISCHARGE OF TEARS (SC0096). CONVULSIONS, SUDDEN MUSCLE CONTRACTIONS (SC0034). COMA, STATE OF DEEP UNCONSCIOUSNESS (SC0583).
CARDIAC, PERTAINING TO HEART (SC0023);
ARREST, A STOPPAGE (SC0577).
CIRCULATORY, PERTAINING TO CIRCULATION (SC0613);
COLLAPSE, EXTREME PROSTRATION (SC0029).

HEPATIC, PERTAINING TO THE LIVER (SC0081);
FAILURE, LOSS OF FUNCTION (SC0386).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 8)
IF THIS CHEMICAL GETS INTO THE EYES, WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 8)
PHOSPHORUS BURNS IN THE SKIN SHOULD BE IMMERSED IMMEDIATELY IN WATER TO AVOID CONTACT WITH AIR. PHOSPHORUS PARTICLES ARE REMOVED GENTLY UNDER WATER AND THE WOUND IS WASHED WITH 1% COPPER SULFATE SOLUTION TO COAT THE RESIDUAL PARTICLES WITH A PROTECTIVE FILM OF COPPER PHOSPHIDE; THESE FLUORESCE AND CAN BE READILY REMOVED IN A DARKENED ROOM. FOLLOWING INITIAL TREATMENT, CHEMICAL BURNS SHOULD BE TREATED AS THERMAL BURNS OF COMPARABLE SIZE AND EXTENT. (MERCK MANUAL, 15TH ED.). FOR BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 8)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 8)
PHOSPHORUS/PHOSPHINE/PHOSPHIDE EXPOSURE: EMERGENCY TREATMENT - REMOVE POISON BY GASTRIC LAVAGE WITH 5-10 L OF TAP WATER. IF A GASTRIC TUBE IS NOT IMMEDIATELY AVAILABLE, INDUCE EMESIS. TREATMENT MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. FURTHER TREATMENT - TREAT PULMONARY EDEMA AND SHOCK. GIVE 10% CALCIUM GLUCONATE, 10 ML INTRAVENOUSLY, TO MAINTAIN SERUM CALCIUM. GIVE 1-4 LITERS OF 5% GLUCOSE IN WATER OR 10% INVERT SUGAR IN WATER INTRAVENOUSLY DAILY UNTIL A HIGH CARBOHYDRATE DIET CAN BE GIVEN ORALLY. TREAT HEPATIC FAILURE. GET MEDICAL ATTENTION IMMEDIATELY. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(5 OF 8)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY

IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(6 OF 8)
PULMONARY EDEMA - RELIEVE ANXIETY. GIVE MORPHINE SULFATE, 10 MG, TO DECREASE RATE OF RAPID, INEFFICIENT RESPIRATION. GIVE 40% OXYGEN BY FACE MASK. USE INTERMITTENT POSITIVE-PRESSURE OXYGEN RESUSCITATOR FOR SHORT PERIODS. GIVE AMINOPHYLLINE, 0.5 G, INTRAVENOUSLY, TO RELIEVE ASSOCIATED BRONCHIAL CONSTRICTION. TREAT EDEMA CAUSED BY MORPHINE OR MORPHINE ANALOGS BY GIVING NALOXONE AND OXYGEN. GENERAL MEASURES - DIURESIS WITH ETHACRYNIC ACID (EDECRIN), 25 MG ORALLY OR INTRAVENOUSLY, OR FLUROSEMIDE, 20-80 MG ORALLY OR INTRAVENOUSLY, IS HELPFUL BECAUSE IT REDUCES FLUID VOLUME. DO NOT INJECT AT A RATE FASTER THAN 10 MG/MIN. GIVE CORTICOSTEROID ANTI-INFLAMMATORY AGENT IN MAXIMUM DOSES. IF PULMONARY EDEMA IS THE RESULT OF HEART FAILURE, DIGITALIZE THE PATIENT. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(7 OF 8)
CIRCULATORY FAILURE/SHOCK - PLACE PATIENT IN SUPINE POSITION WITH FEET ELEVATED. ESTABLISH AND MAINTAIN AN ADEQUATE AIRWAY. MAINTAIN BODY WARMTH BY APPLICATION OF BLANKETS, BUT DO NOT APPLY EXTERNAL HEAT. RELIEVE PAIN WITH MORPHINE SULFATE, 10 MG/70 KG SUBCUTANEOUSLY OR INTRAVENOUSLY, FOR OTHERWISE UNCONTROLLABLE PAIN. DO NOT GIVE MORPHINE TO UNCONSCIOUS OR STUPOROUS PATIENTS. PATIENTS WITH DEPRESSED RESPIRATION SHOULD NOT BE GIVEN MORPHINE UNLESS PERSONNEL AND EQUIPMENT TO MAINTAIN RESPIRATION ARE IMMEDIATELY AVAILABLE. RESTORE AND MAINTAIN ADEQUATE BLOOD VOLUME. PROCEDURE MUST PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

(8 OF 8)
LIVER DAMAGE - DISCONTINUE ALL DRUGS AND CHEMICALS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING IS SEVERE AND ORAL FLUIDS ARE NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 5-10% DEXTROSE IN 0.3-0.5 N SALINE. ADMINISTER MAINTENANCE FLUIDS AND ELECTROLYTES AS NECESSARY, DEPENDING ON RENAL FUNCTION. RESUME ORAL FEEDINGS AS SOON AS THE PATIENT CAN TOLERATE THEM. CONTROL THE AMOUNT OF PROTEIN IN THE DIET IN ORDER TO CORRECT THE SERUM PROTEIN LEVEL. GIVE VITAMIN K, PHYTONADIONE, 2.5 MG DAILY. IF ANEMIA IS SEVERE, CONSIDER A BLOOD TRANSFUSION. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

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AN ACCESSION NUMBER: 1684. 9208.

CN CHEMICAL NAME: ISOPROPYL ALCOHOL.

SYNONYMS: ISOPROPANOL. ETHYL CARBINOL. PETROHOL. DIMETHYLCARBINOL. PRO. AVANTIN. UN 1219. ISOHOL. PROPAN-2-OL. 2-PROPANOL. SEC-PROPYL ALCOHOL. COMBI-SCHUTZ. ALCOSOLVE. N-PROPAN-2-OL. TAKINEOCOL. ALCOJEL. IMSOL A. PROPOL. STCC 4904205.

RN CAS NUMBER: 67-63-0.

REG. TOXIC NUMBER: NT8050000.

CHEMICAL FORMULA: C3H8O.

PD

PHYSICAL DESCRIPTION:
COLORLESS LIQUID WITH AN ODOR OF ALCOHOL.

| | |
|---|---|
| MOL WT: | 60.10 |
| BOILING PT: | 180 F (82 C) |
| SOLUBILITY: | SOLUBLE |
| FLASH PT: | 52 F (12 C) |
| VAPOR PRES: | 40 MMHG @ 24 C |
| MELT PT: | -129 F (-89 C) |
| UEL IN AIR: | 12.7% @ 93 C |
| LEL IN AIR: | 2% |
| MEC IN AIR: | 750 F (399 C) |
| SPEC GRAVITY: | 0.7855 |
| VAPOR DENSITY: | 2.1 |
| ODOR THRESHOLD: | 40-45 PPM |
| OCTANOL/WATER CO-EFFICIENT: | -0.16/0.28 (CALC.). |

PERMISSABLE EXPOSURE:
400 PPM OSHA TWA; 500 PPM OSHA STEL
400 PPM ACGIH TWA; 500 PPM ACGIH STEL
400 PPM NIOSH RECOMMENDED 10 HR TWA
500 PPM NIOSH RECOMMENDED STEL
HUMAN SUFFICIENT EVIDENCE FOR CARCINOGENICITY (IARC GROUP-1 FOR MANUFACTURING, STRONG-ACID PROCESS)
HUMAN/ANIMAL INADEQUATE EVIDENCE FOR CARCINOGENICITY (IARC GROUP-3)
REPRODUCTIVE EFFECTS DATA (RTECS); MUTAGENIC DATA (RTECS)
AQUATIC TOXICITY RATING 1 (TLM96:1000-100 PPM)
CRITICAL RANGE, 24H - CREEK CHUB 900-1100 PPM
CERCLA HAZARD RATINGS - TOXICITY 2 - IGNITABILITY 3 - REACTIVITY 0 - PERSISTENCE 0
TOXICOLOGY: ISOPROPYL ALCOHOL IS AN EYE AND MUCOUS MEMBRANE IRRITANT AND MAY BE IRRITATING TO THE SKIN. IT IS SLIGHTLY TOXIC BY INGESTION AND SKIN ABSORPTION. IT IS A CENTRAL NERVOUS SYSTEM DEPRESSANT. POISONING MAY AFFECT THE RESPIRATORY SYSTEM AND KIDNEYS. EXPOSURE TO ISOPROPYL ALCOHOL AT THE PERMISSIBLE EXPOSURE LIMIT MAY RESULT IN MILD IRRITATION OF THE NOSE AND THROAT. AT 800 PPM THE IRRITATION WAS NOT SEVERE BUT UNCOMFORTABLE. SYMPTOMS FROM INGESTION MAY INCLUDE CENTRAL NERVOUS SYSTEM DEPRESSION AND HYPOGLYCEMIA, TENDERNESS AND EDEMA OF MUSCLES, AND ARRHYTHMIAS. DEPRESSED RESPIRATION AND DEATH DUE TO RESPIRATORY PARALYSIS MAY OCCUR IN A FEW HOURS AFTER EXPOSURE. THERE HAS BEEN AN INCREASED INCIDENCE OF CANCER OF THE PARANASAL SINUSES, AND POSSIBLY THE LARYNX, IN THE MANUFACTURING OF ISOPROPYL ALCOHOL BY THE STRONG ACID PROCESS, INVOLVING THE FORMATION OF ISOPROPYL OILS. IT IS NOT CLEAR WHICH SUBSTANCES ARE RESPONSIBLE.
ISOPROPYL ALCOHOL IS TREATED AS A MATERIAL WITH GOOD WARNING PROPERTIES SINCE ITS ODOR CAN BE DETECTED AT OR BELOW THE PERMISSIBLE EXPOSURE LIMIT. THE THRESHOLD LIMIT VALUE WAS ESTABLISHED BASED ON EYE, NOSE AND THROAT IRRITATION.
PERSONS WITH PRE-EXISTING SKIN DISORDERS OR IMPAIRED LIVER, RENAL AND

ORL-HMN TDLO: 223 MG/KG ORL-MAN TDLO: 14,432 MG/KG
ORL-RAT LD50: 5045 MG/KG SKN-RBT LD50: 12,800 MG/KG

29CFR1910.1200 OSHA HAZARD COMMUNICATION STANDARD REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF A HAZARD COMMUNICATION PROGRAM, LABELS AND OTHER FORMS OF WARNING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING. REQUIRES DISTRIBUTORS TO TRANSMIT REQUIRED INFORMATION TO EMPLOYEES.

DANGEROUS EXPOSURE:
20,000 PPM OSHA/NIOSH
COLORLESS LIQUID WITH AN ODOR.

IC

INCOMPATIBILITIES:
SEND BACK AREA EXCEDED. ALUMINUM: DISSOLUTION IS EXOTHERMIC BARIUM PERCHLORATE: FORMATION OF EXPLOSIVE COMPOUND. 2-BUTANONE: (METHYL ETHYL KETONE): ACCELERATES THE PEROXIDATION OF THE ALCOHOL. CHROMIUM TRIOXIDE (GRANULAR): IGNITION. COATINGS: MAY BE ATTACKED. DIOXYGENYL TETRAFLUOROBORATE: IGNITION AT AMBIENT TEMPERATURES. HYDROGEN + PALLADIUM (PARTICLES): IGNITION ON EXPOSURE TO AIR. HYDROGEN PEROXIDE: FORMATION OF EXPLOSIVE COMPOUND. KETONES: MARKEDLY INCREASES THE POSSIBILITY OF PEROXIDATION. NITROFORM (TRINITROMETHANE): DISSOLVES LIBERATING HEAT AND POSSIBLY EXPLODING. OLEUM: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER. OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD. OXYGEN (GAS): AUTOXIDATION, ON EXPOSURE TO LIGHT, RESULTS IN FORMATION OF KETONES AND POTENTIALLY EXPLOSIVE HYDROGEN PEROXIDE. PHOSGENE: IN THE PRESENCE OF IRON SALTS, MAY EXPLODE. PLASTICS: MAY BE ATTACKED. POTASSIUM TERT-BUTOXIDE: IGNITION. RUBBER: MAY BE ATTACKED. SODIUM DICHROMATE + SULFURIC ACID: EXOTHERMIC REACTION WITH POSSIBLE INCANDESCENCE.

CL

CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).
EMPLOYERS SHALL ENSURE THAT CLOTHING WET WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OPERATION OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.
-ACGIH "GUIDELINES FOR THE SELECTION OF CHEMICAL PROTECTIVE CLOTHING" INDICATED THE FOLLOWING PROTECTIVE RATINGS FOR MATERIALS COMMONLY USED FOR PROTECTIVE CLOTHING. THESE RATINGS ARE BASED PRIMARILY ON QUANTITATIVE TEST RESULTS AND QUALITATIVE RESISTANCE INFORMATION. (THE RECOMMENDATIONS APPLY TO THE PURE SUBSTANCE ONLY; BREAKTHROUGH-TIME MAY VARY FOR MIXTURES.) (A "+" DESIGNATES A BLEND OF MATERIALS, WHILE A "/" DESIGNATES A COATED OR LAMINATED MATERIAL.) -
ISOPROPYL ALCOHOL: EXCELLENT/GOOD: NEOPRENE NITRILE TEFLON GOOD/FAIR: BUTYL CHLORINATED POLYETHYLENE NATURAL RUBBER+NEOPRENE+NITRILE VITON/NEOPRENE CHLOROBUTYL VITON BUTYL/NEOPRENE STYRENE-BUTADIENE RUBBER POOR/FAIR: NITRILE+POLYVINYL CHLORIDE POLYVINYL CHLORIDE NEOPRENE/NATURAL RUBBER POOR: NEOPRENE+NATURAL RUBBER POLYETHYLENE NATURAL RUBBER.

WEAR EYE PROTECTION TO PREVENT:
FOLLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS":
EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE SPLASH-PROOF SAFETY GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE THIS LIQUID

EMPLOYEE SHOULD WASH:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES WET WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

WORK CLOTHING SHOULD BE CHANGED DAILY:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE CONTAMINANT AND THE EXTENT OF EXPOSURE, CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

REMOVE CLOTHING:
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':
EMPLOYERS SHALL ENSURE THAT ANY CLOTHING WHICH BECOMES WET WITH THIS FLAMMABLE LIQUID BE REMOVED IMMEDIATELY AND NOT REWORN UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

THE FOLLOWING EQUIPMENT SHOULD BE AVAILABLE:
NO SPECIFIC REQUIREMENT. IF INDICATED BY THE NATURE OF THE SUBSTANCE AND THE PROBABILITY OF EXPOSURE, PROVIDE AN EYE WASH AND FACILITIES FOR QUICK DRENCHING OF THE BODY WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

RP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED):
1000 PPM
- POWERED AIR-PURIFYING RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE
- CHEMICAL CARTRIDGE RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE WITH A FULL FACE-PIECE

10,000 PPM
- SUPPLIED-AIR RESPIRATOR OPERATED IN CONTINUOUS FLOW MODE

12,000 PPM
- GAS MASK WITH AN ORGANIC VAPOR CANISTER (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACE-PIECE

ESCAPE
- GAS MASK WITH AN ORGANIC VAPOR CANISTER (CHIN-STYLE OR FRONTOR BACK-MOUNTED CANISTER)
- APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACE-PIECE OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE WITH AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

MS

MEDICAL SURVEILLANCE:
GENERAL MEDICAL HISTORY.
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR.
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
PHYSICIAN PRE-PLACEMENT AND ANNUAL EXAMS.
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION.
OSHA: SKIN DISEASE.

KIDNEY FUNCTION.
CHRONIC RESPIRATORY DISEASE.
29CFR1910.20 OSHA STANDARD SUBPART C - GENERAL SAFETY AND HEALTH PROVISIONS PROVIDES FOR EMPLOYEE, DESIGNATED REPRESENTATIVE, AND OSHA ACCESS TO EMPLOYER-MAINTAINED EXPOSURE AND MEDICAL RECORDS RELEVANT TO EMPLOYEES EXPOSED TO TOXIC SUBSTANCES AND HARMFUL PHYSICAL AGENTS.
53FR38140 9/29/88 (AMENDED).

RE

ROUTE OF ENTRY:
INHALATION. SKIN OR EYE CONTACT. SKIN ABSORPTION. INGESTION.

TO

TARGET ORGANS:
EYES. SKIN. RESPIRATORY SYSTEM. CENTRAL NERVOUS SYSTEM. KIDNEYS.

SP

SYMPTOMS:
SKIN, COVERING OF BODY (SC0174);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
EYE, ORGAN OF SIGHT (SC0170);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090).
MUCOUS MEMBRANE, MEMBRANE LINING PASSAGES/CAVITIES (SC0109);
IRRITATION, EXTREME REACTION TO A CONDITION (SC0090). DERMATITIS, INFLAMMATION OF SKIN (SC0044). ERYTHEMA, REDNESS, SPOTS ON SKIN (SC0060). CONJUNCTIVITIS, INFLAMMATION OF EYES (SC0031). IRITIS, INFLAMMATION OF THE IRIS (SC0471).
CORNEAL, TRANSPARENT MEMBRANE OVER EYE (SC0035);
OPACITY, LACK OF TRANSPARENCY (SC0121).
ABDOMINAL, SECTION BETWEEN THORAX AND PELVIS (SC0750);
PAIN, SUFFERING, EITHER PHYSICAL OR MENTAL (SC0182). HEMATEMESIS, BLOODY VOMITUS (SC0273). NAUSEA, SICKNESS AT THE STOMACH (SC0115). VOMITING, PERTAINING TO NAUSEA (SC0166). HEMORRHAGE, BLEEDING (SC0080).
CENTRAL NERVOUS SYSTEM, PERTAINING TO NEURAL BODY SYSTEM (SC0028);
DEPRESSION, DECREASE IN ACTIVITY/FUNCTION (SC0043). HEADACHE, PAIN IN HEAD OR CRANIUM AREA (SC0075). DIZZINESS, FEELING FAINT, LIGHT-HEADED, UNSTEADY(SC0048). FACE/NECK FLUSHED, VASODILATION WITH HEAT OF FACE/NECK (SC0215). INCOORDINATION, LACK OF COORDINATION (SC0085). STUPOR, LETHARGY, UNCONSCIOUSNESS (SC0214). CONFUSION, IN A BEWILDERED STATE (SC0030). HYPOTENSION, LOW BLOOD PRESSURE (SC0180). AREFLEXIA, ABSENCE OR LOSS OF REFLEXES (SC0444). NARCOSIS, STUPOR OR SLEEP DUE TO NARCOTIC (SC0113). OLIGURIA, DECREASED URINATION (SC0323). DIURESIS, EXCESS SECRETION OF URINE (SC0511). HYPOGLYCEMIA, ABNORMALLY LOW BLOOD SUGAR (SC0321).
MUSCLE, TISSUE RESPONSIBLE FOR MOTION (SC0623);
TENDERNESS, PAINFULNESS TO PRESSURE OR CONTACT (SC0159).
MUSCLE, TISSUE RESPONSIBLE FOR MOTION (SC0623);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181).
CARDIAC, PERTAINING TO HEART (SC0023);
ARRHYTHMIA, ABSENCE OF RHYTHM; IRREGULARITY (SC0010).
RESPIRATORY, PERTAINING TO THE LUNGS (SC0142);
PARALYSIS, LOSS OF POWER OF VOLUNTARY MOVEMENT (SC0124). KIDNEY DAMAGE INJURY TO THE KIDNEY (SC0220). TRACHEOBRONCHITIS, INFLAMMATION OF TRACHEA AND BRONCHI (SC0160).
BRONCHIAL, PERTAINING TO THE BRONCHI (SC0346);
PNEUMONIA, ACUTE INFECTIOUS DISEASE OF LUNGS (SC0136).
PULMONARY, PERTAINING TO THE RESPIRATORY TRACT (SC0500);
EDEMA, FLUID RETENTION WITH SWELLING (SC0181).
KIDNEY, POST-PERITONEUM ORGAN FOR URINE WASTE(SC0094);
EFFECTS, SIGNS AND SYMPTOMS (SC0579).
PARANASAL SINUS, SINUS NEAR NASAL CAVITIES (SC0232);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
LARYNX, VOICE ORGAN (SC0256);
CANCER, MALIGNANT TUMOR OR NEOPLASM (SC0020).
REPRODUCTIVE EFFECTS, BIRTH DEFECTS (SC0281);
IN EXPERIMENTAL ANIMALS, (SC0212).

FA

FIRST AID.

(1 OF 5)
IF THIS CHEMICAL GETS INTO THE EYES, WASH THE EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(2 OF 5)
IF THIS CHEMICAL GETS ON THE SKIN, REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

(3 OF 5)
IF THIS CHEMICAL HAS BEEN INHALED, REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

(4 OF 5)
INGESTED ALCOHOLS: REMOVE INGESTED MATERIAL BY GASTRIC LAVAGE OR EMESIS. GIVE ARTIFICIAL RESPIRATION WITH OXYGEN IF RESPIRATION IS DEPRESSED. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). GET MEDICAL ATTENTION IMMEDIATELY. ADMINISTRATION OF GASTRIC LAVAGE SHOULD BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL.

(5 OF 5)
GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM THE MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF THE TEETH, DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA. AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER. IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE. PROCEDURE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

DT
SPECIAL DIAGNOSTIC TESTS AND INDEXES OF EXPOSURE:
IF SYMPTOMS OF CENTRAL NERVOUS SYSTEM OCCUR, OBTAIN BLOOD GLUCOSE AND RECTAL TEMPERATURE. PERFORM COMPLETE NEUROLOGIC EXAMINATION AND ANY OTHER SPECIFIC NEUROLOGIC TESTS AS APPLCABLE.
BLOOD ALCOHOL.

ASELINE LIV
ER DOCUMENT SELECTION._:

END OF DOCUMENTS IN LIST_:
BRS SEARCH MODE - ENTER QUERY
2_: ..OFF

*CONNECT TIME 0:03:26 HH:MM:SS 0.057 DEC HRS SESSION 176

MATERIAL MAY
(Title 17, U.S.

# Occupational Health Guideline for Dinitrotoluene

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula: 2,4-$(NO_2)_2C_6H_3CH_3$
- Synonyms: 2,4-Dinitrotoluene; DNT
- Appearance and odor: Orange-yellow solid (sometimes shipped molten in tank cars) with a characteristic odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for dinitrotoluene is 1.5 milligrams of dinitrotoluene per cubic meter of air (mg/m³) averaged over an eight-hour work shift.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Dinitrotoluene can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed; It is readily absorbed through the skin. Even a small amount absorbed from clothes or shoes may cause toxic symptoms.

- **Effects of overexposure**

*1. Short-term Exposure:* Dinitrotoluene affects the ability of blood to carry oxygen normally. A bluish discoloration of the skin may occur with headache, irritability, dizziness, weakness, nausea, vomiting, shortness of breath, drowsiness, and unconsciousness. If treatment is not given promptly, death may occur. The onset of symptoms may be delayed. The ingestion of alcohol may cause increased susceptibility to the effects of dinitrotoluene.

*2. Long-term Exposure:* Repeated or prolonged exposure to dinitrotoluene may cause anemia and jaundice.

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to dinitrotoluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to dinitrotoluene at potentially hazardous levels:

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the blood, liver, and cardiovascular system should be stressed.

—A complete blood count: Dinitrotoluene has been shown to cause methemoglobinemia. Those with blood disorders may be at increased risk. A complete blood count should be performed, including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit. Observe for Heinz bodies.

—Liver function tests: Since liver damage has been observed in humans exposed to dinitrotoluene, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

*2. Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis. Methemoglobin determinations should be performed at any time overexposure is suspected or signs and symptoms of toxicity occur. The level of dinitrotoluene in the urine should be determined; excretion of dinitrotoluene in excess of 25 mg/liter indicates significant absorption.

- **Summary of toxicology**

Dinitrotoluene absorption, whether from inhalation of the vapor or absorption of the solid through skin, causes anoxia due to the formation of methemoglobin; jaundice and anemia have been reported. Signs and symptoms of

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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overexposure are due to the loss of oxygen-carrying capacity of the blood. Rapid absorption through the intact skin is frequently the main route of entry. The onset of symptoms of methemoglobinemia is often insidious, and may be delayed for up to 4 hours; headache is commonly the first symptom and may become quite intense as the severity of methemoglobinemia progresses. Cyanosis develops early in the course of intoxication, first in the lips, the nose, and the ear lobes, and is often recognized by fellow workers. Cyanosis occurs when the methemoglobin concentration is 15% or more. The individual may feel well, have no complaints, and may insist that nothing is wrong until the methemoglobin concentrations approaches approximately 40%. At methemoglobin concentrations of over 40% there usually is weakness and dizziness; at up to 70% concentration there may be ataxia, dyspnea on mild exertion, tachycardia, nausea, vomiting, and drowsiness. Ingestion of alcohol is reported to aggravate the toxic effects of dinitrotoluene.

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 182.1
2. Boiling point (760 mm Hg): Slow decompostion at 250 C (482 F); self-sustained decomposition at 270 C (518 F)
3. Specific gravity (water = 1): Solid: 1.52; Liquid: 1.32
4. Vapor density (air = 1 at boiling point of dinitrotoluene): Not applicable (too high boiling)
5. Melting point: 70 C (158 F)
6. Vapor pressure at 20 C (68 F): 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.03
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Temperatures above 250 C (482 F)
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with caustics and chemically active metals such as tin or zinc may cause evolution of heat and increase in pressure.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving dinitrotoluene.
4. Special precautions: Liquid dinitrotoluene will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: 206.7 C (404 F) (closed cup)
2. Autoignition temperature: Data not available
3. Impact sensitivity (minimum fall of a 2 kg weight to cause at least one explosion in ten trials): Greater than 100 centimeters
4. Flammable limits in air, % by volume: Not available
4. Extinguishant: Water, dry chemical, carbon dioxide

- **Warning properties**

1. Odor Threshold: No quantitative information is available concerning the odor threshold of dinitrotoluene.
2. Eye Irritation Level: Grant states that "a severe burn of the skin, eyelids, and cornea of one eye, with permanent scarring, has been attributed in one instance to hot fumes of dinitrotoluene." There is no quantitative information available concerning the concentrations which would produce these effects.
3. Evaluation of Warning Properties: Since no quantitative information is available relating the warning properties of dinitrotoluene to air concentration, this substance is treated as a material with poor warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for dinitrotoluene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

## RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with molten dinitrotoluene.
- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with dinitrotoluene or liquids containing dinitrotoluene, where skin contact may occur.
- If employees' clothing may have become contaminated with solid dinitrotoluene, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing contaminated with dinitrotoluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of dinitrotoluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the dinitrotoluene, the person performing the operation should be informed of dinitrotoluene's hazardous properties.
- Where exposure of an employee's body to dinitrotoluene or liquids containing dinitrotoluene may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes wet with molten dinitrotoluene or liquids containing dinitrotoluene should be removed immediately and non-impervious clothing which becomes contaminated with solid dinitrotoluene should be removed promptly and such clothing should not be reworn until the dinitrotoluene is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of molten dinitrotoluene contacting the eyes.

## SANITATION

- Skin that becomes wet with molten dinitrotoluene or liquids containing dinitrotoluene should be immediately washed or showered with soap or mild detergent and water to remove any dinitrotoluene.
- Workers subject to skin contact with dinitrotoluene or liquids containing dinitrotoluene should wash with soap or mild detergent and water any areas of the body which may have contacted dinitrotoluene at the end of each work day.
- Skin that becomes contaminated with dinitrotoluene should be promptly washed or showered with soap or mild detergent and water to remove any dinitrotoluene.
- Eating and smoking should not be permitted in areas where dinitrotoluene or liquids containing dinitrotoluene are handled, processed, or stored.
- Employees who handle dinitrotoluene or liquids containing dinitrotoluene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to dinitrotoluene may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Use in the manufacture of toluene diisocyanate for production of polyurethane plastics | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment |
| Use in production of military and some commercial explosives; use to plasticize cellulose nitrate in explosives; use to moderate burning rate of propellants and explosives; use in manufacture of gelatin explosives (less sensitive to shock or friction); use as a waterproofing coating for some smokeless powders; use as an intermediate in TNT manufacture | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment |
| Use in manufacture of azo dye intermediates; use in organic synthesis in preparation of toluidines, dyes, and explosives | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If dinitrotoluene or liquids containing dinitrotoluene get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. If molten dinitrotoluene gets into the eyes, flush the eyes immediately with large amounts of water to remove heat. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If dinitrotoluene or liquids containing dinitrotoluene get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If dinitroto-

luene or liquids containing dinitrotoluene penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately. If molten dinitrotoluene gets on the skin, immediately flush the skin with water to remove heat. Wash the skin with soap or mild detergent and water. Get medical attention immediately.

• **Breathing**

If a person breathes in large amounts of dinitrotoluene, 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.

• **Swallowing**

When dinitrotoluene has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If dinitrotoluene is spilled, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill.
3. For small quantities, sweep onto paper or other suitable material and burn in a suitable combustion chamber which allows burning in an unconfined condition and is equipped with an appropriate effluent gas cleaning device. Large quantities may be reclaimed; however, if this is not practical, dissolve in fuel oil and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
4. If in the molten form, allow to cool and solidify and treat as in (3) above.

• Waste disposal methods:

Dinitrotoluene may be disposed of:

1. By making packages of dinitrotoluene in paper or other flammable material and burning in a suitable combustion chamber which allows burning in an unconfined condition and is equipped with an appropriate effluent gas cleaning device.
2. By dissolving dinitrotoluene in fuel oil and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

## REFERENCES


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## RESPIRATORY PROTECTION FOR DINITROTOLUENE

| Condition | Minimum Respiratory Protection* Required Above 1.5 mg/m³ |
|---|---|
| Particulate or Vapor Concentration | |
| 15 mg/m³ or less | Any supplied-air respirator.<br>Any self-contained breathing apparatus. |
| 75 mg/m³ or less | Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| 200 mg/m³ or less | A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode. |
| Greater than 200 mg/m³ or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors and particulates.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

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## INTRODUCTION

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## SUBSTANCE IDENTIFICATION

- Formula: $CH_3C_6H_2(NO_2)_3$
- Synonyms: TNT; trinitrotoluol; 2,4,6-trinitrotoluene; sym-trinitrotoluene
- Appearance and odor: Colorless to pale yellow, odorless solid.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for trinitrotoluene is 1.5 milligrams of trinitrotoluene per cubic meter of air (mg/m³) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for trinitrotoluene a Threshold Limit Value of 0.5 mg/m³ with a skin notation.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Trinitrotoluene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

Exposure to trinitrotoluene can cause liver damage with yellow jaundice and anemia which may be fatal. It may also cause irritation of the eyes, nose, and throat with sneezing, cough, and sore throat. It may cause a skin rash and stain the skin, hair, and nails a yellowish color. It may affect the ability of the blood to carry oxygen. This may result in a bluish discoloration of the skin, weakness, drowsiness, shortness of breath and unconsciousness. In addition, it may cause muscular pains, heart irregularities, kidney irritation, cataracts of the eyes, menstrual irregularities, and nerve damage.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to trinitrotoluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to trinitrotoluene at potentially hazardous levels:

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of asthma, allergies, or known sensitization to trinitrotoluene would be expected to be at increased risk from exposure. Examination of the blood, liver, eyes, cardiovascular system, nervous system, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Trinitrotoluene has been shown to cause aplastic anemia in humans. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

—Liver function tests: Since liver damage has been observed in humans exposed to trinitrotoluene, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has been observed in humans exposed to trinitrotoluene, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

*2. Periodic Medical Examination:* The aforementioned medical examinations should be repeated on a semi-annual basis.

- **Summary of toxicology**

Trinitrotoluene (TNT) dust or fume causes liver

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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damage, aplastic anemia, cyanosis, and dermatitis. There have been numerous fatalities of workers exposed to TNT in munitions plants; in a series of 22 fatal cases, 8 died from toxic hepatitis, 13 from aplastic anemia, and 1 from a combination of both. The vapor or dust can cause irritation of mucous membranes, resulting in sneezing, cough, and sore throat. Although intense or prolonged exposure to TNT may cause some cyanosis, it is not regarded as a strong producer of methemoglobin. Other occasional effects are leukocytosis or leukopenia, peripheral neuritis, muscular pains, cardiac irregularities, and renal irritation. Cataracts have been observed in a considerable proportion of chronically exposed workers; one report indicates that 26 of 61 workers with an average exposure of 8.4 years had a characteristic peripheral cataract. TNT causes sensitization dermatitis; the hands, wrists, and forearms are most commonly affected, but skin at friction points such as the collar line, belt line, and ankles is also often involved; erythema, papules, and an itchy eczema can be severe. The skin, hair, and nails of exposed workers may be stained yellow.

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 227
2. Boiling point (760 mm Hg): 240 C (464 F) (explodes)
3. Specific gravity (water = 1): 1.65
4. Vapor density (air = 1 at boiling point of trinitrotoluene): Not applicable
5. Melting point: 81 C (178 F)
6. Vapor pressure at 85 C (185 F): 0.053 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.013
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Slow decomposition occurs above 180 C (356 F). Exposure to light may increase impact sensitivity. Rapid heating may cause detonation.
2. Incompatibilities: Contact with strong oxidizers may cause fire. Contact with ammonia or with strong alkalies may increase sensitivity to shock. Can react vigorously with oxidizable materials.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving trinitrotoluene.
4. Special precautions: Protect from shock.

- **Flammability**

1. Flash point: Explodes
2. Impact sensitivity (minimum fall of a 2 kg weight to cause at least one explosion in ten trials): 100 cm
3. Explosion temperature (temperature required to cause explosion in five seconds): 475 C (887 F)
4. Extinguishant: Water may be used on small fires. Do not attempt to extinguish large fires.

- **Warning properties**

1. Odor Threshold: No quantitative information is available concerning the odor threshold of TNT.
2. Eye Irritation Level: Grant states that "irritation of the eyes and skin is not uncommon among munitions workers exposed to its dust and fumes." No quantitative information is available concerning the air concentrations which produce the eye irritation.
3. Evaluation of Warning Properties: Since no quantitative information is available relating warning properties to air concentrations of TNT, this substance is treated as a material with poor warning properties. The concentration in saturated air at 20 C might result in a significant exposure relative to the permissible exposure.

## MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

At the time of publication of this guideline, no measurement method for trinitrotoluene had been published by NIOSH.

## RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solid trinitrotoluene or liquids containing trinitrotoluene.

• If employees' clothing may have become contaminated with solid trinitrotoluene, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing which may have become contaminated with solid trinitrotoluene or liquids containing trinitrotoluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of trinitrotoluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the trinitrotoluene, the person performing the operation should be informed of trinitrotoluene's hazardous properties.

• Non-impervious clothing which becomes contaminated with trinitrotoluene should be removed promptly and not reworn until the trinitrotoluene is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where solid trinitrotoluene or liquids containing trinitrotoluene may contact the eyes.

## SANITATION

• Workers subject to skin contact with solid trinitrotoluene or liquids containing trinitrotoluene should wash with soap or mild detergent and water any areas of the body which may have contacted trinitrotoluene at the end of each work day.

• Skin that becomes contaminated with trinitrotoluene should be promptly washed or showered with soap or mild detergent and water to remove any trinitrotoluene.

• Eating and smoking should not be permitted in areas where solid trinitrotoluene or liquids containing trinitrotoluene are handled, processed, or stored.

• Employees who handle solid trinitrotoluene or liquids containing trinitrotoluene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to trinitrotoluene may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Use in the manufacture of shells, bombs, grenades, and mines; use in commercial explosives, and propellant compositions | Process enclosure; local exhaust ventilation; personal protective equipment |
| Use in the production of intermediates for synthesis of dyestuffs and photographic chemicals | Process enclosure; local exhaust ventilation; personal protective equipment |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If trinitrotoluene or liquids containing trinitrotoluene get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If trinitrotoluene or liquids containing trinitrotoluene get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If trinitrotoluene or liquids containing trinitrotoluene penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

• **Breathing**

If a person breathes in large amounts of trinitrotoluene, 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.

• **Swallowing**

When trinitrotoluene or liquids containing trinitrotoluene have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If trinitrotoluene is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Attempt to reclaim spilled material; however, do not sweep or burn unless this is supervised by explosives experts.

• Waste disposal method:

Trinitrotoluene may be disposed of only by explosives experts.

## REFERENCES


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## RESPIRATORY PROTECTION FOR TRINITROTOLUENE

| Condition | Minimum Respiratory Protection* Required Above 1.5 mg/m³ |
|---|---|
| Particulate or Vapor Concentration | |
| 15 mg/m³ or 1.5 ppm or less | Any supplied-air respirator.<br>Any self-contained breathing apparatus. |
| 75 mg/m³ or 7.5 ppm or less | Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| 3000 mg/m³ or 300 ppm or less | A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode. |
| Greater than 3000 mg/m³ or 300 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors and particulates.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

# ATTACHMENT B

# RESPIRATORY PROTECTION PROGRAM

## ATTACHMENT B

## RESPIRATORY PROTECTION PROGRAM FOR NAVSURFWARCENDIV, CRANE, INDIANA, SITE INVESTIGATION

The following respiratory protection program is in accordance with OSHA 29 CFR 1910.134 Respiratory Protection Program requirements. This program governs the selection and use of respirators on-site.

Respirators for the SEC Donohue Inc. field sampling team will be provided by SEC Donohue Inc. The respiratory protection program will be administered by, and is the responsibility of the Corporate Health and Safety Manager (CHSM) and/or SSO for the site. Subcontractors (i.e. drillers) will furnish their own respirators, fit test records, and medical surveillance for their employees. The CHSM and/or SSO will be responsible for ensuring that they are in compliance with this respiratory protection program.

Respirators will be selected according to the hazard and level of protection determined to be needed, by reviewing action levels, by monitoring the breathing zone (BZ), and the decision of the CHSM and/or the SSO. The respirators and levels are:

| Level | Respirator |
|---|---|
| | The determination of level will be based on air monitoring results using an HNu/OVA. |
| B | Positive Pressure-Pressure Demand Self-Contained Breathing Apparatus (SCBA) or Supplied Air Respirator with 5-minute escape bottle. Level B is 5 to 250 ppm above background in breathing zone. |
| C | Full-face air purifying (HEPA) respirator with combination dust and organic vapor/acid gas cartridge. Level C is 1 ppm to 5 ppm above background in the BZ. The full facepiece respirator with combination dust and organic vapor/acid gas cartridge will be appropriate for the dusty conditions and organic vapors that may be encountered. |
| D | No respirator required. Level D is continuous readings to 1 ppm above background or less in the worker's BZ. |

- The respirator users will be fit tested with the size, style, and make of the respirator they will be using on-site. The fit test will be recorded and these Fit Test Records will be maintained in the Command Post.

- Employee respirator training is provided on an annual basis and at site-specific training sessions. This training includes:

  - A discussion of the nature of the respiratory hazards and the dangers if the respirator is not used properly.

  - The reasons that respirators are required for protection, along with any engineering controls that may be used.

  - Instruction in the selection, use, sanitary care, maintenance, proper storage, and limitation of the full facepiece respirator with combination cartridge, and the SCBA.

  - Practice in proper fitting, wearing, adjusting, and checking face seal of the respirator.

  - An opportunity to handle the respirator.

  - Instruction on how to recognize and cope with emergency situations requiring respiratory protection.

  - Explanation of the requirements for a self-contained breathing device for work in unknown concentrations and Immediately Dangerous to Life or Health atmosphere and for fire fighting.

  - Explanation of the medical surveillance program and how it relates to respirator use.

  - Explanation of the requirements for maintaining a tight seal, why beard and facial hair is prohibited, and why use of contact lenses while wearing respirators is prohibited.

Respirators will be assigned to individual workers. Each individual shall be responsible for cleaning and maintaining their assigned respirator. They will be cleaned and disinfected before being reassigned. Respirators will be cleaned after each day of work according to manufacturer's instruction. The cleaning will be done at the Command Post. Used cartridges will be disposed of and replaced with new ones.

After cleaning, the respirators will be inspected and checked for defects such as excessive dirt, cracks or other distortions, scratches, incorrectly mounted lens, broken or worn cartridge holders on the facepiece, breaks, loss of elasticity, broken buckles, and excessively worn serrations on head harness that may cause slippage on the headstraps or head harness.

Further checks include:

- A check of the tightness of the connections.
- A check of the facepiece, valves, connecting tube, and canisters.
- A check of the regulator and warning devices on the SCBA for proper functioning if used.
- For air purifying:
  - Check the exhalation valve after removing its cover for:
    - -- Foreign material, such as detergent residue, dust particles, or human hair under the valve seat.
    - -- Cracks, tears, or distortion in the valve material.
    - -- Improper insertion of the valve body in the facepiece.
    - -- Cracks, breaks, or chips in the valve body, particularly in the sealing surface.
    - -- Missing or defective valve cover.
    - -- Improper installation of the valve in the valve body.
  - Check the air purifying elements for:
    - -- Incorrect cartridges, canister, or filter for the hazard.
    - -- Incorrect installation, loose connections, missing or worn gaskets, or cross threading in holder.
    - -- Expired shelf life of cartridge or canister.

-- Cracks, dents, or breaks in the cartridge or canister case.

-- Evidence of prior use of cartridge or canister, such as broken seal tape, foil, or other sealing material.

- For air supplied respirators, check the air supply system for:

  - Integrity and condition of air supply lines and hoses, including attachments and end fitting.

  - Check the corrugated breathing tube for:

    -- Broken or missing end connectors, gaskets, or O-rings.

    -- Missing or loose hose clamp.

    -- Deterioration (done by stretching hose and looking for cracks).

  - Correct operation and condition of all regulators, valves, or other air-flow regulators.

  - If using a SCBA, check that the cylinder is sufficiently charged for the intended use, preferably fully charged (mandatory on an emergency device). The emergency SCBA will have a tag for logging the monthly inspections.

Monitoring of the work area will be performed and the results will be used to select the appropriate level of protection. Refer to air monitoring section of this HASP (Section 9.0).

This program will be re-evaluated and revisions and updates added regularly.

Persons will not be assigned to tasks requiring the use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. A contracted physician will determine what health and physical conditions are pertinent.

Only those respirators jointly approved by NIOSH/MSHA shall be used. All component parts (i.e. canister, replacement straps, etc.) will be of the same manufacturer.