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FINAL COMPREHENSIVE CORRECTIVE MEASURES STUDY WORK PLAN VOLUME II CNC  
CHARLESTON SC  
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ENSAFE

**VOLUME II**

**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION NAVY  
NAVAL BASE CHARLESTON  
CHARLESTON, SOUTH CAROLINA  
CTO-029**

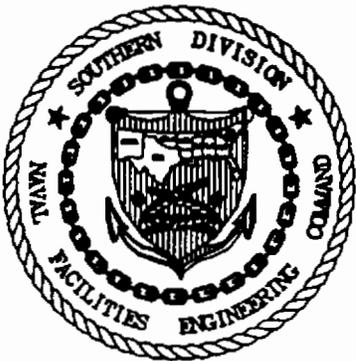


**FINAL COMPREHENSIVE  
CORRECTIVE MEASURES STUDY  
WORK PLAN**

**Prepared for:**

**DEPARTMENT OF THE NAVY  
SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
CHARLESTON, SOUTH CAROLINA**

**SOUTHDIV CONTRACT NUMBER: N62467-89-D-0318**



**Prepared by:**

**ENSAFE/ALLEN & HOSHALL  
5720 SUMMER TREES DRIVE, SUITE 8  
MEMPHIS, TENNESSEE 38134  
(901) 383-9115**

**June 25, 1997**

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**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION NAVY  
CHARLESTON NAVAL WEAPONS STATION  
CHARLESTON, SOUTH CAROLINA  
CTO-0115**



**FINAL COMPREHENSIVE  
CORRECTIVE MEASURES STUDY  
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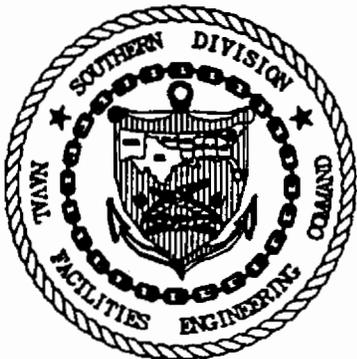
Prepared for:

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Charleston, South Carolina

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Prepared by:

EnSafe/Allen & Hoshall  
5720 Summer Trees Drive, Suite 8  
Memphis, Tennessee 38134  
(901) 383-9115



The Contractor, EnSafe/Allen & Hoshall, hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 is complete, accurate, and complies with all requirements of the contract.

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Signature

Todd Haverkast, P.E.

Name:

Todd Haverkast

Title:

Task Order Manager

June 25, 1997

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**Appendix A Analytical Methods, Sample Containers, Preservation, and Holding Times**

## ACRONYM LIST

ACGIH	American Conference of Governmental Industrial Hygienists
AL	Action Level
AOC	Area of Concern
APEG	Alkaline Polyethylene Glycol
AST	Above Ground Storage Tank
ASTM	American Society of Testing and Materials
BCP	BRAC Cleanup Plan
BCT	BRAC Cleanup Team
BEQ	Bachelor Enlisted Quarters
BNA	Business and National Affairs
BOD	Biological Oxygen Demand
BRAC	Base Realignment and Closure
BTU	British Thermal Unit
CAMU	Corrective Action Management Unit
CAMP	Corrective Action Management Plan
cc	Cubic Centimeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CH <sub>4</sub>	Methane
CHASP	Comprehensive Health and Safety Plan
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Procedures
CM	Corrective Measures
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CNSY	Charleston Naval Shipyard
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
COLIWASA	Composite Liquid Waste Sampler
COPC	Contaminant of Potential Concern
CRP	Community Relations Plan
CRZ	Contaminant Reduction Zone
CSAP	Comprehensive Sampling and Analysis Plan
CSI	Confirmatory Sampling Investigation
CSV	Chlorinated Semivolatiles
CV	Chlorinated Volatiles
°C	Degree Centigrade

DANC	Decontaminating Agent Noncorrosive
DMP	Data Management Plan
DNAPL	Dense Non-aqueous Phase Liquid
DO	Dissolved Oxygen
DOD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
DQO	Data Quality Objective
E/A&H	EnSafe/Allen & Hoshall
EBS	Environmental Baseline Survey
$E_h$	Redox Potential
EIC	Engineer in Charge
ENR	Engineering News Record
EOD	Explosive Ordnance Detachment
EPA	Environmental Protection Agency
ESDLOPQCM	USEPA Environmental Services Division <i>Laboratory Operations and Quality Control Manual</i> (1990)
(ev) <sub>3</sub>	Ionization Potential
EZ	Exclusion Zone
°F	Degree Fahrenheit
FIA	Flame Ionization Analyzer
FID	Flame Ionization Detector
FISC	Fleet Industrial Supply Center
ft <sup>2</sup>	Square Feet
GC	Gas Chromatograph
GIS	Geographic Information System
gm	Gram
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCL	Hydrochloric Acid
HASP	Health and Safety Plan
HSWA	Hazardous and Solid Waste Amendment
IDLH	Immediately Dangerous to Life and Health
IDW	Investigation-Derived Waste
IM	Interim Measure
IR	Installation Restoration
KPEG	Potassium Polyethylene Glycol
L	Liter
LDR	Land Disposal Restriction
LEL	Lower Explosion Limit
LFG	Landfill Gas
LTTD	Low Temperature Thermal Desorption

M&S	Marshall & Stevens
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MD	Maryland
mil	One-thousands of an Inch
ml	Milliter
mg/L	Milligram per Liter
mg/m <sup>3</sup>	Milligram per Cubic Meter
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
N/A	Not Applicable
NaOH	Sodium Hydroxide
NAVBASE	Naval Base Charleston
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Contingency Plan
NCR	NEESA Contract Representative
NCSD	North Charleston Sewer District
NCSV	Non-chlorinated Semivolatile
NCV	Non-chlorinated Volatile
NEESA	Naval Energy and Environmental Support Activity
NFA	No Further Action
NFESC	Naval Facilities Engineering Support Center
NIOSH	National Institute for Occupational Safety and Health
NMOC	Non-methane Organic Compound
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System
NRRC	Naval Reserve Readiness Center
NTU	Nephelometric Turbidity Unit
O <sub>2</sub>	Oxygen
OB/OD	Open Burn/Open Detonation
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit
pH	Hydrogen Ion Measurement
PAH	Polyaromatic Hydrocarbons
PHSO	Project Health and Safety Officer

PID	Photoionization Detector
PMO	Project Management Office
PMP	Project Management Plan
POL	Petroleum, Oil, and Lubricants
Poly	Polyethylene
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
ppm	Parts per Million
PRG	Preliminary Remedial Goal
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAP	Quality Assurance Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RAB	Restoration Advisory Board
RAC	Response Action Contractor
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
redox	Oxidation/Reduction Potential
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGO	Remedial Goal Option
$R_i$	Radius of Influence
rpm	Revolutions per Minute
RTC	Response to Comments
SAP	Sampling and Analysis Plan
SAR	Supplied Air Respirator
SCBA	Self-contained Breathing Apparatus
SCD	South Carolina Department
SCDHEC	South Carolina Department of Health and Environmental Control
SDIV	Southern Division Naval Facilities Engineering Command
SESE	Shipboard Electronic Systems Evaluation
SHSO	Site Health and Safety Officer
SIOH	Supervision, Inspection and Overhead
SOP QAM	USEPA Environmental Services Division <i>Standard Operations and Quality Assurance Manual</i> (1996)
SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering Command
SOW	Statement of Work
S/S	Stabilization and Solidification
SSL	Soil Screening-Level
STEL	Short Term Exposure Limit
SVE	Soil Vapor Extraction
SVOC	Semivolatile

SW-846	USEPA <i>Test Methods for Evaluating Solid Waste</i> , 3rd. Ed. (1986)
SWMU	Solid Waste Management Unit
SZ	Support Zone
TBA	To Be Announced
TCLP	Toxicity Characteristic Leaching Procedure
TDC	Thermal Conductivity
TDS	Total Dissolved Solids
TGNMO	Total Gaseous Non-Methane Organic
TIC	Target Indicator Compounds
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TSDF	Treatment, Storage and Disposal Facility
TPH	Total Petroleum Hydrocarbon
TSP	Treatability Study Plan
TSS	Total Suspended Solids
TU	Temporary Unit
UCL	Upper Confidence Limit
USCS	Unified Soil Classification Scheme
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
UXO	Unexploded Ordnance
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

## **1.0 INTRODUCTION**

This work plan has been written as a plan addendum to the *Final Comprehensive Sampling and Analysis Plan RCRA Facility Investigation* (E/A&H, August, 1994). It references approved procedures of the final comprehensive RFI sampling and analysis plan and work plan and summarizes proposed treatment technologies, data needs, sampling and analysis procedures and methods, pilot studies, laboratory studies, and bench scale studies. This work plan contains a sampling and analysis plan, a quality assurance plan, data management plan, treatability study plan, and health and safety plan.

Unless otherwise noted, the sampling strategy and procedures will be implemented in accordance with the USEPA Environmental Services Division *Standard Operating Procedures and Quality Assurance Manual*, February 1, 1991 (SOP QAM), included in Volume V of the final comprehensive RFI work plan and revised version dated May 1996. All references to SOP QAM in this document will be based on the May 1996 version, which will be kept onsite to supplement this work plan during all field operations. Sample analyses will be conducted in accordance with the guidance in USEPA *Test Methods for Evaluating Solid Waste, SW-846, 3rd ed.*, Office of Solid Waste and Emergency Response (SW-846), the USEPA Environmental Services Division *Laboratory Operations and Quality Control Manual* (included in Volume V of the comprehensive RFI work plan).

Due to the number and diversity of SWMUs and AOCs to be evaluated at NAVBASE, this work plan does not address site-specific sampling strategies. Instead, that information will be presented in a series of zone-specific work plans to be used in conjunction with this work plan. Each zone-specific work plan will document any deviations from this work plan. The zone-based evaluation rationale is described in greater detail in the comprehensive CMS project management plan. The intent of this approach is to develop a work plan that is independent of the number of evaluation sites, and therefore will not require iterative revisions.

The evaluations will consist of various activities depending upon the nature of the subject site and the work previously completed by Navy contractors. Tasks will likely include, but not be limited to, physical surveys, field sampling, laboratory analysis, bench-scale studies, laboratory treatability studies, and full-scale treatability studies. At a minimum, physical surveys will be conducted at USEPA Data Quality Objective Level II protocol. The field sampling will generally be used to collect samples for treatability. However, field sampling may be needed to further delineate the extent or magnitude of contamination in selected media to evaluate risk. Media to be sampled and analyzed may include soil, groundwater, surface water, sediment, air, and biota.

The laboratories to be used are approved under the Navy's approval program; the QAPs were previously submitted to SCDHEC and USEPA for approval. Laboratories and subcontractors to be used for treatability will be identified on an as-needed basis. Once identified, their QAPs will be submitted to SCDHEC and USEPA for approval. Sample analysis and data collection efforts will satisfy USEPA DQO Level III. Samples submitted may be analyzed at USEPA DQO Level IV for confirmation purposes. Zone-specific work plans will identify when this level is needed. Samples submitted may also be analyzed at USEPA DQO Level IV for treatability purposes. Any laboratory screening procedures will be performed at USEPA DQO Level II. DQO procedures are detailed in Section 5.12 of the SOP QAM and USEPA *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, 1994.

### **General Facility Information**

General information on the facility is provided in the final comprehensive RFI sampling and analysis plan. Information presented includes topography, geology, soil characteristics, surface hydrology, hydrogeology, climatology (temperatures, winds, rainfall, humidity, cloud cover, and climate extremes), and ecological setting (sensitive environments and threatened and endangered species). This information is unchanged.

However, additional information is being added about the facility's geology and hydrogeology as the RFI investigation progresses. This information will be incorporated as each zone is evaluated in the CMS process.

## **2.0 SAMPLING AND ANALYSIS PLAN**

### **2.1 Sampling Strategy**

Before any sampling is conducted, a sampling strategy will be developed. The sampling strategy will consider:

- The possibility of environmental contamination migrating onto and/or off of the facility.
- Specific data needs for various potential presumptive remedies.
- Specific data needs for treatability and technology evaluation.
- Data needs of other related activities such as the risk assessment.
- The specific need for each piece of data.

### **2.2 Orientation Meeting**

Before performing any field activities, personnel will attend an orientation meeting summarizing general and site-specific requirements for sampling, testing, and documentation at NAVBASE. General topics to be discussed will include the base location, the locations of the site office trailer, subject site, decontamination areas within the base, and the comprehensive health and safety plan. Sampling requirements to be discussed will include general sampling protocol, use of proper sampling devices, the sample numbering system, quality assurance/quality control sampling requirements, sample packaging, sample quantities, treatability testing, and investigation-derived wastes. Documentation requirements to be discussed will include the use of field forms, field logbooks, and documentation of photographs.

### **2.3 General Sampling Requirements**

Sampling and analysis procedures and methods which may be used to evaluate data for the CMS and were not included in the comprehensive RFI sampling and analysis plan are specified in Appendix A. Based upon the data needs for the individual treatment technologies, a list of potential treatability studies was compiled, including laboratory, bench-scale, and pilot-scale testing. These studies are outlined in Section 5. In addition, procedures for various physical

measurements that may be required to assess the proposed treatment technologies are outlined in Section 2.3.2 and Section 2.3.3, and air sampling as outlined in Section 2.3.4.

### **2.3.1 Corrective Measures Technology Matrix**

Treatment technologies, including data quality needs, are summarized in Tables 2-1 and 2-2.

### **2.3.2 Sampling Procedures**

General procedures for field personnel to follow when collecting environmental samples and performing treatability testing are included in this section. Detailed surveying, well installation, aquifer testing, and sampling procedures are discussed in Sections 4 to 10 of the comprehensive RFI sampling and analysis plan and Sections 5 through 14 of the SOP QAM. These general procedures are designed to prevent cross-contamination of samples and valid samples which are representative of the site conditions. All forms cited in the comprehensive RFI work plans will be used accordingly. Table 2-3 lists the procedures presented in the final comprehensive RFI sampling and analysis plan and their respective section and page numbers.

### **2.3.3 Water Measurements**

#### **Measurement of Open Channel (Non-Pressure) Flow**

The most common way to measure an open channel's flow rate is to insert a hydraulic structure into the channel which changes the level of liquid in or near the structure. By selecting the shape and dimensions of the hydraulic structure, the rate of flow through or over the restriction will be related to the liquid level in a known manner. Thus, the flow rate through the open channel can be derived by measuring the liquid level.

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Soil and Sediment</i>			
Natural Attenuation	N/A	Nonhalogenated VOCs; SVOCs; Fuel Hydrocarbons; PCBs	Temperature; Moisture Content; Permeability; pH; Soil Homogeneity and Isotropy; Humic Content; Total Organic Content; Biochemical Oxygen Demand; Redox Potential; Nutrient Level; Flow Gradient
Incineration	N/A	CV; NCV; CSV; NCSV; PCBs; Pesticides/Herbicides; Dioxins	Moisture Content; Soil Classification; Soil Fusion Temperature; BOD; COD; TOC; Soil Heating Value; Permeability; Particle-Size Distribution
Thermal Treatment	Thermal Destruction	PCBs; SVOCs	Organic/Inorganic Water Chemistry; Particle Size; Moisture Content; Btu Content; TCLP
	Thermal Desorption	CV; NCV; CSV; NCSV; PCBs; Pesticides/Herbicides; Dioxins; TPH	Organic/Inorganic Water Chemistry; Particle Size; Moisture Content; TCLP
	Steam Extraction	CV; NCV	Permeability; Moisture Content; Soil Homogeneity and Isotropy; Soil Texture; Bulk Density; Depth to Groundwater
	Vitrification (In situ/Ex situ)	CSV; NCSV; PCBs; Dioxins; Inorganics; Pesticides/Herbicides	Moisture Content; Soil Classification; Soil Fusion Temperature; Particle Size; Alkali Content; Depth to Groundwater

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Soil and Sediment</i>			
Biological Treatment	Ex situ (Landfarming, Composting)	NCV; CSV; NCSV; Pesticides/Herbicides; TPH	Organic/Inorganic Water Chemistry; Moisture Content; Soil Texture; Temperature; pH; Soil Microorganisms; Total Nitrogen; Total Phosphorus; Total Organic Carbon
	In situ (Bioventing, Biodegradation)	NCV; CSV; NCSV; Pesticides/Herbicides; TPH	Organic/Inorganic Water Chemistry; Moisture Content; Soil Texture; Permeability; Temperature; pH; Total Nitrogen; Soil Microorganisms; Methane; Total Phosphorus; Depth to Groundwater; Total Organic Carbon
Physical Treatment	Soil Washing	CV; NCV; CSV;NCSV; PCBs; Pesticides/Herbicides; Inorganics	Soil Type; Particle-Size Distribution; Moisture Content; Soil Texture; pH; Organic Content; Bulk Density; Permeability; Oil and Grease
	Solidification/ Stabilization	CSV; NCSV; PCBs; Dioxins; Pesticides/Herbicides; Inorganics	Organic/Inorganic Water Chemistry; Moisture Content; Soil Texture; Temperature; pH; Suspended Solids; Bulk Density; Grain-Size Analysis; Atterberg Limits; Cone Index; Unconfined Compressive Strength

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<b><i>Soil and Sediment</i></b>			
Physical Treatment	Vacuum Extraction	NCV, CV	Organic/Inorganic Water Chemistry; Moisture Content; Air Permeability; Temperature; Depth to Groundwater; pH
	Solvent Extraction	NCV; CSV; NCSV; TPH	Organic/Inorganic Water Chemistry; Total Organic Carbon; Total Recoverable Hydrocarbons; Moisture Content; Soil Texture; Permeability; Bulk Density; Grain-Size Analysis; Clay Content; pH; Temperature; Chemical Oxygen Demand; Cation-Exchange Capacity; Depth to Groundwater; TCLP
	Soil-Vapor Extraction (SVE)	CV; NCV; TPH	Wet Density; Dry Density; Moisture Content; Coefficient of Permeability; Depth to Groundwater; Soil Texture; Soil Homogeneity and Isotropy
	Filter Press	Inorganics	Wet Density; Moisture Content; Soil Texture; Solids Content
Chemical Treatment	Dehalogenation (Base-Catalyzed Decomposition/Glycolate)	Pesticides/Herbicides; PCBs; Dioxins	Total Organic Halides; Humic Content; Moisture Content; Permeability
	Chemical Oxidation/Reduction	Inorganics; Pesticides; PCBs	Organic/Inorganic Water Chemistry; Indicator Parameters; Bicarbonate; Calcium; Chemical Oxygen Demand; Chloride; Zinc; Copper; Iron; Manganese; Nickel; Magnesium; Oil and Grease; pH; Potassium; Sodium; Sulfate; Total Organic Carbon Total Suspended Solids; (Pilot- reagent consumption, optimal pH, and reaction time)
<b><i>Groundwater/Leachate</i></b>			
Natural Attenuation	N/A	Nonhalogenated VOCs; SVOCs; Fuel Hydrocarbons; PCBs	Temperature; Moisture Content; pH; TOC; BOD; COD; Oil and Grease; Suspended Solids

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Groundwater/Leachate</i>			
Biological Treatment	Ex situ (Bioreactors)	CV; NCV; CSV; NCSV; TPH; Pesticides/Herbicides	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Metals, dissolved; Ammonia; Kjeldahl; Nitrate- nitrite; Total Organic Carbon; Phosphorus; Total Solids; Specific Conductance; Temperature; pH; Dissolved Oxygen; Chemical Oxygen Demand
	In situ (Air Sparging)	CV; NCV; CSV; NCSV; TPH; Pesticides/Herbicides	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Metals, dissolved; Ammonia; Kjeldahl; Nitrate- nitrite; Total Organic Carbon; Phosphorus; Total Solids; Specific Conductance; pH; Dissolved Oxygen; Chemical Oxygen Demand
	Natural Wetlands	CV; NCV; CSV; NCSV; TPH; Pesticides/Herbicides	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Metals, dissolved; Ammonia; Kjeldahl; Nitrate- nitrite; Total Organic Carbon; Phosphorus; Total Solids; Specific Conductance; pH; Dissolved Oxygen; Chemical Oxygen Demand; Toxicity Test
Chemical Treatment	Ion Exchange	Inorganics	Organic/Inorganic Water Chemistry; Indicator Parameters; Bicarbonate; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Zinc; Copper; Iron; Manganese; Nickel; Magnesium; Oil and Grease; pH; Potassium; Sodium; Sulfate; Total Organic Carbon Total Suspended Solids

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Groundwater/Leachate</i>			
Chemical Treatment	Oxidation/ Reduction	CV; NCV; CSV; NCSV; PCBs; Pesticides/Herbicides; Dioxins; TPH	Organic/Inorganic Water Chemistry; Indicator Parameters; Bicarbonate; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Zinc; Copper; Iron; Manganese; Nickel; Magnesium; Oil and Grease; pH; Potassium; Sodium; Sulfate; Total Organic Carbon Total Suspended Solids; (Pilot- reagent consumption, optimal pH, and reaction time)
	Metal Precipitation	Inorganics	Organic/Inorganic Water Chemistry; Indicator Parameters; Bicarbonate; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Zinc; Copper; Iron; Manganese; Nickel; Magnesium; Oil and Grease; pH; Potassium; Sodium; Sulfate; Total Organic Carbon Total Suspended Solids; (Pilot- chemical dosage, contact time, mixing rate, optimal pH, and sludge handling)
	pH Adjustment	N/A	Indicator Parameters; Bicarbonate; Calcium; Chloride; Iron; Sodium; Magnesium; Manganese; Potassium; Sulfate; Total Suspended Solids; pH; (Pilot-titration curve)
	UV/Ozone Oxidation and UV Reduction	Petroleum Hydrocarbons; Chlorinated Hydrocarbons; Ordnance Compounds; Organic Compounds; Aromatic Compounds	pH; Temperature; BOD; TOC; COD; E <sub>h</sub> (redox potential)

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Groundwater/Leachate</i>			
Physical Treatment	Adsorption (granular activated carbon)	CV; NCV; CSV; NCSV; Inorganics; Pesticides/Herbicides	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Dissolved Oxygen; Hardness; Iron; Metals, dissolved; Manganese; Ammonia; Kjeldahl; pH; Nitrate-nitrite; Oil and Grease; Organic Carbon; Sulfide; Phosphorus; Sulfate; Suspended Solids
	Filtration	Inorganics	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Dissolved Oxygen; Hardness; Iron; Metals, dissolved; Manganese; Ammonia; Kjeldahl; pH; Nitrate-nitrite; Oil and Grease; Organic Carbon; Sulfide; Phosphorus; Sulfate; Suspended Solids
	Sedimentation/ Dissolve Air Floatation	Inorganics	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Dissolved Oxygen; Hardness; Iron; Metals, dissolved; Manganese; Ammonia; Kjeldahl; pH; Nitrate-nitrite; Oil and Grease; Organic Carbon; Sulfide; Phosphorus; Sulfate; Suspended Solids
	Air Stripping	CV; NCV; CSV; TPH	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Chemical Oxygen Demand; Hardness; Iron; Manganese; Metals, dissolved; Oil and Grease; pH
	Oil/Water Separation	CV; NCV; CSV; TPH; Inorganics	General Water Chemistry; Flow Rates; Phase; Droplet Size

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Groundwater/Leachate</i>			
Thermal Treatment	Wet Air Oxidation	CV; NCV; CSV; TPH; Inorganics	Btu Value; Moisture Content; Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Organic Carbon; Sulfide; Phosphorus; Sulfate; Total Solids
Wells	Directional Wells	None	General Geological Parameters; Groundwater Table; Underground Utilities
	Passive Wells	CSV; Inorganics	Hydraulic Permeability; Water Table Depth; Contaminant Phase; Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chemical Oxygen Demand; Chloride; Dissolved Oxygen; Hardness; Iron; Metals, dissolved; Manganese; Ammonia; Kjeldahl; pH; Nitrate-nitrite; Oil and Grease; Organic Carbon; Sulfide; Phosphorus; Sulfate; Suspended Solids
Extraction	Dual Phase/Free Product	None	Depth to Water Table; Product Phase; Product Density
<i>Air</i>			
Chemical Treatment	Oxidation/Reduction	CV; NCV; CSV; NCSV; PCBs; TPH; Pesticides/Herbicides; Dioxins	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Residual Contaminant Composition
Biological Treatment	Biofilters	NCV; NCSV; TPH;	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Residual Contaminant Composition
Physical Treatment	Adsorption	CV; NCV; CSV; NCSV; Inorganics	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Residual Contaminant Composition
Physical Treatment	Filtration	Inorganics	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Residual Contaminant Composition

**Table 2-1  
 Treatment Technologies Screening Matrix**

Technology	Process Option	Contaminants Treated	Data Quality Needs
<i>Air</i>			
Physical Treatment	Scrubbers	Inorganics	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Residual Contaminant Composition
	Electrostatic Precipitators	Inorganics	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates;
	Condensers	NCV; CV; NCSV; CSV	Air/Oxygen Supply; Flow Rates; Mass Transfer Rates; Contaminant Density
	Dust Suppressants	None	Particle Size; Moisture Content

**Notes:**

- |  |                                     |
|--|-------------------------------------|
| CV - Chlorinated Volatiles             | BOD - Biological Oxygen Demand      |
| NCV - Nonchlorinated Volatiles         | COD - Chemical Oxygen Demand        |
| CSV - Chlorinated Semivolatiles        | TOC - Total Organic Carbon          |
| NCSV - Nonchlorinated Semivolatiles    | TCLP - Toxicity Leachate Procedures |
| PCBs - Polychlorinated Biphenyls       |                                     |
| TPH - Total Petroleum Hydrocarbons     |                                     |
| SVOCs - Semivolatile Organic Compounds |                                     |
| N/A - Not Applicable                   |                                     |

**Table 2-2  
Removal/Containment/Disposal Options**

Action	Process Option	Data Quality Needs
<b>Soil and Sediment</b>		
Cap	Native Soil Single Barrier Double Barrier	Moisture Content; Permeability; In-situ Density; Atterberg Limits; Grain-Size Analysis; Porosity; Depth
Excavation	Dig Up	Organic/Inorganic Water Chemistry; Moisture Content; Permeability; In-situ Density; Atterberg Limits; Porosity; Depth; Grain Size Analysis
Surface Water Controls	Erosion and Runon/Runoff Controls	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Phosphorus; Ammonia; Kjeldahl; Nitrate and Nitrite; Total Suspended Solids
Disposal	Consolidation	Organic/Inorganic Water Chemistry; Moisture Content; Permeability; In-situ Density; Atterberg Limits; Grain-Size Analysis; Depth to Groundwater; TCLP
	RCRA TSDF and Landfills	Organic/Inorganic Water Chemistry; Moisture Content; Soil Texture; Temperature; pH; TCLP; Soil Microorganisms; Total Nitrogen; Total Phosphorus; Depth to Groundwater; Dissolved Oxygen
<b>Groundwater/Leachate</b>		
Vertical Barrier	Slurry Wall	Organic/Inorganic Water Chemistry; Soil Type; Soil Moisture; Particle-Size Distribution; Porosity; Hydraulic Conductivity (saturated and unsaturated); Relative Permeability; Clay Content; Soil Sorptive Capacity; Cation Exchange Capacity; Organic Carbon Content; Soil pH; Depth to Groundwater; Groundwater Velocity and Direction; Depth to Aquitard; (Pilot-compatibility testing with slurry wall material)

**Table 2-2  
 Removal/Containment/Disposal Options**

Action	Process Option	Data Quality Needs
<b>Groundwater/Leachate</b>		
Groundwater Collection	Vertical Extraction Wells	Use of Aquifer; Depth to Water Table; Direction of Flow; Rate of Flow; Hydraulic Conductivity (vertical and horizontal); Effective Porosity; Aquifer Type; Hydraulic Gradient; Identification of Recharge and Discharge Areas; Identification of Aquifer Boundaries; Aquitard Characteristics; (Pilot-slug test)
Leachate Collection	Subsurface Drains	Use of Aquifer; Depth to Water Table; Direction of Flow; Rate of Flow; Hydraulic Conductivity (vertical and horizontal); Effective Porosity; Aquifer Type; Hydraulic Gradient; Identification of Recharge and Discharge Areas; Identification of Aquifer Boundaries; Aquitard Characteristics; (Pilot-slug test)
Disposal	POTW and NPDES	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chloride; Hardness; Metals, dissolved; Manganese; Ammonia; Kjeldahl; Nitrate and Nitrite; Oil and Grease; Organic Carbon; Phosphorus; Total Solids; Specific Conductance; Sulfate; Sulfide; Suspended Solids; Dissolved Oxygen; Chemical Oxygen Demand

**Table 2-2  
 Removal/Containment/Disposal Options**

Action	Process Option	Data Quality Needs
<b>Groundwater/Leachate</b>		
Disposal	RCRA TSDF	Organic/Inorganic Water Chemistry; Indicator Parameters; Acidity-Alkalinity; Biochemical Oxygen Demand; Calcium; Chloride; Hardness; Metals, dissolved; Manganese; Nitrogen, ammonia; Nitrogen, kjeldahl; Nitrogen, nitrate-nitrite; Oil and Grease; Organic Carbon; Phosphorus; Total Solids; Specific Conductance; Sulfate; Sulfide; Suspended Solids; Dissolved Oxygen; Chemical Oxygen Demand
	Land Application	Depth to Water Table; Total Phosphorus; Chloride; Ammonia; Nitrate; Alkalinity; pH; Sodium; Total Dissolved Solids; Soil Type; Hydraulic Conductivity; Application Rate
	Injection	Depth to Water Table; Total Phosphorus; Chloride; Ammonia; Nitrate; Alkalinity; pH; Sodium; Total Dissolved Solids; Total Organic Carbon; Soil Type; Hydraulic Conductivity; Application Rate (2.5 gallons/ft <sup>2</sup> /day or 5/square root of slowest percolation rate)

**Notes:**

Other technologies included are: dredging, sewer line inspection, long-term monitoring, institutional controls, and intrinsic remediation.

**Table 2-3  
List of Approved Sampling Procedures**

<b>Procedure</b>	<b>Comprehensive RFI Sampling &amp; Analysis Plan Section Number</b>	<b>Comprehensive RFI Sampling &amp; Analysis Plan Page Number</b>
Well Inventory	3.1	3-1
Magnetometer Survey	3.2.1	3-2
Electromagnetic Induction Survey	3.2.2	3-7
Cadastral Survey/Geodetic Survey	3.3	3-8
Designating Soil Collection Locations	4.1	4-1
Soil Description	4.2	4-2
Dexsil Cl <sup>-</sup> Screening	4.3.1	4-2
Immunoassay Screening	4.3.2	4-8
Surface Soil Sample Collection	4.4	4-8
Hand-Augering Sample Collection	4.5	4-10
Sample Collection by Drill Rig/Backhoe	4.6	4-11
Split-Barrel Sampling	4.6.1	4-12
Shelby Tube Sampling	4.6.2	4-14
Test Trenching	4.6.3	4-16
Monitoring Well Permitting	5.1	5-1
Monitoring Well Designations	5.2	5-2
Drilling Methods	5.3	5-2
Monitoring Well Construction	5.4	5-3
Filter Pack Material and Screen Slot Size Design	5.4.1	5-4
Monitoring Well Installation (Unconfined Aquifers)	5.4.2	5-4
Monitoring Well Installation (Confined Aquifers)	5.4.3	5-16

**Table 2-3  
 List of Approved Sampling Procedures**

<b>Procedure</b>	<b>Comprehensive RFI Sampling &amp; Analysis Plan Section Number</b>	<b>Comprehensive RFI Sampling &amp; Analysis Plan Page Number</b>
Temporary Monitoring Well Installation for Groundwater Screening (Unconfined Aquifers)	5.4.4	5-20
Developing Monitoring Wells	5.5	5-21
Groundwater Sampling	6.0	6-1
Hydropunch	6.1.1	6-1
Temporary Monitoring Wells	6.1.2	6-2
Purging Static Water	6.2	6-2
Groundwater Sampling	6.3	6-7
Sediment/Surface Water Sampling Procedures	7.0	7-1
Designating Sediment/Surface Water Sample Collection Locations	7.1	7-1
Sediment Sampling	7.2	7-1
Dredge Samples	7.2.1	7-2
Core Samples	7.2.2	7-3
Scoop Samples	7.2.3	7-5
Surface Water Sampling	7.3	7-6
Submerging Laboratory Bottles	7.3.1	7-8
Kemmerer Sampler	7.3.2	7-9
Air Sampling	8.0	8-1
Soil-Gas Survey	8.1	8-1
Passive Soil Gas	8.2	8-3
Ambient and Indoor Air	8.3	8-6
Miscellaneous Sampling Techniques	9.0	9-1
Wipe Sampling	9.1	9-1
Waste Sampling	9.2	9-2

**Table 2-3  
 List of Approved Sampling Procedures**

Procedure	Comprehensive RFI Sampling & Analysis Plan Section Number	Comprehensive RFI Sampling & Analysis Plan Page Number
Soil and Sludge Sampling	9.2.1	9-4
Thin-Walled Tube Sampler	9.2.2	9-4
Aqueous Liquid Sampling	9.2.3	9-5
Ancillary Data Collection	10.0	10-1
Hydrolab Datasonde	10.1	10-1
Current Meter	10.2	10-1
Rain Gauge	10.3	10-1
Water Level Indicator	10.4	10-1
Secchi Disk	10.5	10-2
Hydrological Assessment	10.6	10-2
Slug Testing	10.6.1	10-5
Pumping Tests	10.6.2	10-8
Tidal Influence Study	10.6.3	10-9
Radioactivity Screening - Gamma Sources	10.7	10-9

The hydraulic structures used in measuring flow in open channels are referred to as primary measuring devices, and may be separated into two categories—weirs and flumes. A weir is essentially a dam built across an open channel over which the liquid flows, usually through some type of opening or notch. Each type of weir has an associated equation for determining the flow rate through it. A flume is a specially shaped open channel flow section with an area or slope, or both, that is different from that of the channel. This results in an increased velocity and change in the level of the liquid flowing through the flume.

A secondary measuring device (or open channel flow meter) is used in conjunction with a primary measuring device to measure liquid flow rate in an open channel. The secondary measuring device has two purposes: (1) to measure the liquid level in the primary measuring device, and (2) to convert this liquid level into an appropriate flow rate. Some of the more commonly used methods for liquid level measurements are: floats, electrical, ultrasonic, bubbler, mechanical cam, electronic analog function generator, electronic digital function generator, electronic memory device, and software.

#### **Measurement of Open-Channel (Pressure) Flow**

The following methods/devices for measuring open-channel pressure flow were adapted from the SOP QAM:

***Venturi Meter:*** The Venturi meter employs a conversion of static head to velocity head whereby a differential is created that is proportional to flow. The typical accuracy of a Venturi meter is given at 1 to 2%.

***Orifice Meter:*** This pressure differential device measures flow by the difference in static head. Orifice meters require from 40 to 60 pipe diameters of straight pipe upstream of the installation. They can be quite accurate (i.e., within 0.5%), although their usable range is limited.

***Flow Nozzle:*** The basic principle of operation is the same as that of the Venturi meter. The flow nozzle has an entrance section and a throat, but lacks the diverging section of the Venturi. Flow nozzle accuracies can approach those of Venturi meters.

***Electromagnetic Flow Meter:*** The electromagnetic flow meter operates according to Faraday's law of induction where the conductor is the liquid stream, and the field is produced by a set of electromagnetic coils. The accuracy of the device is within  $\pm 1\%$  of full scale.

#### **2.3.4 Air Measurements**

The following air test methods were adapted from Title 40 CFR 60, Appendix A and should be followed when conducting tests for these specific parameters.

**Method 2E:** Determination of landfill gas and gas production flow rate.

**Principle:** Extraction wells are installed either in a cluster of three or at five locations dispersed throughout the landfill. A blower is used to extract landfill gas from the landfill. Landfill gas composition, landfill pressures near the extraction well, and volumetric flow rate of landfill gas extracted from the wells are measured, and the landfill gas production flow rate is calculated.

**Method 25:** Determination of total gaseous nonmethane organic emissions as carbon in source emissions.

**Principle:** An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by an evacuated sample tank. After sampling is completed, the total gaseous nonmethane organics are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results.

**Method 25A:** Determination of total gaseous organic concentration using a flame ionization analyzer.

**Principle:** A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

**Method 25C:** Determination of nonmethane organic compounds (NMOC) in municipal solid waste landfill gases.

**Principle:** A sample probe perforated at one end is driven or augered to a depth of 1.0 meter below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), and methane (CH<sub>4</sub>); the NMOCs are oxidized to CO<sub>2</sub>, reduced to CH<sub>4</sub>, and measured by a flame ionization detector (FID).

**Method 25D:** Determination of the volatile organic concentration of waste samples.

**Principle:** A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 minutes to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an electrolytic conductivity detector. The volatile organic concentration is the sum of the carbon and chlorine content of the sample.

**Method 3C:** Determination of carbon dioxide, methane, nitrogen, and oxygen from stationary sources.

**Principle:** Sample collection procedures described in Method 25C should be used to collect samples of landfill gas. A portion of the sample is injected into a gas chromatograph and the CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, and O<sub>2</sub> concentrations are determined by using a thermal conductivity detector and integrator.

## 2.4 Managing Samples

Samples will be managed in accordance with Sections 3 and 5.13 of the SOP QAM and Section 11 of the final comprehensive RFI sampling and analysis plan. In addition, analytical

methods, sample containers, preservatives, and hold times for other likely parameters are presented in Appendix A of this report.

Sample packaging will follow both SOP QAM's Appendix D and the U.S. Department of Transportation regulations, 49 Code of Federal Regulations, Parts 172 and 173. Treatability samples generally have a larger volume samples than environmental samples, but require the same care as environmental samples. Treatability samples do not always require preservation.

All samples will be labeled as shown in Section 11.4 of the final comprehensive RFI work plan. Sample custody or possession will be traceable from the time the sample is collected to its delivery at the analytical laboratory. Refer to Sections 3.2 and 5.13 of the SOP QAM and Section 11.5 of the final comprehensive RFI sampling and analysis plan. Samples will be transferred in accordance with Section 3.3.4 of the SOP QAM and Section 11.6 of the final comprehensive RFI sampling and analysis plan.

## **2.5 Analysis**

The quality assurance and quality control objectives for parameters to be measured in the field and in the laboratory for environmental samples were provided in Section 12 of the final comprehensive RFI sampling and analysis plan. Treatability sample parameters may require different field and laboratory QA/QC objectives, which will be identified in zone-specific work plans.

## **2.6 Decontamination**

Decontamination procedures will be performed in accordance with Section 4.3.6 and Appendices B and C of the SOP QAM and Section 15 of the final comprehensive RFI sampling and analysis plan. Decontamination will apply to equipment and personnel.

## **2.7 Investigation-Derived Waste**

Investigation activities and decontamination procedures will generate a quantity of hazardous waste (e.g., contaminated solvents, disposable equipment) called investigation-derived waste. This waste will be handled and disposed of in accordance with Section 5.15 of the SOP QAM and Section 16 of the final comprehensive RFI sampling and analysis plan.

### **3.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN**

#### **3.1 Introduction**

The policies, project organization, objectives, and functional activities, along with QA/QC measures contained in the final comprehensive RFI work plan are adopted. Additions or changes are provided below.

This document is intended to fulfill requirements for ensuring all work will be conducted in accordance with QA/QC protocols and field procedural protocols for environmental monitoring and measurement data.

#### **Applicable Guidance Documents:**

The U.S. Environmental Protection Agency's *Standard Operating Procedures and Quality Assurance Manual*, May 1996 is the only applicable guidance document added or changed.

#### **3.2 QA/QC Objectives**

The quality assurance objectives provided in the final comprehensive RFI work plan remain applicable and will be followed unless specific reasons are given in zone-specific work plans.

#### **3.3 Organization and Responsibilities**

Organization and responsibilities remain the same as those in the final comprehensive RFI work plan unless changed in a zone-specific work plan.

#### **Applicable Regulations:**

USEPA's regulations for Hazardous Waste, Title 40 Code of Federal Regulations, Parts 260 through 280 specifically apply. South Carolina Hazardous Waste Management Regulations (SCWHMR R.61-79) of December 27, 1996, also apply.

#### **4.0 DATA MANAGEMENT PLAN**

This section describes the methods to be used throughout the technology evaluation process to document field work, treatability work, and modeling work, and manage collected data. The procedures and polices provided in the final comprehensive RFI work plan are to be followed. The following sections provide additional procedures to be followed.

##### **4.1 Field Documentation**

The field project manager will be thoroughly familiar with appropriate documentation procedures. In addition to general field documentation, master site logbook, field logbook, and sample logbook procedures, the field manager will be familiar with treatability logbook procedures.

**Treatability Logbook:** A treatability logbook will be used to compile a record of events, procedures, and samples collected and shipped (including QA/QC samples), analyses requested, the air bill number of the shipment, and any pertinent information concerning sample status. This logbook will also be used to record the observations made while conducting the treatability study.

The final comprehensive RFI work plan sections on field data record forms, sample labels, chain-of-custody records, subsurface boring logs, monitoring well construction diagrams, and photographs apply. In addition, treatability and modeling record management procedures are added.

**Treatability Records:** Records generated as a result of performing treatability studies will explain how the study was performed, observations made, and any other necessary information which would allow the study to be duplicated.

**Modeling Records:** Model records will include procedures, assumptions used, calibration run results and final run results, and any other information which would allow a reviewer to adequately review the modeling efforts.

#### **4.2 Data Deliverables**

The final comprehensive RFI work plan data deliverables elements apply. In addition, CMS-specific data deliverables (eg, results of treatability studies or additional soil/groundwater sampling activities) apply.

#### **4.3 Analytical Data Validation**

The final comprehensive RFI work plan analytical data validation elements apply.

#### **4.4 Other Related Data**

The final comprehensive RFI work plan other related data elements apply.

#### **4.5 Reports**

**Progress Reports:** Monthly progress reports prepared by the project manager will include the number of samples collected, sites investigated, monitoring wells installed, any deviations from approved field or laboratory procedures, technology evaluation progress, treatability study status, modeling status, and other appropriate information. These reports will be directed to the EIC.

**Zone Reports:** The zone CMS report will be written after the technology has been evaluated, treatability studies have been completed, modeling has been completed, sampling is completed, and all laboratory analyses have been validated. The report will consolidate and summarize collected data and document the unit evaluation. An initial draft report will be submitted for comment by the Navy, USEPA and SCDHEC. Where appropriate, comments will be incorporated into the final document.

**Final Report:** Final zone CMS reports will be prepared and submitted to the Navy, USEPA and SCDHEC addressing draft comments. A comprehensive final CMS report will be written after all the zone reports have been submitted to USEPA and SCDHEC for review and comment. The final report will be comprehensive, addressing the NAVBASE as a whole. The report will consolidate and summarize the results and conclusions presented in each zone report.

Interim reports or technical memorandums will be completed as necessary to describe significant divergence of site conditions from those anticipated, secure concurrence on the need for emergency or interim corrective measures, or to gain regulatory input on unanticipated issues.

**Tables, Graphs, and Illustrations:** Data obtained from sampling and analysis procedures will be summarized and presented in tables, supported by raw laboratory reports submitted to the EIC under separate cover. The EIC is Mr. Matthew A. Hunt of SOUTHNAVFACENGCOM who is responsible for the technical and financial management of the Installation Restoration Project at Charleston Naval Base. Several formats will be used to present sampling results graphically. Isoconcentration maps will be developed for soil and groundwater parameters, if possible. In addition, maps showing sample locations and results will also be completed. Groundwater surface contours, along with flow direction and gradient will also be displayed on the site base maps. Cross-sectional plots may be used if they would enhance understanding of the site.

Diagrams and schematics of technologies and/or treatment trains will present general flow diagrams and system controls. Cost will be presented in tabular format. Forms completed during the investigation will be included in appendices of the report.

Accumulated data and analytical results will be interpreted as a project team effort. The expertise of each project team member will be used to develop proper conclusions and recommendations. The final decision about interpretation of data for the report will lie with the task order manager and the South Carolina-registered Professional Engineer and Geologist.

## **5.0 TREATABILITY STUDY PLAN**

Treatability studies provide valuable site-specific data necessary to support remedial actions. They serve two primary purposes: (1) to aid in the selection of the remedy, and (2) to aid in the implementation of the selected remedy. The levels of treatability testing are: (1) laboratory testing, (2) bench-scale testing, and (3) pilot-scale testing.

Each level of treatability testing has different requirements and provides different information about a particular technology. The three levels of testing and specific treatability tests applicable to NAVBASE are described in the following sections. All treatability testing that may be conducted for NAVBASE will follow good laboratory procedures under EPA guidance.

The following describes a general approach for potential treatability studies that may be conducted at Charleston Naval Base. It was not the intention of this section to establish a single and/or inflexible approach to specific treatability studies. Flexibility will be the key attribute in planning, designing and implementing site-specific treatability studies.

### **5.1 Laboratory Testing**

Laboratory testing is designed to establish the validity of a treatment technology quickly and inexpensively. Validity depends on the ability of the technology to achieve performance goals set prior to the testing. If the goals are not attained, the technology is rejected. If the performance goals are met or exceeded, the technology is retained for further evaluation.

Laboratory testing is typically designed to monitor a particular contaminant (i.e., determine whether a reduction in toxicity, mobility, or volume is occurring). Additionally, the focus of the investigation of a technology is on screening a large number of parameters to identify those that will be critical for later bench- or pilot-scale testing. Proposed laboratory tests identified for NAVBASE are as described below.

### **5.1.1 Activated Carbon Adsorption**

**Purpose:** A laboratory adsorption study is conducted to evaluate the empirical constants of the Freundlich isotherm. Development of the isotherm aids in evaluation of the feasibility and economics of adsorption.

**Methodology:** If granular carbon is to be evaluated, the carbon must first be ground to pass a 325-mesh screen. Secondly, waste must be mixed with the carbon and water and stirred for a period of time until adsorption equilibrium is reached. A carbon dosage of 500 mg/L is mixed with the waste for various periods of time and the degree of adsorption is determined at selected time intervals. A mixing time sufficient to achieve 90% or more of equilibrium should be used for subsequent studies. Usually, a two-hour contact is sufficient to attain greater than 90% of equilibrium, though in some cases a longer contact time is required. The initial testing should include a 24-hour contact time. If the equilibrium value after two hours is greater than 90% of the 24-hour value, the two-hour test can be used.

**Evaluation:** Various dosages of carbon are then mixed with waste for the time interval selected. The carbon is then filtered off and the concentration remaining in solution is measured. These data are then plotted in accordance with the Freundlich isotherm to determine the adsorption characteristics. The amount of carbon required can be estimated from this plot for any required removal. This treatability study evaluates activated carbon for the removal of organic compounds from water. Typically different concentrations of activated carbon are tested for the treatment of the water to develop a carbon isotherm. The isotherm which is prepared can be used to predict the quantity of activated carbon needed for full-scale water treatment.

The Freundlich isotherm is used most commonly to describe the adsorption characteristics of the activated carbon used in water and wastewater treatment.

The empirically derived Freundlich isotherm is derived as follows:

$$x/m = K_f C_e^{1/n}$$

**where:**       $x/m$  = amount of adsorbate adsorbed per unit weight of adsorbent (carbon)  
                  $C_e$  = equilibrium concentration of adsorbate in solution after adsorption  
                  $K_f, n$  = empirical constants

The constants in the Freundlich isotherm can be determined by plotting  $(x/m)$  versus  $C$  and making use of the above equation written as:

$$x/m = K_f C_e^{1/n}$$

### **5.1.2 Chemical Dechlorination for PCB-Contaminated Soils**

The primary objective of this laboratory test is to identify the optimum chemical dechlorination treatment for remediation of PCB-contaminated site soils. Treatment will be performed by evaluating the processes associated with chemical dechlorination, emphasizing the potassium polyethylene glycolate (KPEG) dechlorination process.

Typically, chemical reactions involved in the dechlorination process are initiated using heat in an oxygen-free environment. Temperatures range from ambient levels to as high as 500 degrees Celsius. For full-scale processes, off-gases are generally recovered in a series of scrubbers, filters, and other gas treatment apparatus in which they are treated.

The KPEG process proceeds by nucleophilic displacement. In this type of reaction, a nucleophile, typically a hydroxide ion, displaces the chlorine atom from the organic compound. This technology is not specifically designed for use as a water treatment process. The treatment

of soil using this technology is also typically performed in a reactor, although it is possible to design a study to evaluate the technology as an in situ treatment for soils.

### **5.1.3 Terminal Electron Accepting Processes**

**Purpose:** Terminal electron accepting processes refer to the degradation of organic contaminants in the subsurface by biological or chemical mechanisms. Biological mechanisms, also known as biotic mechanisms, can be aerobic (where oxygen is the terminal electron acceptor) or anaerobic (where nitrate, sulfate, oxidized iron, or carbon dioxide substitute for oxygen as the terminal electron acceptor). Chemical mechanisms refer to natural chemical oxidation of organic contaminants in the subsurface. Terminal electron accepting processes are important in evaluating natural attenuation. Laboratory studies are sometimes performed, at the same time as field evaluation of natural attenuation, to understand the feasibility of terminal electron accepting processes. These laboratory studies, commonly known as microcosm studies, can be used to estimate degradation rates and the role of biodegradation in the degradation process.

**Methodology:** Core samples from an aquifer are collected for construction of a laboratory microcosm. One or more core samples can be collected to adequately represent the subsurface. Prior to selecting locations for core sample collection, subsurface characteristics pertaining to geology, hydrogeology, and geochemistry must be well understood. Some of the geochemical factors used to select locations for microcosms are electron acceptor concentrations, redox potential, alkalinity, pH, temperature, and chloride concentrations. Once sample locations are selected, it is important to quickly transfer the core aquifer material into the appropriate jar, exclude air by adding groundwater, and seal the jar without headspace to ensure sample integrity and stability during acquisition.

Generally at least three replicate microcosms for both living and control treatments are constructed for each sampling event. Controls are established by spiking the core material in a microcosm with mercuric chloride or sodium azide to exclude the biological pathway.

During construction of the microcosms, all operations should take place in an anaerobic compartment. These compartments exclude oxygen and provide an environment in which the integrity of the core material may be maintained, since many strict anaerobic bacteria are sensitive to oxygen. If possible, groundwater from the site should be used to prepare dosing solutions to restore water lost from the core barrel during sample collection. The microcosms should be incubated in the dark at the aquifer's ambient temperature. Studies generally last from 12 to 18 months.

**Evaluation:** Microcosm studies are often evaluated, with emphasis on terminal electron accepting processes by sacrificing replicate microcosms at each sampling interval. Microcosm studies often distinguish a pattern of sequential biodegradation (which can be correlated to biotic terminal electron accepting processes). Batch microcosms sampled every two months in triplicate for approximately 12 to 18 months can resolve biotic from abiotic losses with a detection limit of 0.001 to 0.0005 per day. Comparisons are generally made on a first-order removal or degradation rate. Mathematically, this rate is computed as the slope of a linear regression of the natural logarithm of the concentration remaining against time of incubation for both the living and control microcosm. These slopes (removal rates) are compared to determine whether they are different and to estimate the extent of any difference at the given confidence level.

Besides measurement of contaminant and daughter product concentrations, terminal electron acceptors can also be inorganically analyzed. This additional inorganic analysis could provide more detailed interpretations of the degradation pattern and the electron accepting process.

## **5.2 Bench-Scale Testing**

The primary objective of bench-scale testing is to confirm the method or methods which will reduce the contaminant compounds to meet the site's performance goals. This level of testing provides a quantitative evaluation of the performance of a technology and focuses on the critical

parameters that have an impact on that performance. The operational and performance information resulting from bench-scale testing permits a more accurate prediction of full-scale cost and sizing of unit operations.

Bench-scale testing requires two or three replications in most cases. A moderate to high level of QA/QC is generally needed to increase the confidence in the decision that the technology selected can meet the site's performance goals. The size and scope of bench-scale testing is normally limited to studies performed in-house or on the laboratory bench-top with equipment designed to simulate the basic operation of a treatment process.

Based upon the treatment technologies to be evaluated for NAVBASE, the bench-scale tests described in the following sections may be performed.

### **5.2.1 Continuous Carbon Adsorption Systems**

**Purpose:** Carbon adsorption is a contaminated-water treatment technology to remove organic and inorganic contaminants from a waste stream. Bench-scale studies are performed prior to design and installation of a carbon system. Design information such as the attainable rate of contaminated water flow, quantity of carbon required, time required for treatment, attainable effluent levels, and frequency of carbon regeneration can be obtained from bench-scale studies and scaled up for a remedial system.

**Methodology:** Most carbon adsorption systems treat contaminated water continuously. Therefore, bench-scale studies using carbon columns generally operate continuously. Depending on the type of full-scale system envisioned, the bench-scale system can have a single carbon column, a series of columns, upflow columns, or downflow columns. Columns are generally 2-inch in diameter and 4- to 6-foot high glass cylinders, stoppered at both ends, with ports of entry and exit for the contaminated water. The rate of flow can be controlled by means of a variable speed pump. As the contaminated water flows through the glass column filled with

carbon (also known as the carbon bed), the concentration of the contaminants decreases. At the point of exit, the effluent water should have concentrations equal to or less than the cleanup levels. As more contaminated water flows through the column, more and more of the carbon gets exhausted (i.e. the available adsorption sites on the carbon gradually decrease) until the concentration of the contaminant in the effluent rises above the allowable cleanup goal. At this point, the carbon in the column needs to be replaced or regenerated.

**Evaluation:** By varying the length of the carbon column, the flow rate, the type of carbon used, and the mechanism (series flow, upflow, downflow, and so on), a bench-scale study can be used to optimize the system and obtain design parameters for a feasible remedial system. Empirical equations such as the Bohart-Adams equations are available in the literature and can be used to calculate design parameters. Such empirical equations can be used to calculate service time (the time at which the carbon needs to be replaced or regenerated) and the quantities of carbon required to treat expected volumes of contaminated water.

### **5.2.2 Low Temperature Thermal Desorption (LTTD)**

LTTD systems are physical separation processes. Wastes are heated to a temperature between 90 and 320 degrees Celsius to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system. All thermal desorption systems require treatment of the off-gas to remove particulates and contaminants. Particulates are typically removed by wet scrubbers or fabric filters. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or catalytic oxidizer.

It is necessary to conduct treatability studies for this technology to determine its applicability and effectiveness for a specific site.

The following factors can be determined from the treatability study:

- Required temperatures for volatilization of water and organic contaminants
- Retention times
- Throughput rates
- Whether or not dewatering is necessary to achieve acceptable soil moisture content levels
- If soil residue will require stabilization due to heavy metal content

Determining these factors during the treatability study will save both time and money when employing the full-scale technology.

### **5.2.3 Jar Testing**

**Purpose:** Jar testing is the common term for bench-scale studies performed prior to installing physical/chemical processes for the treatment of wastewater and groundwater. Jar tests simulate the actual treatment process on a small scale. One of the most common applications of the jar test is to estimate the requirements and operational conditions for coagulation and flocculation by performing bench-scale tests. Some of the parameters evaluated during a jar test are: (1) the dosage of the coagulant, (2) the need for coagulant and flocculent aids and their dosage, (3) the need for pH adjusters and pH optimization, and (4) the need for alkalinity adjusters.

**Methodology:** Jar tests are performed using a multiple stirring apparatus with a variable-speed drive. A typical unit consists of six agitator paddles mechanically coupled to operate at the same speed, which can be from 10 to 100 revolutions per minute (rpm). The coagulation containers are 1- to 2-liter beakers or battery jars.

The procedure for conducting a jar test is standardized with small variations between different tests with different objectives. Generally, five to six beakers or jars are filled with a one-liter sample of each contaminated liquid. Different coagulants or different concentrations of a

particular coagulant are added to each of the jars. The samples are mixed at a rapid rate of 100 rpm for 10 seconds to one minute. This step simulates the rapid mixing step in the treatment process. Soon after, the samples are allowed to flocculate at a lower stirring rate of approximately 30 rpm for 15 to 30 minutes. The stirring is then stopped and the nature of the floc, clarity of supernatant, and the nature of the settling floc are evaluated. Supernatant samples can be collected for chemical or physical analyses. The experiment can be repeated at different pHs or alkalinities.

**Evaluation:** One of the advantages of the jar test is the ease of evaluation and optimization. They can be evaluated by: (1) physical observations, (2) physical tests, and (3) chemical tests. Physical observations include observing the time taken for the floc (sludge) to settle after flocculation, studying the nature of the floc, the clarity of the supernatant, and the settling floc's characteristics. These observations indicate the sludge-forming characteristics during actual treatment. Turbidity can also be tested as an indication of applicability or comparison of different parameters. Chemical analyses require analytical testing such as measurement of total organic carbon, chemical oxygen demand, biochemical oxygen demand or the measurement of specific organic compounds in the waste stream. Chemical testing will provide specific information on which coagulant and/or coagulant aid provided the best results and the pH at which these results were observed. The optimum coagulant dosage and pH are then used to scale-up requirements and costs for a full-scale remedial process system.

### **5.3 Pilot-Scale Testing**

The purpose of pilot-scale testing is to evaluate the performance of a technology and to obtain detailed cost and design information. It provides the most accurate scale-up information of the three levels of treatability testing. As with bench-scale-testing, the objectives of pilot-scale testing should be clearly stated. In addition to identifying the critical parameters, other variables (e.g., materials handling, treatment of residuals) should also be investigated at this testing level.

The pilot-scale tests outlined in the following sections represent proposed technologies to be evaluated for NAVBASE.

### **5.3.1 Soil Bioremediation Pilot Testing for In Situ and Ex Situ Technologies**

#### ***Ex Situ: Land Treatment***

**Purpose:** Land treatment or landfarming is the tilling and cultivation of soil to enhance the biodegradation of hazardous compounds. Prior to constructing a landfarming system at a hazardous waste site, pilot tests are performed on a smaller scale to evaluate optimum conditions for biological treatment. Information obtained from pilot tests is then used to design a full-scale remedial system.

**Methodology:** Operating parameters that are evaluated during pilot testing are nutrient needs (nitrogen and phosphorus), bioaugmentation (the addition of commercially available microorganisms capable of degrading the hazardous material), and other amendments such as pH adjusters and soil amendments to improve soil quality. In addition, a control unit is also evaluated where operations are restricted to tilling and moisture control.

Pilot systems can be unlined or lined to collect leachate. Contaminated soil is generally placed in 8- to 10-inch lifts. Pilot testing units average a few hundred square feet in area. Tilling, the single most important operation and the major oxygen enhancer, is performed once or twice per week. Moisture control is the second important controlling factor. Small garden spray systems are used to supply water to the treatment cells when needed.

Nutrient addition to one of the test units generally involves addition of designed quantities of fertilizer or organic nutrients in the form of manures, such as chicken manure. Nitrogen and phosphorus are the main components of the nutrient amendment. Nutrient addition can be performed either at the beginning of the pilot study or in stages, depending on the requirements. Bioaugmentation is performed by adding specific microorganisms that can be purchased from

microbial product suppliers. At some contaminated sites, especially those with recent spills, indigenous microorganisms may not have developed the enzymes capable of degrading the waste. In such cases, exogenous microorganisms could be beneficial. The pilot test will examine this need.

Other parameters evaluated during pilot testing are pH adjusters and soil amendments such as sawdust. Microorganisms thrive under a narrow pH range and some soils could either be acidic or alkaline, making microorganism survival difficult. In such cases, it is essential to add adjusters such as lime to alter the pH to a suitable level. Such testing is performed during pilot testing before implementation of the technology. Some soils also need amendments to make them more workable, specifically for tilling. Such amendments are also evaluated in the pilot tests.

**Evaluation:** The contaminants of concern are periodically tested analytically during the pilot study. Analytical testing can be used to estimate the rates of degradation. Degradation rates for the different pilot units can then be compared to decide which remedial alternative is to be implemented. In addition, the pilot test can be used to estimate treatment and amendments costs, if needed. Tilling, moisture control, and irrigation requirements can also be estimated from pilot study operations.

***In Situ Treatment: Bioventing***

**Purpose:** Bioventing is the process of advecting gases through unsaturated subsurface soils to stimulate in situ biological activity and enhance bioremediation of contaminants. It generally involves supplying oxygen in situ to oxygen-deprived indigenous microbes by injecting air in unsaturated contaminated soil at low flow rates. Pilot testing for bioventing is required to estimate the areal influence (also known as the radius of influence,  $R_I$ ) of air injection and the soil-gas permeability ( $k$ ) into the subsurface, determine the air permeability, and estimate the rate of biological degradation of soil contaminants.

An estimate of the soil's permeability to fluid flow ( $k$ ) and the radius of influence ( $R_I$ ) of venting wells are both important elements of a full-scale bioventing design. Onsite testing provides the most accurate estimate of the soil-gas permeability,  $k$ . Onsite testing can also be used to determine the radius of influence that can be achieved for a given well configuration and its flow rate and air pressure. Soil-gas permeability, or intrinsic permeability, can be defined as a soil's fluid flow capacity, and varies according to grain-size, soil uniformity, porosity, and moisture content. The value of  $k$  is a physical property of the soil:  $k$  does not change with different extraction/injection rates or different pressure levels. These data are used to design full-scale systems, specifically to space vent wells, to size blower equipment, and to ensure that the entire site receives a supply of oxygen-rich air to sustain in situ biodegradation.

**Methodology:** Equipment for pilot bioventing testing generally consists of a vent well and a blower system to provide airflow through the subsurface, creating a pressure gradient for a air permeability testing and increasing subsurface oxygen levels for in situ respiration testing. The diameter of the vent well may vary between 2 and 4 inches and be placed with the screened interval in the contaminated soil. Soil-gas monitoring points will be used for pressure and soil-gas (oxygen and carbon dioxide) measurements and will be installed at least three locations. Ideally, these will be in a straight line at 5- to 10-foot intervals depending on the soil type.

**Evaluation:** Evaluation of a bioventing pilot study includes determination of soil-air permeability, radius of influence, performing in situ respiration tests, periodic soil sampling to estimate changes in contaminant concentrations, and periodically measuring soil-gas pressure and oxygen.

The radius of influence and soil-air permeability are estimated from measurements of soil-gas pressure at the monitoring points. Soil-gas pressure is generally measured in the transient phase or at steady state. The value of  $R_I$  can be determined by actually measuring the outer limit of pressure influence under steady-state conditions, or by plotting pressure at each monitoring

point vs. the log of the radial distance from the vent well and extrapolating the straight line to zero pressure.

The estimated radius of influence ( $R_I$ ) is actually an estimate of the radius in which measurable soil-gas pressure is affected and does not always equate to gas flow. In highly permeable gravel, for example, significant gas flow can occur well beyond the measurable radius of influence. On the other hand, in a low-permeability clay, a small pressure gradient may not result in significant gas flow. In general, if the  $R_I$  is greater than the depth of the vent well, the site is probably suitable for bioventing. If the  $R_I$  is less than the vent well depth, the question of practicality arises. Scaling up a bioventing project at such a site may require more closely spaced vent wells than is either economically feasible or physically possible. The decision to proceed with bioventing will be site-specific and somewhat subjective.

The following formula is used to calculate the soil air permeability,  $k$ :

$$k = \frac{Q\mu \ln(R_w/R_I)}{H\pi P_w [(1 - P_{atm}/P_w)^2]}$$

where:

Q	=	average flow of air into bioventing well
$\mu$	=	air viscosity
$R_w$	=	radius of vent well
$R_I$	=	measured radius of influence of bioventing
H	=	depth of screen of vent well
$P_{atm}$	=	ambient pressure
$P_w$	=	average absolute pressure at vent well.

The general accepted limiting value of air permeability at which bioventing is not a viable alternative is  $10^{-8}$  cm<sup>2</sup>. At values lower than this, bioventing is unlikely to be the optimal

remedial approach. At values marginally higher, bioventing efficiency is best verified through pilot studies.

The in situ respiration test can be used to determine if in situ microbial activity is occurring and if it is oxygen limited. It also provides a quick estimate of in situ biodegradation rates so that a full-scale bioventing system can be designed. To perform the test, air with 1 to 2% oxygen is injected into the monitoring points. Following injection, the change in oxygen and carbon dioxide is measured over time. Typically, air is measured at two, four, six, and eight hours and then every 4 to 12 hours, depending on the rate at which oxygen is utilized. The in situ respiration test is terminated when the oxygen level is about 5%, or about 5 days after sampling. Oxygen use rate will be determined from the data obtained during the test as the percent of oxygen changes over time. Biodegradation rates can be obtained from standard stoichiometric relationships for oxidation of the contaminants of concern and the oxygen use rate. The contaminants of concern are analytically tested periodically during the bioventing pilot study from subsurface samples collected from different radial points around the vent well. Analytical testing can be used to estimate degradation rates.

Finally, the data and results from the pilot study tests can be used to estimate the feasibility of bioventing, requirements for full-scale design, and cost of implementation.

### **5.3.2 Groundwater Bioremediation Pilot Testing for In Situ and Ex Situ Technologies**

#### ***Ex Situ: Bioreactors***

**Purpose:** Bioreactors are aboveground treatment systems used to treat contaminated water that is pumped out of the ground as part of a remedial system such as a pump-and-treat system. Bioreactors are generally limited to treatment of groundwater contaminated with organic wastes. Bench-scale studies can be performed on a laboratory scale prior to installing a bioreactor system onsite. These bench-scale systems simulate a remedial system and provide design data needed to implement a full-scale system.

**Methodology:** Bench-scale study requirements for bioreactors vary depending on the contaminant type and the biological mechanism. A simple set-up would involve a container of approximately one gallon capacity made of PVC or plexiglass. For a continuous flow system, a continuous feed pump moves the waste water from the source through a pH adjuster and into the bioreactor. Nutrient supplementation may be required. A continuous source of air supply to maintain oxygen-rich conditions is installed if the remedial system is aerobic. The air often serves the purpose of mixing the contaminated water. Provisions are made in the reactor for removal of sludge which forms from contaminant removal and biomass production.

**Evaluation:** The efficiency of a bioreactor system can be evaluated from the rate of flow at which a desirable effluent concentration (usually the cleanup concentration) can be sustained. The bench-scale study can also estimate the sludge quantities during full-scale treatment. The size of the bioreactor to be used for full-scale treatment and the air system can also be estimated from the bench-scale study.

***In Situ Treatment: Air sparging***

**Purpose:** In situ air sparging of groundwater increases the water's dissolved oxygen content and enhances the growth of indigenous microbes which consume the aquifer's organic contaminants. Air is sparged directly into the groundwater to saturate water near the air-water interface with dissolved oxygen, which increases by advection (the flow of water containing dissolved oxygen) or by dispersion through the water. Pilot tests are used to determine the efficacy of air sparging and the feasibility of reducing contaminants of concern to cleanup levels. Information from a pilot study can be used to design and implement a remedial system to clean up the aquifer and to estimate cost.

**Methodology:** The setup for performing a pilot air sparging test generally consists of a blower to supply air, an air injection well to supply air to the aquifer, and a series of upgradient and downgradient wells (observation wells) to evaluate the system. The air sparging well is

generally from 2 to 4 inches in diameter with a 2- to 3-foot long screen at the bottom. Several downgradient wells can be installed 5 to 20 feet apart in the direction of groundwater flow. The air injection rate for air sparging is generally 5 to 10 standard cubic feet per minute. The air injection well can also be used to inject nutrients or exogenous microorganisms if needed.

**Evaluation:** The pilot air sparging system is evaluated by periodic collection and analysis of groundwater samples from the observation wells. These samples are analyzed for the contaminants of concern, microbial populations, and nutrients such as nitrogen and phosphorus. In addition, dissolved oxygen and pH are generally field tested throughout the study. Trends in dissolved oxygen can be used to evaluate the remediation progress. Microbial populations and nutrient measurements are used to evaluate the need to amend the aquifer with exogenous microorganisms or addition of nutrients. Analytical results of the contaminants of concern are used to estimate degradation rates at different aquifer locations.

Finally, the data and results from the pilot study tests can be used to estimate the feasibility of air sparging, requirements for full-scale design, and implementation cost.

### **5.3.3 Natural Attenuation Pilot Test**

Natural subsurface processes (i.e., dilution, volatilization, biodegradation, adsorption, and chemical reactions) reduce contaminant concentrations. Consideration of this technology requires modeling and evaluation of contaminant degradation rates and pathways. The primary modeling objective is to demonstrate that natural processes will reduce contaminant concentrations below regulatory standards before potential exposure pathways are completed. Sampling and analysis must also be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives.

A pilot study for this technology would consist of installing observation wells (upgradient, downgradient and at the source) to monitor for all contaminants of concern. Geochemical

parameters (DO, pH, microbial populations, nutrients) would be analyzed over a period of time (approximately 12-18 months) to assess the degradation rate. Determining the feasibility of employing natural attenuation at a site would rely largely on the results obtained from the treatability test which was conducted.

#### **5.3.4 Soil-Vapor Extraction (SVE) Pilot Test**

**Purpose:** Soil-vapor extraction pilot tests are typically conducted prior to design of SVE systems to assess soil permeability to gas, vapor flow rates, subsurface vacuum distribution, contaminant concentration locations, etc. This information can then be used in SVE remediation modeling to determine SVE design parameters such as contaminant removal rates, effective radius of influence, the design wellhead vacuum, and total system vapor flow rate.

**Test Objectives:** Soil containing varying concentrations of volatile organic compounds can be remediated using the SVE mass-transfer technique. The feasibility and design of such remedial systems, however, requires information regarding the in situ contaminant characteristics, concentration, and formational flow characteristics. To acquire this data, SVE pilot tests are conducted.

Formations of varying thicknesses and varying permeabilities are placed under the influence of a vacuum source. Surrounding piezometers placed at various distances (generally at the same depth and screened interval) are sampled for vacuum influence using a magnahelic gauge, or other low vacuum measuring instrument. SVE testing is performed to acquire actual in situ data which may be used for SVE systems design. In situ data are more accurate than the use of tables or graphs for the estimation of gas permeability and conductivity.

#### **Materials and Methods:**

*Well Installation and Construction* — Vacuum extraction well(s) are installed to serve as the source well where the vacuum is applied. They are typically constructed in the same manner

as a monitoring well, although not completed in a water-bearing zone. It is important to create a positive surface seal at the surface (cement-bentonite grout seal) to prevent short-circuiting of air. Piezometers are placed at varying distances away from the extraction well. These distances depend on the soil type (e.g., in a tight, less permeable soil, the piezometers would be spaced closer than in a more permeable formation). The piezometers are constructed and completed in the same manner as the SVE extraction well. However, they are typically only 1-inch diameter wells (for cost purposes). The number of piezometers again depend on soil type and the area in which the test is to be conducted. In general, the more monitoring points and the more directions away from the extraction well, the better. A perfect set-up would be to have more than three monitoring points at varying distances, in each direction away from the extraction well.

Also, during the installation of the SVE well and monitoring points, Shelby tube samples should be collected for each target soil type. Wet density, dry density, percent moisture, and coefficient of permeability may be necessary to evaluate flow characteristics of the soil type.

*Vacuum Source* — A regenerative or positive displacement blower is typically used as the vacuum source. The blower should be able to produce enough vacuum/flow to gather good data and be equipped with a vacuum gauge to monitor generated vacuum. Depending on the local air emission requirements, an off-gas control system may be needed. This is typically just the exhaust (effluent) piped to a carbon canister. The blower should also be equipped with a valve that can vary the vacuum to the well, that is, a valve installed to the atmosphere on the blower. By opening and closing this valve, the blower vacuum is increased/decreased.

*Laboratory Analysis* — Some SVE tests use a PID or FID to measure vapor concentrations extracted. However, a more accurate analysis is obviously obtained through laboratory analysis. Therefore, the SVE pilot-test equipment should be equipped with sample ports which will allow soil vapor to be withdrawn from different locations. The two most important locations are

before and after any necessary off-gas control device. In general, soil vapor should be withdrawn before to allow calculation of off-gas emissions for the full-scale SVE system. Soil vapor is withdrawn through a standard septum (Pete's port installed in the piping), using a 20-cc syringe connected via an on-off valve. The first 40-cc of gas are discarded to flush the syringe and fill it with in situ soil vapor. The next 20-cc of gas is withdrawn in the syringe, plugged (valve off), and immediately transferred to an evacuated 20-cc glass container for laboratory analysis.

*Monitoring Instrumentation* — Vacuum gauges are used to measure vacuum influence at the monitoring points. Flow measurement devices, which are used to measure the system flow rate, are typically pitot tubes installed in the piping; however, other instruments are available for measurement of flow.

**Preliminary Data:** Preliminary data, or background data, are necessary for later data correction. This is usually measuring the static conditions at the monitoring points (vacuum readings with no source applied). Examples are outside weather conditions or temperature, or sometimes the atmospheric pressure which can affect gauge readings.

*Start* — Begin the test at a predetermined vacuum level, usually with the dilution valve completely open and no vacuum stress applied to the wellhead. Again, this depends on soil type, etc. Periodically measure/record vacuum readings at the monitoring points and at the wellhead/vacuum source. Also, measure the flow rate and the vapor concentration (or take soil vapor samples). The length of running the test at this initial vacuum/flow rate will depend upon how your readings change. Once they do not significantly change, the vacuum can be increased. However, you should gather enough data during this initial phase of the test. Increase the vacuum. Once vacuum is increased, repeat the readings again periodically as before. Ultimately you are trying to reach a point at which the vacuum blower is at a maximum state (or you have

completely shut off the dilution source which regulates the blower vacuum) and you are putting the maximum stress on the soil. Be careful to avoid damage to the blower at this point.

Also, if possible, visually inspect the system for evidence of water being pulled into the piping. This can be done by having piping which you can see through (i.e., Plexiglass). If water is being pulled in, the blower could be damaged. During design of the full-scale system, a water knock-out tank would need to be installed.

*End* — Once the test is completed, or the vacuum source is stopped, continue to monitor/record the vacuum at the monitoring points to see how quickly the vacuum drops back to where it was when the preliminary data were taken.

**Data Reduction:** Even though flow rates were measured during the test, a flow rate can also be derived from evaluation of pressure vacuum data collected at the defined distances from the extraction well. The value for this constant may be determined by the vacuum readings.

$$P_1, r_1 : P_2, r_2$$

Such that:

$$P_2^2 - P_1^2 = \frac{Q_m mRT}{pwKh} \ln(r_2 - r_1)$$

**where:**

Qm	=	Flow rate
P	=	Pressure
r	=	Radius
m	=	Viscosity of Air
R	=	Gas Constant

T	=	Temperature, °K
w	=	MW of air
K	=	Soil/Air Permeability
h	=	Formation thickness
p	=	3.1416

One of the most critical data reductions is determining the intrinsic air permeability. The physical characteristics of the vapor extraction well/monitoring point system, the vacuum pressure data, and the air flow rates obtained during the pilot testing are used as input to determine the relative intrinsic air permeability of the soil strata through which the air flows. The intrinsic air permeability tensor is the matrix of soil air permeability values along specified axes. Based on boring log data and the vacuum pressure measurements at the monitoring points, the air flow pathways within the subsurface are likely to be predominantly in the radial direction. Intrinsic air permeability may be calculated by:

$$k = \frac{10^{-8} r^2 e u}{4 P_{atm}} \exp\left(\frac{B}{A} + 0.5772\right)$$

**Where:**

k	=	Air permeability
r	=	Radial distance from extraction well
e	=	Soil porosity
u	=	Viscosity of air
P	=	Atmospheric pressure
B	=	Y intercept
A	=	Slope

Use this equation to find A and B by graphing, and then calculate k. Calculated permeabilities are compared to criteria to see if SVE is appropriate for the target soil.

### **5.3.5 Ultraviolet Oxidation Pilot Test**

Ultraviolet (UV) oxidation is a destructive process that oxidizes organic and explosive constituents in waste waters by adding oxidizers and irradiation with UV light. If complete mineralization is achieved, the end products of oxidation are CO<sub>2</sub>, water, and salts. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput being treated. Pilot-scale testing will likely be required to optimize a UV oxidation system.

Single-lamp bench-top reactors that can be operated in batch or continuous modes are available for treatability studies. Parameters to be addressed in the treatability study include the following:

- Contact or Retention Time
- Oxidizer Influent Dosages
- UV Lamp Intensity
- Proper pH and Temperature

### **5.3.6 Solidification/Stabilization Pilot Test**

Solidification/stabilization (S/S) is a technology which reduces the mobility of hazardous substances and contaminants through both physical and chemical means. Unlike other remedial technologies, S/S immobilizes contaminants within the medium (i.e., soil, sand) that they are contained in, instead of removing them or reducing their concentrations.

Pilot-scale testing is required for solidification/stabilization because of its imprecise nature and because most wastes are far from homogeneous.

When selecting the stabilization/solidification treatment technology for a site:

- Review existing chemical and physical interferences between the waste and the binder.
- Identify potential pretreatment options for the waste or the site that would extend the application of solidification/stabilization or improve the containment properties of the product.
- Assess site conditions that could affect the solidification/stabilization of the waste or its ultimate disposal.

During treatability testing, different waste-to-binder ratios are used to stabilize/solidify waste samples. Selection of the optimum ratio is usually based on leach-test and durability-test results. Toxicity leaching procedures, unconfined compressive strength, wet-dry, and freeze-thaw tests may be among those required of a stabilized/solidified product at a given site. Treatability testing can define process control requirements, including mixing requirements, curing time, and quality control parameters, which can save time and money during field operations.

## **6.0 HEALTH AND SAFETY PLAN**

### **6.1 Introduction**

The following health and safety plan (HASP) is designed to assure the safety and health of site workers throughout the completion of activities related to the U.S. Navy CLEAN Program, Comprehensive Corrective Measures Study for the designated zones at NAVBASE Charleston. The Navy project contract number with E/A&H is *N62467-89-D-0318*.

USEPA has divided the NAVBASE into individual SWMUs and AOCs referred to as sites. Where SWMUs and AOCs overlap or are very close to one another, they are investigated as one site. For investigative purposes, "sites" have been grouped into "zones." This HASP is written to provide health and safety guidance, and information for activities performed under the comprehensive corrective measures study work plan.

This HASP covers project-specific hazards associated with the corrective measures study. The *E/A&H NAVBASE Charleston Comprehensive Health and Safety Plan (CHASP)* (E/A&H August 1994) provides activity-specific details for general operations at NAVBASE Charleston. Site-specific supplemental information will be provided in each zone-specific HASP. This document is organized as follows to explain conditions and expected hazards to workers.

- Section 6.2, Employee Protection, identifies the chemical and physical hazards expected to be encountered throughout the CMS and specifies procedures and controls to abate these hazards.
- Section 6.3, Decontamination, provides information on decontamination procedures.
- Section 6.4, Authorized Personnel.

- Section 6.5, Emergency Procedures, provides the information on emergency procedures, including where to go, who to contact, and what E/A&H personnel are and are not authorized to do in an emergency

Prior to beginning work at a site, personnel shall review the CHSAP, this HASP, and the corresponding site-specific section of the zone HASP to make sure that they are aware of known and potential hazards. Further the zone-specific HASP for each site shall be reviewed to ensure that all personnel are aware of known and potential site hazards. For each site, it is recommended that a copy of the applicable site-specific section be photocopied and carried into the field. At least one copy of both this plan, zone-specific HASP, and the CHASP shall be available in the field trailer.

#### **6.1.1 Applicability**

The provisions of this plan are mandatory for E/A&H field personnel. These personnel must read this plan and sign the acceptance form (see Attachment A) before starting site activities. In addition, personnel will adhere to the most current requirements of Title 29 Code of Federal Regulations 1910.120, Standards for Hazardous Waste Operations and Emergency Response (29 CFR 1910.120 [HAZWOPER]), as specified for workers involved with corrective actions under RCRA.

All non-E/A&H personnel present in E/A&H work areas shall either adopt and abide by this HASP and the corresponding CHASP, or shall have their own safety plan which, at least, meets the requirements of E/A&H's plans. Subcontractors who adopt the provisions of this plan will be wholly responsible for enforcing the plan requirements with their employees and shall provide each employee with personal protective equipment (PPE) and implement controls as specified in the HASP, zone-specific HASP, and the CHASP.

This HASP applies to specific planned activities and procedures such as soil boring; hand augering; installing and developing groundwater monitoring wells; installation and sparging of soil vapor extraction systems; application of in situ chemical treatments; soil surveying; and collecting soil, groundwater, surface water, sediment, air and biota samples. Non-routine procedures and tasks involving non-routine hazards are not adequately addressed in this plan.

Examples of such procedures are:

- Confined space entry
- Sampling, handling, or removing unidentified drums
- Unexploded ordinance (UXO), working with, or nearby UXO

Should it be necessary to conduct these or other high-risk tasks, specific health and safety procedures must be developed, approved, and implemented before proceeding.

### **6.1.2 Work Zones**

Section 2.1 of the CHASP describes the function and interrelation of the three work zones which, in combination, comprise the work area. The three work zones are:

- Exclusion Zone (EZ)
- Contaminant Reduction Zone (CRZ)
- Support Zone (SZ)

These work zones will be established and used during field work covered under this HASP. The location of these zones is dependent on the work task, layout of the site, weather, and logistical factors. These zones need to be formally demarcated when working in Level C or B.

For purposes of site control, the entire work zone should be delineated to keep non-authorized personnel a safe distance from field activities.

### **6.1.3 Work Area Access**

Authorized personnel (Section 6.4) will be allowed access to work areas as long as they follow the requirements of this HASP, zone-specific HASP and the CHASP. See also Work Area Access, Section 2.2 of the CHASP.

## **6.2 Employee Protection**

Employee protection appropriate to the work being completed under the comprehensive and zone-specific CMS work plans are determined through knowledge of planned activities, the chemical treatments, and field analysis proposed for the study. The physical and chemical hazards due to site contaminants are addressed in the zone-specific HASP. These hazards and hazard abatement procedures are discussed in general in the following sections:

- Section 6.2.1: Work Limitations
- Section 6.2.2: Physical Hazards
- Section 6.2.3: Chemical Hazards
- Section 6.2.4: Selection of Personal Protective Equipment
- Section 6.2.5: Air Monitoring

### **6.2.1 Work Limitations**

It is expected that all site activities will be conducted during daylight. E/A&H assumes that during this investigation, normal activities will continue; therefore, investigatory work should be coordinated to minimize impacts on non-site-related activities.

### **6.2.2 Zone Physical Hazards**

Field personnel should be aware of the dangers associated with physical hazards typically encountered during environmental investigations, and act in a manner to minimize them. These hazards include heat- and cold-related illnesses, severe weather, above-ground and underground

utilities, working with and around drill rigs and heavy equipment, uneven terrain, slippery surfaces, and lifting.

Some sites could provide habitat for poisonous flora and fauna, such as poison ivy and snakes. Depending on the time of year, and the site location, the use of snake chaps could be prudent. Before working at these sites check with the Site Health and Safety Officer (SHSO) for more definitive information.

### **Trenching and Excavations**

EnSafe is concerned about employee safety while working in or around excavations. Therefore, all operations involving excavation or trenching will adhere to 29 CFR 1926.650. An *excavation* is considered to be any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal. A *trench* is a narrow excavation (in relation to its length) made below the ground surface. In general, the depth is greater than the width, but the width of the trench (measured at the bottom) is not to be greater than 15 feet.

**No personnel will be allowed to enter an unshored or unsloped excavation. Personnel must obtain approval from either the project health and safety officer (PHSO) or the SHSO.**

**Utilities:** The estimated location of utilities — such as sewer, telephone, fuel, electric, potable/sanitary water — or any other underground installations that reasonably may be expected to be encountered during excavation work shall be determined before opening an excavation.

When excavation operations approach the estimated location of underground installations, their exact location shall be determined by safe and acceptable means.

**Access and Egress:** A stairway, ladder, ramp, or other safe means of egress shall be placed in trenches 4 feet or more deep so no more than 25 feet of lateral travel will be required for employees.

To collect samples from landfills, a series of test pits and/or trenches may be excavated. **E/A&H personnel shall not be within 5 feet of the edge of an excavation(s).** When collecting samples, the backhoe operator shall remove soil and groundwater from the excavation and move the bucket a safe distance from its edge, allowing the scientist/geologist to collect a sample from the bucket. Before collecting a sample, the backhoe will be placed in a nonoperating position and the operator will signal that it is safe to approach the bucket. For the geologist/scientist to photograph the excavation, it is recommended that he/she take pictures standing on the backhoe while it is in a nonoperating position. The excavations are to be backfilled as soon as the onsite analysis of the sample is performed. **At no time will an open excavation be left unattended.**

**Under no circumstances will any person be permitted to enter an unsloped or unshored excavation.** If someone must enter the excavation, the site supervisor shall request the SHSO to develop an acceptable entry procedure, which may include shoring the excavation's sides.

**Inspections:** A competent person will inspect excavations, the adjacent areas, and protective systems daily to determine if any situations could result in cave-ins, protective system failures, hazardous atmospheres, or other hazardous conditions. The competent person will conduct the inspection before work starts and as needed throughout the shift.

Inspections also will be made after every rainstorm to ensure that no water has accumulated. Employees shall not work in excavations where water has accumulated, unless adequate precautions are taken to protect them. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to

prevent cave-ins, water removal to control the level of accumulating water, or using a safety harness and lifeline.

### **Underground Utilities and Electrical Safety**

One safety concern is underground utilities. To assure site worker's safety during intrusive activities, the following precautions will be taken:

- A subcontractor specializing in utility-location techniques will be employed to assist the field teams in clearing locations for subsurface sampling points.
- Sites covered with asphalt or concrete will be cored before drilling or hand-augering activities begin.
- Subsurface borings will be advanced with a posthole digger or hand auger to 5 feet below ground surface to ensure that the drill rig will not encounter a subsurface utility when the exact location of utilities cannot be determined.
- If a subsurface obstruction is encountered, the boring will be terminated. When a boring is terminated, the borehole will be pressure-grouted to the soil/asphalt or concrete interface, and the asphalt or concrete plug will be cemented back in place flush with the existing surface grade.

Due to the conditions outlined above, all intrusive work will be completed with respect to the requirements specified in 29 CFR 1926.416, including posting the area with appropriate warning signs and using insulated gloves and boots when appropriate.

All non-permanent electrical field equipment powered by a 110 volt or greater source will have a ground fault circuit interrupter or equivalent installed where there is the potential for electrical

shock. The ground fault circuit interrupter or equivalent shall be installed as close to the fixed source of power as possible in order to provide the greatest level of protection to employees.

### **Procedures and Equipment for Extreme Hot or Cold Weather**

The site supervisor and the SHSO shall be aware of the potential for heat stress and other environmental illnesses. When environmental or work conditions dictate, work regimens shall be implemented to minimize the potential for employee illness. Field staff will be responsible for monitoring co-workers for signs or symptoms of heat- or cold-induced illness. For a discussion of the more common heat- and cold-related illnesses and their associated symptoms, see CHASP Section 6.5.1.

Due to the ambient environmental conditions typical for Charleston, South Carolina, the heat index and/or core body temperature (area and/or personal) may be monitored during hot weather and/or when elevated levels of PPE are used. Measures available to prevent the onset of heat related illness include: adjusting work-rest regimens, using cool vests to help control core body temperature, and providing drinks designed to replenish spent electrolytes (Gatorade, Squench, or similar). More radical measures such as working at night with proper lighting will be explored if additional precautions are needed.

### **Severe Weather**

During extreme weather conditions, the site supervisor shall use his/her best judgment and has the authority to stop field work or dismiss workers for the day. Examples of conditions that may warrant work stoppage include: tornado or hurricane warnings, thunder and/or lightning, high winds, hail, flooding, and snow and ice storms.

Field work shall not be conducted when lightning can be seen from the work area. When lightning is observed or thunder is heard, cease work, shut down equipment, perform emergency personal and equipment decontamination (see Section 6.3) as needed, then seek shelter.

### **Working Around Drill Rigs and Heavy Equipment**

Heavy equipment and drill rig operations will adhere to the procedures outlined in the CHASP, Appendix B, Drilling Safety Guide.

### **Drilling or Coring Within Buildings**

In addition to the hazards present during routine drilling and coring operations, drilling or coring in a building presents an additional hazard, the buildup of exhaust gases and, in particular, carbon monoxide. Carbon monoxide, a colorless and odorless gas, can affect a person with little advance warning or physiological indicators. Early symptoms of overexposure include drowsiness, lack of attention, and headaches. While severe cases of overexposure to carbon monoxide can cause death, a more likely scenario is that a lesser exposure would cause a worker to be inattentive, drowsy, or make a poor decision that results in an serious accident.

**While drilling within buildings is not planned for this for this CMS, should this change, the following procedures will be followed:**

The threshold limit value (TLV) (recommended standard) of carbon monoxide is 25 parts per million (ppm) and Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) is 35 ppm with a ceiling limit (not to exceed) of 200 ppm. When operating an internal-combustion-powered drill or coring rig indoors, even in large open spaces, the TLV and PEL can be reached in a few minutes. To reduce the potential of overexposure whenever drilling or coring in an enclosed structure, regardless of its size, the following minimum procedures shall be followed:

- Exhaust ducts and "smoke ejectors" (or equivalent) shall be attached to the exhaust stack of the drill or coring rig and extended outside the building. (A smoke ejector is a fan that attaches to flexible ducting and is used to draw exhaust gases down through the duct

and exhaust them outside.) The duct exhaust will be located such that the potential for re-entrainment of exhaust gases is negated.

- A real-time, direct-reading carbon monoxide meter shall continuously monitor the EZ. Carbon monoxide readings shall be taken and documented at regular intervals, no more than 30 minutes between readings. The rest of the time the instrument shall be left running in the work area. The audible alarm shall be set to trigger no higher than 25 ppm.
- To the extent practical, additional measures should be taken to assure adequate ventilation. Suggested measures include opening doors and windows to the outside, using exhaust fans to both draw exhaust fumes out of and circulate fresh air into the work area, and setting heating ventilation, and air conditioning systems to 100 percent outside air. Use these ventilation measures **before** initiating drilling operations.
- Should carbon monoxide readings reach 25 ppm, work shall be halted, drilling equipment deactivated, and personnel evacuated from the area. Work may not resume in the area until carbon monoxide concentrations are below 10 ppm.

### **Confined Space Entry**

E/A&H is concerned about employee safety when working in or around confined spaces. Therefore, E/A&H personnel are required to characterize the potential hazards associated with entering any confined space. Refer to the following definitions for space characterization information.

**Confined Space:** A space that is: (1) large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit; and (3) is not designed for human occupancy. Confined spaces may include, but are not limited

to, storage tanks, manholes, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, trenches, vats, and open-top spaces more than 4 feet deep such as test pits, tubs, vaults, or any place with limited ventilation.

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

***Non-permit Confined Space:*** A confined space that does not contain or, have the potential to contain any atmospheric hazard capable of causing death or serious physical harm.

**NOTE: E/A&H PERSONNEL SHALL NOT PERFORM PERMIT- OR NON-PERMIT-REQUIRED CONFINED SPACE ENTRY WITHOUT FIRST OBTAINING WRITTEN APPROVAL FROM A COMPANY PRINCIPAL AND THE PROJECT HEALTH AND SAFETY MANAGER. ALL CONFINED SPACE ENTRY WILL BE SUPERVISED BY THE PROJECT HEALTH AND SAFETY MANAGER, AND WILL BE CONDUCTED WITH RESPECT TO THE E/A&H CORPORATE CONFINED SPACE ENTRY PROGRAM AND 29 CFR 1910.146.**

E/A&H conducted extensive research into identifying sampling locations with respect to underground utilities and other operations or physical obstacles. It is not anticipated, based on that same research, that E/A&H or subcontractor personnel will be required to perform permit- or non-permit-required confined space entry to collect samples. However, if field conditions warrant performance of confined space entry for sample collection or investigation purposes, it

will be conducted under the requirements of the E/A&H corporate confined space entry program and 29 CFR 1910.146.

### **Radiation Protection**

Radioactive materials/hazards are potentially present within zones of natural sources of radiation and as a result of past operational activities at NAVBASE. As part of the base closure process, the Navy has conducted radiological surveys to verify that Naval-related radioactive materials have been removed. The Navy has surveyed and released all accessible areas of NAVBASE. However, all personnel must be aware of the potential to come in contact with naturally occurring radioactive materials.

Once the survey has been completed and the Navy releases the site, work may be performed at that site. This applies to all E/A&H employees and their contractors while conducting field work in each zone, such as walkover investigations, drilling, well development, soil sampling, water sampling, treatability studies and trenching.

### **Standard Safe Work Practices**

- When conducting field work personnel should walk. Running greatly increases the probability of slipping, tripping, and falling.
  
- Eating, drinking, chewing gum or tobacco, smoking, or any activity that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated, unless authorized by the SHSO.
  
- Hands and face must be thoroughly washed upon leaving the work area.
  
- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as practical after leaving the CRZ.

- Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, leachate, or discolored surfaces, or lean, sit, or place equipment on drums, containers, or on soil suspected of being contaminated.
- Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on cleanup or response operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Consumption of alcoholic beverages is prohibited.
- Adequate side and overhead clearance must be maintained to ensure that the drill rig boom does not touch or pass close to any overhead power lines or other overhead obstacles or obstructions.
- Utility lines should be marked using characteristic spray paint or labeled stakes. A buffer zone, 3 yards to either side of a utility line, should be maintained during all subsurface investigations.
- Due to the flammable properties of the potential chemical hazards, all spark or ignition sources should be bonded and/or grounded or mitigated before soil boring advancement or other site activities begin.

#### **General Rules of Conduct**

- Liquor, firearms, narcotics, tape recorders, and other contraband items are not permitted on the premises.

- Any violation of local, state, or federal laws, or conduct which is outside the generally accepted moral standards of the community is prohibited.
- Violation of the Espionage Act, willfully hindering or limiting production, or sabotage is not permitted.
- Willfully damaging or destroying property, or removing government records is forbidden.
- Misappropriation or unauthorized altering of any government records is forbidden.
- Securing government tools in a personal or contractor's tool box is forbidden.
- Gambling in any form, selling tickets or articles, taking orders, soliciting subscriptions, taking collections, etc., is forbidden.
- Doing personal work in government shop or office, using government property or material for unauthorized purposes, or using government telephones for unnecessary or unauthorized local or long-distance telephone calls is forbidden.
- Compliance with posted signs and notices is required.
- Boisterousness and noisy or offensive work habits, abusive language, or any verbal, written, symbolic, or other communicative expression which tends to disrupt the work or morale of others is forbidden.
- Fighting or threatening bodily harm to another is forbidden.
- Defacing any government property is forbidden.

- Wearing clothes with offensive logos, pictures, or phrases is forbidden. Appropriate attire is required at all times.
- All persons operating motor vehicles will obey all NAVBASE traffic regulations.

### **Medical Monitoring Program**

See CHASP Section 7.0.

#### **6.2.3 Chemical Hazards**

Chemical hazards are selected based to the projected activities defined in the comprehensive CMS work plan. This HASP does not cover the site-specific contaminants of concern. These are defined in detail in each zone-specific HASP. This HASP defines the chemicals selected to complete the corrective measures study. Material safety data sheets (MSDSs) will be obtained whenever a new chemical or treatment product is selected for use in the project. Further, the MSDS must reviewed and approved by the PHSO prior to use at the site. All employees shall read and follow the manufacturers' recommendations for all chemicals and test protocols used during the study.

Chemical hazard information relating to site contaminants are defined in appropriate zone-specific HASP section on chemical hazards. The MSDS for these contaminants are contained in the zone-specific HASP.

Table 6-1 lists chemicals identified for use in the CMS.

**Table 6-1  
 CMS Chemical Hazards  
 Exposure Information**

Compound	Ionization Potential (ev) <sub>1</sub>	Odor Threshold (ppm)	OSHA PEL <sub>1</sub>	ACGIH TLV <sub>2</sub>	NIOSH REL <sub>3</sub>	Action Level
Aluminum Oxide	N/A	N/A	15 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>	Not Listed	5 mg/m <sup>3</sup>
Calcium Hydroxide	N/A	N/A	15 mg/m <sup>3</sup>	5 mg/m <sup>3</sup>	5 mg/m <sup>3</sup>	2.5 mg/m <sup>3</sup>
Calcium Oxide	N/A	N/A	5 mg/m <sup>3</sup>	2 mg/m <sup>3</sup>	2 mg/m <sup>3</sup>	1 mg/m <sup>3</sup>
Hydrochloric Acid	N/A	N/A	7 mg/m <sup>3</sup>	7 mg/m <sup>3</sup>	7 mg/m <sup>3</sup>	3.5 mg/m <sup>3</sup>
Hydrogen Peroxide	10.54	N/A	Not Listed	1 ppm	1 ppm	0.5 ppm
Magnesium Hydroxide	N/A	N/A	Not Listed	Not Listed	Not Listed	N/A
Nitric Acid	N/A		2 to 4 ppm - STEL	2 to 4 ppm (STEL)	2 ppm	1 ppm
Sodium Bicarbonate	N/A	N/A	Not Listed	Not Listed	Not Listed	N/A
Sodium Carbonate	N/A	N/A	Not Listed	Not Listed	Not Listed	N/A
Sodium Hydroxide	N/A	N/A	2 mg/m <sup>3</sup> - Ceiling	2 mg/m <sup>3</sup> - Ceiling	2 mg/m <sup>3</sup> - Ceiling	1 mg/m <sup>3</sup>
Sulfuric Acid	N/A	N/A	1 mg/m <sup>3</sup>	1 mg/m <sup>3</sup> 3 mg/m <sup>3</sup> - STEL	1 mg/m <sup>3</sup>	0.5 mg/m <sup>3</sup>

**Notes:**

<sup>1</sup>29 CFR 1910.1000, Table Z-1-A. Limits For Air Contaminants.

<sup>2</sup>1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists.

<sup>3</sup>National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards, June 1990.

<sup>4</sup>Odor Thresholds for Chemicals with Established Occupational Health Standards, American Industrial Hygiene Association, 1989, Range of All Reference Values.

STEL - Short-term Exposure Limit

#### **6.2.4 Selection of Personal Protective Equipment**

It is important that specified PPE protects against known and suspected site hazards. Selection of protective equipment is based on the types, concentrations, and routes of personal exposure that may be encountered. In situations where the types of materials and possibilities of contact are unknown or the hazards are not clearly identifiable, a more subjective determination must be made of the PPE required, and greater emphasis is placed on experience and sound safety practices.

As is discussed above, PPE for site workers will be based on previous site history and on the activities to be performed there. The zone-specific HASP will describe the site, discuss the work planned there, and assess the hazards and **specify PPE for those activities**, based on the site chemical and physical hazards. PPE requirements are subject to change as site information is updated or changes. **A decision to deviate from specified levels of PPE as contained in the zone-specific HASP must be made or reviewed by the PHSO and SHSO.** Further, the minimum required PPE for each site is Level D with nitrile gloves. Tyvek (or equivalent), though not required with Level D, is available for employee use. Table 6-2 presents the levels of PPE which may be employed and the criteria for upgrading PPE.

#### **6.2.5 Air Monitoring**

Air will be monitored for VOCs during all site invasive activities. Air monitoring may also be conducted to evaluate airborne contaminants other than VOCs such as mercury vapors, hydrogen sulfide, carbon monoxide, and combustible gases. When possible, real-time monitoring instruments will be used to measure airborne contaminant levels. If an acceptable real time instrument is not available or appropriate, colorimetric indicating tubes or air sampling pumps and sorbent tubes will be used.

Air monitoring for VOCs will be accomplished using a PID or FID. The PID or FID will be field calibrated to measure VOCs relative to a 100 ppm isobutylene standard. If VOCs are

**Table 6-2**  
**Level of Protection and Criteria**

Level of Protection	Criteria for Use	Equipment
Level A	<ul style="list-style-type: none"> <li>• When atmospheres are "immediately dangerous to life and health" (IDLH in the <i>NIOSH/OSHA Pocket Guide to Chemical Hazards</i> or other guides.)</li> <li>• When known atmospheres or potential situations could affect the skin or eyes or be absorbed into the body through these surfaces. Consult standard references to obtain concentrations hazardous to skin, eyes, or mucous membranes.</li> <li>• Potential situations include those where immersion may occur, vapors may be generated, or splashing may occur through site activities.</li> <li>• Where atmospheres are oxygen-deficient.</li> <li>• When the type(s) and or potential concentration of toxic substances are not known.</li> </ul>	<ul style="list-style-type: none"> <li>• Positive-pressure, full-facepiece, self-contained breathing apparatus (SCBA) or positive-pressure supplied air respirator (SAR) with escape SCBA.</li> <li>• Fully encapsulating chemical protective suit.</li> <li>• Chemical-resistant inner and outer gloves.</li> <li>• Steel toe and steel shank chemical-resistant boots.</li> <li>• Hard hat under suit.</li> <li>• Two-way radios worn inside suit.</li> <li>• Optional: coveralls, long cotton underwear, disposable protective suit, gloves and boots, over fully encapsulating suit.</li> </ul>
Level B	<ul style="list-style-type: none"> <li>• When respiratory protection is warranted and cartridge respirators are not appropriate. Examples of these conditions are:                             <ul style="list-style-type: none"> <li>— when work area may contain less than 19.5 percent oxygen,</li> <li>— when expected contaminants do not have appropriate warning properties, e.g., vinyl chloride, or</li> <li>— when cartridges are not available to protect against all contaminants.</li> </ul> </li> <li>• Hazards associated with limited dermal exposure are not significant.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical-resistant clothes, coveralls.</li> <li>• Positive-pressure, full-face SCBA or SAR with escape bottle.</li> <li>• Hard hat.</li> <li>• Chemical-resistant outer and inner gloves.</li> <li>• Steel toe and steel shank boots.</li> <li>• Chemical-resistant outer boots.</li> </ul>
Level C	<ul style="list-style-type: none"> <li>• When respiratory protection is warranted and cartridge respirators are appropriate.</li> <li>• When PID or FID readings exceed the action level.</li> <li>• When air monitoring indicates airborne concentration of a chemical is 50 percent or more of the PEL or TLV and the work area contains at least 19.5 percent oxygen.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical-resistant coveralls.</li> <li>• Full-face, air-purifying respirator equipped with cartridges suitable for the hazard.</li> <li>• Hard hat.</li> <li>• Chemical-resistant outer and inner gloves.</li> <li>• Steel toe and steel shank boots.</li> <li>• Disposable outer boots.</li> </ul>

**Table 6-2  
 Level of Protection and Criteria**

Level of Protection	Criteria for Use	Equipment
Modified Level D	<ul style="list-style-type: none"> <li>• When chemical contamination is known or expected to be present, yet inhalation risk is low and respiratory protection is not required.</li> <li>• Site contaminants may be absorbed through the skin.</li> <li>• The "default level" of PPE required when the HASP does not specify another level of PPE and the work area has at least 19.5 percent oxygen.</li> <li>• When minimal or no chemical contamination is expected.</li> <li>• When zone-specific HASP specifies Level D protection is adequate and the work area has at least 19.5 percent oxygen.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical-resistant coveralls.</li> <li>• Chemical-resistant outer gloves; inner gloves or glove liners, optional.</li> <li>• Steel toe and steel shank boots.</li> <li>• Hard hat.</li> <li>• Safety glasses with side shields or safety goggles.</li> <li>• Optional: chemical-resistant outer boots.</li> <li>• Inner gloves or chemical-resistant gloves needed to handle soil or water samples.</li> <li>• Optional: coveralls and disposable outer boots.</li> <li>• Work clothes.</li> </ul>

detected down-hole, colorimetric detector tubes and/or other sampling media may be used to determine the identification and approximate concentration of these compounds.

The PHSO reserves the right to require personal exposure monitoring or other types of air sample collection and analysis. These samples may be required for a variety of reasons including: PID or FID readings exceed or approach the action level, to determine if personal exposures are below OSHA PELs, or to identify a chemical odor. Personal samples will be collected during each site activity in which Level C PPE is prescribed. Sampling strategies will be biased to represent worst-case exposures. Personal monitoring data will be collected and analyzed with respect to National Institute for Occupational Safety and Health (NIOSH) *Manual of Analytical Methods*.

Air monitoring for respirable dusts may be performed using a real-time aerosol monitor (miniRAM) to measure airborne dust concentrations. In addition to the real-time monitoring, some air samples should be collected to document the actual concentrations measured per a NIOSH-approved method.

A combustible gas indicator (CGI) may be used during soil borings and well installations. The CGI will be field-calibrated to measure flammable gases relative to a methane standard. Downhole CGI readings will be collected periodically during soil-disturbing operations. Field activities will immediately cease if downhole readings exceed 20 percent of the lower explosive limit (LEL). If CGI readings do not subside, the area will be immediately evacuated and the situation re-evaluated to determine how to proceed. The area will be investigated; operations may not proceed until downhole readings are below 20 percent LEL.

#### **Action Level and Ceiling Concentration**

Each site at NAVBASE has a designated action level and ceiling concentration. For this project the action level is defined as the PID or FID reading in the breathing zone above which

respiratory protection must be upgraded and; chemical protective clothing may also be upgraded. The action level is determined on a site-by-site basis. To exceed the action level, PID or FID readings should be sustainable. Readings should remain above the action level for at least one or two minutes at a time. Readings that are elevated for only a few seconds every 15 or 20 minutes do not exceed the action level and do not require workers to upgrade their level of PPE.

The general action level, as determined on a properly calibrated PID or FID, is 5 PID or FID units above background. PPE shall be upgraded to Level C (assuming that cartridge respirators are appropriate, otherwise Level B) if airborne VOC concentrations in the breathing zone exceed the action level, or if the concentration of any contaminant exceeds 50 percent of the OSHA PEL. This baseline action level and PPE requirement may be superseded by more stringent site-specific levels, as identified in each site-specific hazard analysis and employee protection section.

If breathing zone levels exceed the action level, or site conditions indicate that additional health and safety precautions are needed, field activities in the area shall stop. Field staff shall notify the site supervisor of the situation and he/she shall contact the project manager and/or the PHSO. The PHSO will be responsible for reassessing the hazards and prescribing revised health and safety requirements as necessary, including upgraded PPE requirements, revised work schedules, and revised decontamination procedures. See Table 6-2 for specific criteria for each protection level.

If PID or FID readings exceed 10 units, the SHSO shall contact the PHSO and discuss the need to identify and quantify airborne contaminants. Work shall not proceed until breathing zone concentrations return to background levels and it is reasonably anticipated that breathing zone readings will stay approximately at background levels, or the chemical constituent(s) are identified and appropriate PPE is donned.

The ceiling concentration is defined as the maximum allowable PID or FID reading in the breathing zone regardless of PPE. A ceiling concentration of 50 PID or FID units has been established. Should VOC concentrations exceed 50 ppm in the breathing zone, field workers should secure their equipment and back off the site. Work shall not resume until the site supervisor understands why VOC concentrations became elevated, knows the major constituents of the VOCs being generated, and the VOCs in the breathing zone are less than 5 ppm or workers have upgraded to Level C or B. The proper PPE upgrade shall be determined by the PHSO based on site-specific chemical information.

Field monitoring values will be recorded in a field logbook and copies must be posted for field personnel review.

### **Equipment Maintenance**

Before being used daily, PIDs, FIDs, CGIs, and other monitoring equipment shall be calibrated or their proper function verified. Throughout the day this equipment shall be periodically checked to ensure that it is working properly. A final calibration shall be conducted at the end of the workday, at which time each instrument will be checked to ensure that it is free from surface contamination. Air monitoring equipment shall detect the calibration standard within a range of plus or minus 10 percent; otherwise, the instrument shall be considered malfunctioning. Field staff shall note in their field notebooks that they conducted these calibrations and checks and note whether the equipment was functioning properly.

When equipment is not functioning properly, it should be brought to the attention of the site supervisor or SHSO, who will arrange to repair or replace that equipment as needed.

## **6.3 Decontamination**

### **6.3.1 Personnel and Equipment Decontamination**

As needed, a contaminated reduction zone will be established adjacent to the exclusion zone established for invasive activities, and will include stations for decontaminating personnel, PPE, and hand tools. Typically, a portion of the contaminated reduction zone will be covered with sheets of 6-mil polyethylene (generally, an area 20 feet by 20 feet is sufficient) with specific stations to accommodate the removal and disposal of the protective clothing, boot covers, gloves, and respiratory protection.

Heavy equipment and field equipment that cannot adequately be decontaminated in the contaminated reduction zone may be decontaminated on a more centrally located decontamination pad. Table 6-3 lists equipment that may be convenient to have onsite to decontaminate heavy equipment and vehicles; this table also explains how this equipment may be used.

**Table 6-3  
Equipment Recommended for Decontaminating Heavy Equipment and Vehicles**

---

Tanks or drums to store collected wash and rinse solutions, alternatively, equipment to treat collected wash and rinse solutions may be substituted.
Pumps, and filters as needed to collect wash and rinsate solutions.
Pressurized steam sprayers for steam cleaning equipment.
Long-handled brushes for general cleaning of exterior surfaces. Also shovels and other equipment may be used to dislodge caked-on contaminated mud on the undercarriage or in the tires.
Wash solutions, selected for their ability to remove (dissolve, etc.) contaminants
Rinse solutions, selected for their ability to remove contaminants and wash solutions.
Pressurized sprayers for washing and rinsing, particularly hard-to-reach areas.
Clean buckets that can hold cleaning and rinsing solutions.
Brooms and brushes that can be used to clean the interior, operator areas of vehicles and equipment.

---

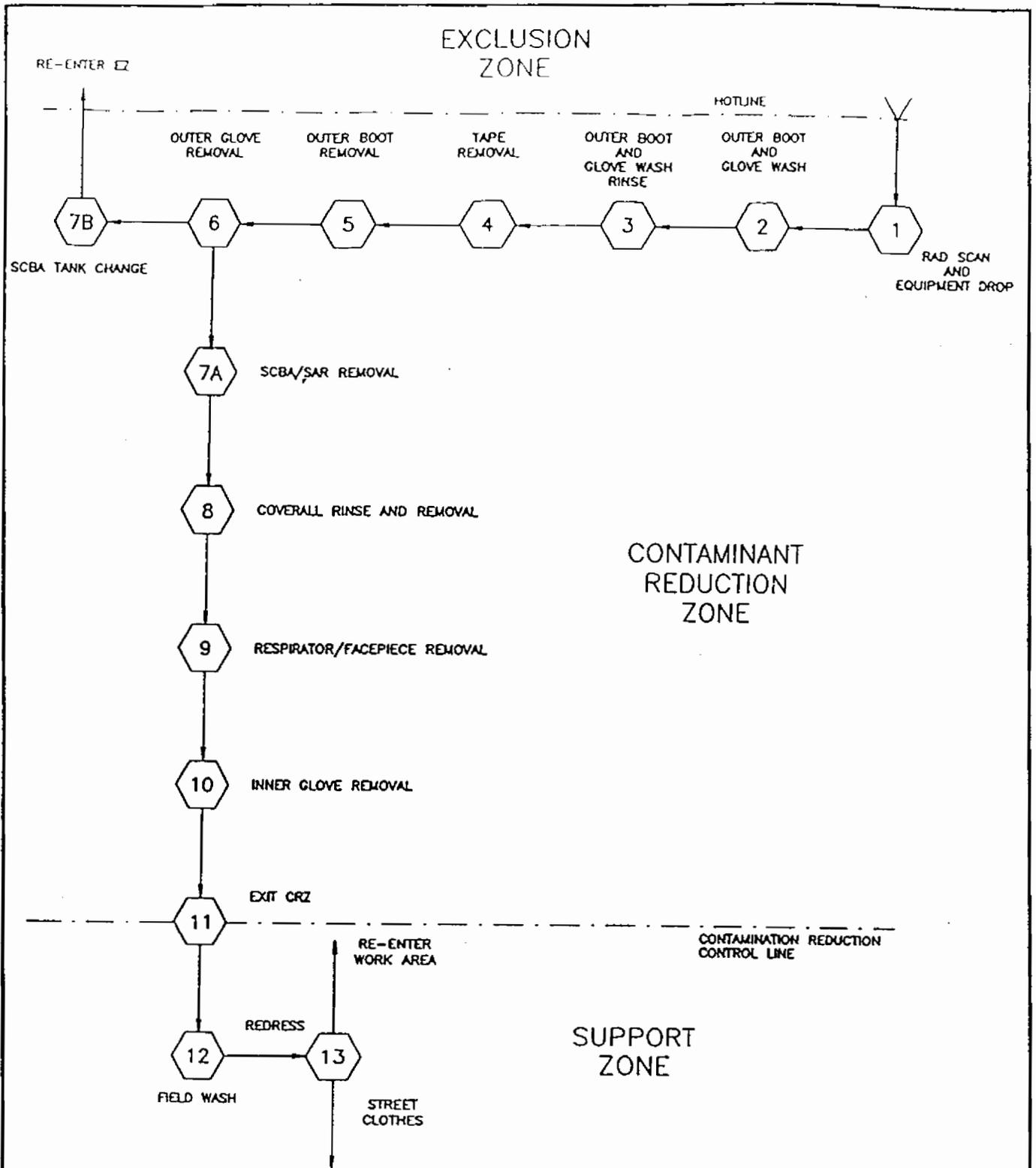
The full contamination layout provided on the following page shows one method of laying out an acceptable decontamination area for Level B PPE (Figure 6-1). There are numerous ways to lay out decontamination areas. Decontamination areas for Level C and Modified D PPE should be based on this concept of decontamination, but can be scaled back in accordance with the decontamination needs of the specific site and level of PPE. As a general rule, people working in the contaminated reduction zone and assisting in the decontamination of workers leaving the exclusion zone, shall be outfitted in PPE that is one protection level below what the existing workers are using. For example, if workers leave the EZ in Level C, personnel in the contaminated reduction zone should be in Modified D.

Often equipment may be adequately decontaminated using a soapy wash solution and following specified rinsing procedures. Normally equipment will be decontaminated in Level D with gloves or Modified D PPE.

In the event of inclement weather (e.g., lightning) or an emergency requiring immediate evacuation, contaminated equipment will be bagged or wrapped and taped in 6-mil polyethylene sheeting and tagged as "contaminated" for later decontamination. Respirators not only need to be decontaminated and cleaned between uses, but also need to be sanitized. Alcohol swabs are generally sufficient.

### **6.3.2 Full Decontamination Procedures**

Workers shall use the following cleaning and decontamination procedures when exiting the EZ. These procedures should be followed when workers are leaving the area for lunch, at the end of their shift, or when work is completed for an EZ. Procedures for rest breaks and changing SCBA tanks and cartridges are described in Section 6.3.3. Not all steps apply to every situation; follow applicable procedures. Decontamination procedures shall start at the EZ/CRZ interface and continue away from the EZ toward the SZ.



COMPREHENSIVE  
CMS SAP  
NAVAL BASE CHARLESTON  
CHARLESTON, S.C.

FIGURE 6-1  
LEVEL B PROTECTION SHEET

DWG DATE: 1/29/97

DWG NAME: BOARD

## **Full Decontamination**

1. ***Equipment drop.*** Deposit used equipment onto plastic drop cloths or into a plastic-lined tub. All gross contamination should be removed here, fine cleaning and decontamination of equipment may be completed here or elsewhere. Before moving equipment that is still contaminated, wrap and tape it.
  
2. ***Outer boot and glove wash.*** Wash/remove gross contamination from outer boots, outer gloves, SCBA, and/or airline equipment.
  
3. ***Tape removal.*** Remove tape from ankles and wrists and dispose of in plastic-lined drum.
  
4. ***Outer boot removal.*** Remove outer boots; disposable outer boots may be disposed of in the same waste container used in Step 1. Non-disposable boots need a thorough cleaning before they can be removed from the site. (If non-disposable boots are used, it is preferable to have them dedicated to the project.)
  
5. ***Outer glove removal.*** Remove and dispose of outer gloves. Gloves may be disposed in the same waste container as used in Step 1.
  
6. ***Removal of Self Contained Breathing Apparatus and Supplied Air Respirator .*** For Level B\*.  

SCBA — With buddy or other site worker, remove backpack, remove facepiece, and shut off air flow.

SAR — With buddy or other site worker, remove harness and escape bottle, remove face piece, and shut off air flow.

- \* If coveralls are significantly contaminated, leave the respirator facepiece on, disconnect the air hose just downstream of the regulator, turn off the flow of air, remove the backpack or equipment harness, and leave the facepiece in place. Remove the facepiece in Step 8.
7. **Coverall removal.** Rinse coveralls, if needed; remove coveralls and dispose of them. The same drum may be used as in Step 1. Double-bag non-disposable coveralls with the outer bag clearly labeled "contaminated."
  8. **Respirator removal.** Remove respirator (or facepiece of Level B equipment, if it is still being worn). Dispose of spent cartridges, clean, disinfect, dry, and properly store respirator or facepiece.
  9. **Inner glove removal.** Remove and dispose of inner gloves.
  10. **Exit area.** Exit the CRZ via the SZ.
  11. **Field wash.** Wash and rinse hands and face.
  12. **Re-dress.** Re-dress into appropriate PPE for re-entry or change into street clothes.

**Notes:**

- All wastes (soil and water) generated during personal decontamination will be collected in 55-gallon drums. The drums will be labeled by E/A&H personnel; final disposal will be by the Navy.

- Hard hats and eye protection devices should be washed at the end of each workday with soap and water solution.

### **6.3.3 Partial Decontamination Procedures**

#### **To change a respirator cartridge or SCBA tank:**

1. ***Outer boot and glove wash.*** Wash outer boots and gloves. Wash/remove gross contamination from SCBA and/or airline equipment.
2. ***Tape removal.*** Remove tape from ankles and wrists and dispose of it in a plastic-lined drum.
3. ***Facepiece removal.*** Disconnect facepiece and air hose just downstream of regulator. The facepiece may remain in place, or be removed and cleaned. Remove the spent tank from the backpack and replace it with a full tank. Connect air hose and turn on air.
4. ***Respirator removal.*** Remove respirator, remove used cartridges, clean and disinfect respirator, install new cartridges, and don respirator.
5. ***Respirator check.*** Check to make sure that respirator still seals properly to your face.
6. ***Don clean PPE.*** Put on clean outer gloves, tape wrists (as applicable), and re-enter EZ.

#### **When taking a rest break:**

1. ***Outer boot and glove wash.*** Wash outer boots and gloves. Wash/remove gross contamination from SCBA and/or SAR equipment.

2. ***Tape removal.*** Remove tape from ankles and wrists and dispose of in a plastic-lined drum.
3. ***Respirator removal.*** Remove SCBA unit, SAR harness, or respirator, and place in a clean area; plastic sheeting may be needed.
4. ***Coverall removal.*** Remove outer wear if it is ripped or significantly contaminated. In hot weather, at least unzip and pull down upper half of coveralls.
5. ***Inner glove removal.*** Remove and dispose of inner gloves.
6. ***Wash.*** Wash and rinse hands and face at the field wash station.
7. ***Rest break.*** Take rest break. Remember to drink plenty of water, Gatorade, or other similar beverage.
8. ***Don inner gloves.*** Put on inner gloves.
9. ***Don PPE.*** Don coveralls, outer boots, and outer gloves. Tape wrists and ankles (as needed), and re-enter the EZ.

**Decontamination procedures, based on Level D protection:**

- Brush heavily soiled boots and rinse outer gloves and boots with soap and water.
- Remove gloves and deposit them in a trash container.
- Dispose gloves and other disposable PPE in a trash container.
- Wash hands and face, and preferably shower as soon as practical.

#### **6.3.4 Closure of the Decontamination Station**

All disposable clothing and plastic sheeting used during site activities at sites with Level D through Level C will be double-bagged and disposed of in a refuse container. Decontamination and rinse solutions and disposable PPE from Level B sites will be placed in a labeled 55-gallon drum (separate solids and liquids) for later analysis and disposal. All washtubs, pails, buckets, etc., will be washed and rinsed at the end of each workday.

#### **6.4 Authorized Personnel**

Only those individuals identified as necessary to the investigative operations at each work site will be considered authorized. The Navy and E/A&H will determine which personnel are necessary and authorized. E/A&H personnel who are to perform work in an E/A&H controlled area shall have current HAZWOPER training certificates on file onsite, shall be under appropriate medical surveillance, and shall be equipped and willing to don all PPE specified by the health and safety plan. Individuals whose current documentation is not on file, or those with more recent documentation (have attended a refresher course), will provide the onsite supervisor copies of their documentation before entering any work area.

Subcontractors, DOD oversight personnel, and other site visitors shall also demonstrate compliance with the requirements specified above, prior to being designated "authorized personnel."

Personnel anticipated to be onsite at various times during site activities include:

- Engineer-in-Charge — Mr. Matthew A. Hunt (SOUTHDIVNAVFACENGCOM)
- Site Contact — Mr. Billy Drawdy (Caretaker Site Office)
- Principal-In-Charge — Mr. Jim Speakman, Ph.D., P.E. (E/A&H)
- Task Order Manager — Mr. Todd Haverkost, P.G. (E/A&H)
- Site Supervisor — TBA (E/A&H)

- Comprehensive CMS Project Manager — Mr. Larry Bowers, P.E. (E/A&H)
- Zone-Specific CMS Project Engineers — TBA (E/A&H engineering staff)
- Zone-Specific CMS Field Personnel — TBA (E/A&H field support staff)
- Site Health and Safety Officer — Mr. Tim McCord (E/A&H)
- Project Health and Safety Officer — Mr. John Borowski, C.I.H. (E/A&H)

### **Responsibilities of Key Field Staff**

Key field staff for this project, in terms of health and safety are:

- Site Supervisor
- Site Health and Safety Officer
- (All) Field Staff

The primary health and safety responsibilities associated with each of these positions are delineated in CHASP, Sections 8.1, 8.2 and 8.3, respectively.

### **6.5 Emergency Information**

All hazardous waste site activities present a potential risk to onsite personnel. During routine operations, risk is minimized by establishing good work practices, staying alert, and using proper PPE. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated.

If any situation or unplanned occurrence requires outside emergency, immediately call the appropriate contact from the following list:

<b>Contact</b>	<b>Agency or Organization</b>	<b>Telephone</b>
Mr. Billy Drawdy	Caretaker Site Office, Naval Base Charleston	(803) 743-9985
Mr. Matthew A. Hunt	SOUTHDIV NAVFACENGCOM Engineer-in-Charge	(803) 820-5525
Mr. Todd Haverkost, P.G.	EnSafe/Allen & Hoshall	(803) 884-0029
Law Enforcement	N. Charleston Police	911
Fire Department	N. Charleston Fire Department	911
Ambulance Service	N. Charleston Fire Department	911
Hospital	Roper Hospital	(803) 744-2110
Southern Poison Control Center	_____	(800) 922-1117
Mr. Larry Bowers, P.E.	EnSafe/Allen & Hoshall Comprehensive CMS Project Manager	(757) 766-9556
Mr. John Borowski, C.I.H.	EnSafe/Allen & Hoshall Project Health and Safety Officer	(901) 372-7962
Mr. Tim McCord	EnSafe/Allen & Hoshall Site Health and Safety Officer	(803) 747-0336

As soon as practical, Billy Drawdy, CSO; Matthew Hunt, SOUTHDIVNAVFACENGCOM Engineer-in-Charge; Mr. Todd Haverkost, E/A&H Charleston Office Manager; and Mr. John Borowski, E/A&H PHSO, shall be fully apprised of the situation. Other persons, as appropriate may also need to be contacted.

### **6.5.1 Site Resources**

A cellular telephone will be available in the SZ for routine and emergency communication/coordination with NAVBASE, SOUTHDIVNAVFACECOM, and the E/A&H field office. First-aid and eye wash equipment will be available at the work area and in each field vehicle.

### **6.5.2 Emergency Procedures**

Examples of an emergency include:

- A fire, explosion, or similar event at or near the site whether related to this project or not;
- A member of the field crew sustains a significant injury, or experiences symptoms of a chemical exposure; or
- The discovery of a condition which suggests that site conditions are imminently more dangerous or hazardous than anticipated.

In an emergency, the following emergency procedures should be followed:

- If it is necessary to evacuate the area, immediately proceed to a rally point and remain there until instructed otherwise.
- Use planned escape routes.
- If a member of the field team experiences effects or symptoms of exposure while on the scene, the field crew will immediately halt work and act according to the instructions provided by the site supervisor or, in his absence, the SHSO.

- For applicable site activities, including all Level B activities, use wind indicators to continuously indicate downwind, preferred escape routes, from upwind routes.
  
- Investigate condition(s) suggesting that site conditions may be more hazardous than anticipated. The condition observed and the decisions made shall be recorded in the safety logbook, or in the field logbook if a safety logbook is not being maintained. If there are doubts about how to proceed, suspend work and leave the work area until the PHSO has evaluated the situation and provided the appropriate instructions to the field team.
  
- If an accident occurs, the site supervisor is to complete an Accident Report Form (see Attachment A) for submittal to the managing Principal-in-Charge of the project.
  
- If a member of the field crew suffers a personal injury, **call 911 if an ambulance is needed**. Next alert appropriate emergency response agencies as the situation dictates. Complete an Accident Report Form for any such incident.
  
- If a member of the field crew suffers chemical exposure, flush the affected areas immediately with copious amounts of clean water, and if the situation dictates, the SHSO should alert appropriate emergency response agencies, or personally ensure that the exposed individual is transported to the nearest medical treatment facility for prompt treatment. (See Attachment B for directions to the emergency medical facility.) An Accident Report Form will be completed for any such incident.

Additional information on appropriate chemical exposure treatment methods will be provided through MSDS in Attachment C of this HASP. Directions to the nearest emergency medical facility capable of providing general emergency medical assistance and treating chemical burns are provided in Attachment B of this HASP.

## **6.6 Forms**

The following forms will be used in implementing this Health and Safety Plan:

- Plan Acceptance Form
- Accident Report Form

A HASP Plan Acceptance Form will be completed by all employees working onsite before site activities begin. Examples of each form are provided in Attachment A of this plan.

**All completed forms must be returned to the Task Order Manager at EnSafe/Allen & Hoshall, Memphis, Tennessee.**

**PLAN ACCEPTANCE FORM  
PROJECT HEALTH AND SAFETY PLAN**

**INSTRUCTIONS:** This form is to be completed by each person working onsite and returned to EnSafe, Memphis, Tennessee.

Project # \_\_\_\_\_

Project: \_\_\_\_\_

**SITE-SPECIFIC HEALTH AND SAFETY PLAN FOR ALL SITE ACTIVITIES**

I represent that I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

\_\_\_\_\_  
Signed

\_\_\_\_\_  
Print Name

\_\_\_\_\_  
Company

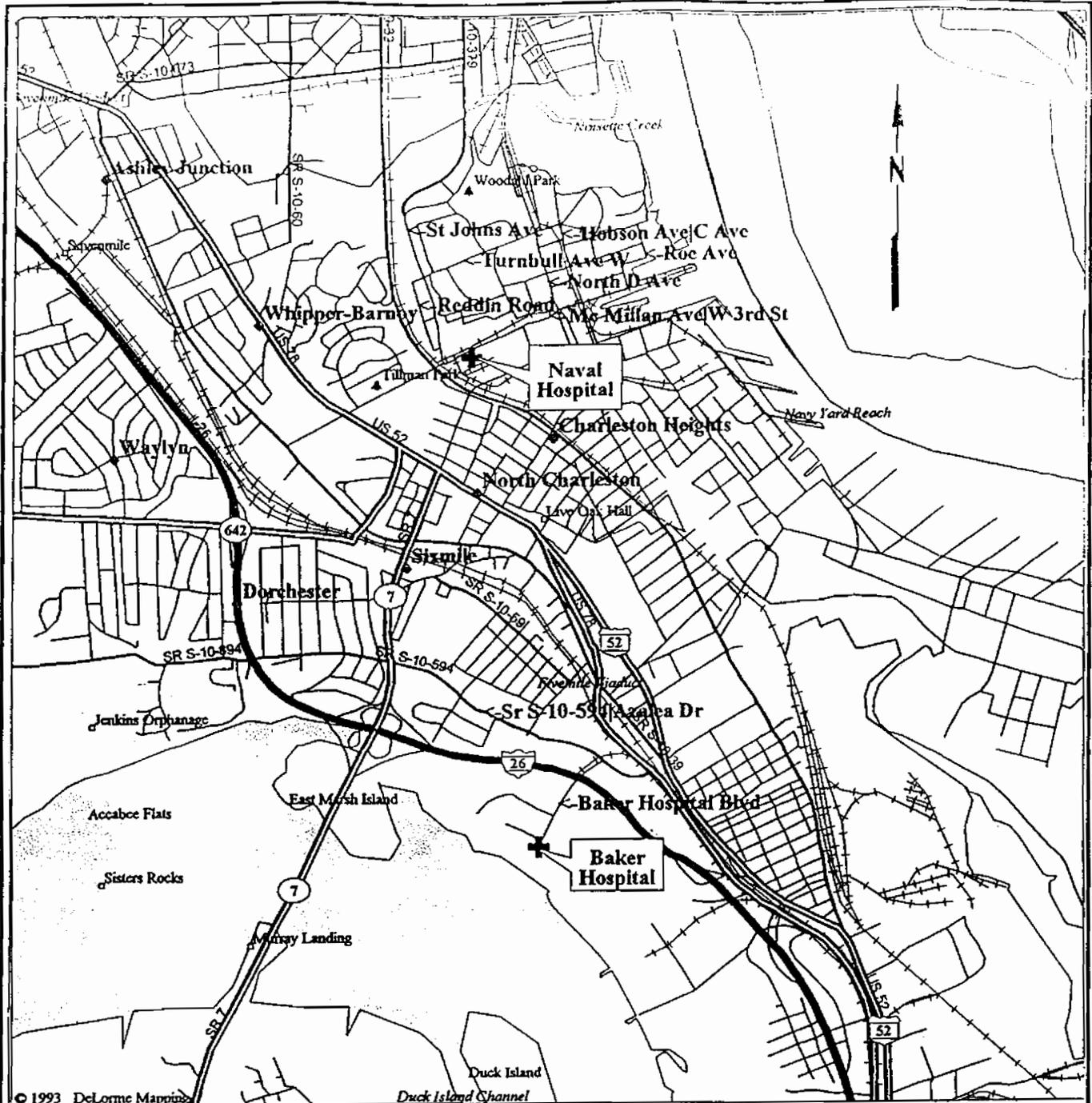
\_\_\_\_\_  
Date

## ACCIDENT REPORT FORM

<b>SUPERVISOR'S REPORT OF ACCIDENT</b>		<b>DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS</b>	
<b>TO</b>		<b>FROM</b>	
		<b>TELEPHONE (include area code)</b>	
<b>NAME OF INJURED OR ILL WORKER AND COMPANY</b>			
<b>WORKER'S SOCIAL SECURITY NUMBER</b>			
<b>DATE OF ACCIDENT</b>		<b>TIME OF ACCIDENT</b>	<b>EXACT LOCATION OF ACCIDENT</b>
<b>NARRATIVE DESCRIPTION OF ACCIDENT</b>			
<b>NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED</b>			<b>LOST TIME</b>  YES <input type="checkbox"/> NO <input type="checkbox"/>
<b>PROBABLE DISABILITY (Check one)</b>			
FATAL <input type="checkbox"/> LOST WORKDAY <input type="checkbox"/> WITH ____ DAYS AWAY FROM WORK                LOST WORKDAY <input type="checkbox"/> WITH ____ DAYS OF RESTRICTED ACTIVITY                NO LOST WORKDAY <input type="checkbox"/> FIRST-AID ONLY <input type="checkbox"/>			
<b>CORRECTIVE ACTION RECOMMENDED (By whom and by when)</b>			
<b>NAME OF SUPERVISOR (Print)</b>		<b>TITLE</b>	
<b>CC:</b>		<b>DATE</b>	

**Attachment B**

**Hospital Route**



© 1993 DeLorme Mapping

2000 Feet

1000 Meters



DRAFT  
 COMPREHENSIVE  
 CMS SAP  
 NAVAL BASE CHARLESTON  
 CHARLESTON, S.C.

HEALTH AND SAFETY PLAN  
 HOSPITAL DIRECTIONS

DWG DATE: 1/29/97

DWG NAME: BOARD

**Attachment C**  
**Material Safety Data Sheets**

MSDS for ALUMINUM OXIDE

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: ALUMINUM OXIDE  
 FORMULA: AL<sub>2</sub>O<sub>3</sub>  
 FORMULA WT: 101.96  
 CAS NO.: 1344-28-1  
 NIOSH/RTECS NO.: BD1200000  
 COMMON SYNONYMS: ALUMINA  
 PRODUCT CODES: 4901,0535,0537,0536,0539,0538,0541,0540  
 EFFECTIVE: 11/12/86  
 REVISION #02

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1 SLIGHT  
 FLAMMABILITY - 0 NONE  
 REACTIVITY - 0 NONE  
 CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

## CAUTION

MAY CAUSE IRRITATION

MAY BE HARMFUL IF INHALED

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
ALUMINUM OXIDE	90-100	1344-28-1

## 3 - PHYSICAL DATA

BOILING POINT: 2977 C ( 5391 F) VAPOR PRESSURE(MM HG): N/A  
 MELTING POINT: 2030 C ( 3686 F) VAPOR DENSITY(AIR=1): N/A  
 SPECIFIC GRAVITY: 4.00 EVAPORATION RATE: N/A  
 (H<sub>2</sub>O=1) (BUTYL ACETATE=1)

MSDS for ALUMINUM OXIDE

Page 2

SOLUBILITY(H2O): NEGLIGIBLE (LESS THAN 0.1 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: WHITE POWDER WITH NO ODOR.

---

4 - FIRE AND EXPLOSION HAZARD DATA

---

FLASH POINT (CLOSED CUP: N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

---

5 - HEALTH HAZARD DATA

---

THRESHOLD LIMIT VALUE (TLV/TWA): 10 MG/M3 ( PPM)

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

DUST INHALATION MAY CAUSE TIGHTNESS AND PAIN IN CHEST, COUGHING, AND DIFFICULTY IN BREATHING.

EXCESSIVE INHALATION OF DUST IS IRRITATING AND MAY BE SEVERELY DAMAGING TO RESPIRATORY PASSAGES AND/OR LUNGS.

CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION.

TARGET ORGANS

NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

LUNG DISEASE

ROUTES OF ENTRY

INHALATION, SKIN CONTACT, EYE CONTACT

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED PERSON TO FRESH AIR. GET MEDICAL ATTENTION.

EYE CONTACT: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION.

SKIN CONTACT: IMMEDIATELY WASH WITH PLENTY OF SOAP AND WATER FOR AT LEAST 15 MINUTES.

---

6 - REACTIVITY DATA

---

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: NONE DOCUMENTED

7 - SPILL AND DISPOSAL PROCEDURES

---

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SUITABLE PROTECTIVE CLOTHING. CAREFULLY SWEEP UP AND REMOVE.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

---

8 - PROTECTIVE EQUIPMENT

---

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION EXCEEDS TLV, A DUST/MIST RESPIRATOR IS RECOMMENDED. IF CONCENTRATION EXCEEDS CAPACITY OF RESPIRATOR, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, PROPER GLOVES ARE RECOMMENDED.

---

9 - STORAGE AND HANDLING PRECAUTIONS

---

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

---

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

---

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

MSDS for CALCIUM HYDROXIDE

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: CALCIUM HYDROXIDE  
 FORMULA: CA(OH)2  
 FORMULA WT: 74.09  
 CAS NO.: 01305-62-0  
 NIOSH/RTECS NO.: EW2800000  
 COMMON SYNONYMS: CALCIUM HYDRATE; SLAKED LIME  
 PRODUCT CODES: 1372,5143,5033,1374  
 EFFECTIVE: 09/26/85  
 REVISION #01

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1 SLIGHT  
 FLAMMABILITY - 0 NONE  
 REACTIVITY - 1 SLIGHT  
 CONTACT - 2 MODERATE

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

## WARNING

CAUSES IRRITATION

AVOID CONTACT WITH EYES, SKIN, CLOTHING.

KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
CALCIUM HYDROXIDE	90-100	1305-62-0
CALCIUM HYDROXIDE	90-100	1305-62-0

## 3 - PHYSICAL DATA

BOILING POINT: N/A VAPOR PRESSURE(MM HG): N/A  
 MELTING POINT: 580 C ( 1076 F) VAPOR DENSITY(AIR=1): 2.5  
 SPECIFIC GRAVITY: 2.24 EVAPORATION RATE: N/A  
 (H2O=1) (BUTYL ACETATE=1)

MSDS for CALCIUM HYDROXIDE

Page 2

SOLUBILITY(H2O): NEGLIGIBLE (LESS THAN 0.1 %) % VOLATILES BY VOLUME: 0  
APPEARANCE & ODOR: SOFT, ODORLESS SOLID OR CRYSTALS.

---

4 - FIRE AND EXPLOSION HAZARD DATA

---

FLASH POINT (CLOSED CUP: N/A  
FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %  
FIRE EXTINGUISHING MEDIA  
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

---

5 - HEALTH HAZARD DATA

---

THRESHOLD LIMIT VALUE (TLV/TWA): 5 MG/M3 ( PPM)  
TOXICITY: LD50 (ORAL-RAT) (MG/KG) - 7340  
CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE  
DUST MAY IRRITATE NOSE AND THROAT.  
CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION.

TARGET ORGANS  
NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE  
NONE IDENTIFIED

ROUTES OF ENTRY  
NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES  
CALL A PHYSICIAN.  
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT  
15 MINUTES. FLUSH SKIN WITH WATER.

---

6 - REACTIVITY DATA

---

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR  
INCOMPATIBLES: STRONG ACIDS

---

7 - SPILL AND DISPOSAL PROCEDURES

---

---

MSDS for CALCIUM HYDROXIDE

Page 3

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STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE  
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.

WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

---

8 - PROTECTIVE EQUIPMENT

---

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS ABOVE 2 PPM, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, UNIFORM, RUBBER GLOVES ARE RECOMMENDED.

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9 - STORAGE AND HANDLING PRECAUTIONS

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SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

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10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

MSDS for CALCIUM OXIDE

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: CALCIUM OXIDE  
 FORMULA: CAO  
 FORMULA WT: 56.08  
 CAS NO.: 01305-78-8  
 NIOSH/RTECS NO.: EW3100000  
 COMMON SYNONYMS: LIME; CALX; QUICKLIME; CALCIUM MONOXIDE; BURNT LIME  
 PRODUCT CODES: 1414,1410,4902  
 EFFECTIVE: 09/18/86  
 REVISION #03

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1 SLIGHT  
 FLAMMABILITY - 0 NONE  
 REACTIVITY - 1 SLIGHT  
 CONTACT - 2 MODERATE

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

## WARNING

CAUSES IRRITATION  
 HARMFUL IF SWALLOWED

AVOID CONTACT WITH EYES, SKIN, CLOTHING.

KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
CALCIUM OXIDE	90-100	1305-78-8

## 3 - PHYSICAL DATA

BOILING POINT: 2850 C ( 5162 F) VAPOR PRESSURE(MM HG): N/A  
 MELTING POINT: 2572 C ( 4662 F) VAPOR DENSITY(AIR=1): 1.9  
 SPECIFIC GRAVITY: 3.34 EVAPORATION RATE: N/A  
 (H2O=1) (BUTYL ACETATE=1)

MSDS for CALCIUM OXIDE

Page 2

SOLUBILITY(H2O): NEGLIGIBLE (LESS THAN 0.1 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: WHITE TO GRAY SOLID WITH NO ODOR.

---

4 - FIRE AND EXPLOSION HAZARD DATA

---

FLASH POINT (CLOSED CUP: N/A NFPA 704M RATING: 1-0-1

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

UNUSUAL FIRE & EXPLOSION HAZARDS

CONTACT WITH MOISTURE OR WATER MAY GENERATE SUFFICIENT HEAT TO  
IGNITE COMBUSTIBLE MATERIALS.

---

5 - HEALTH HAZARD DATA

---

THRESHOLD LIMIT VALUE (TLV/TWA): 2 MG/M3 ( PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 5 MG/M3 ( PPM)

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

DUST MAY BE IRRITATING TO EYES, NOSE, THROAT, OR LUNGS.  
DUST INHALATION MAY CAUSE TIGHTNESS AND PAIN IN CHEST, COUGHING, AND  
DIFFICULTY IN BREATHING.  
CONTACT WITH SKIN OR EYES MAY CAUSE SEVERE IRRITATION OR BURNS.  
INGESTION MAY CAUSE IRRITATION AND BURNING TO MOUTH AND STOMACH.

TARGET ORGANS

RESPIRATORY SYSTEM, KIDNEYS, PROSTATE, BLOOD

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

INHALATION, INGESTION

EMERGENCY AND FIRST AID PROCEDURES

CALL A PHYSICIAN.

IF SWALLOWED, DO NOT INDUCE VOMITING; IF CONSCIOUS, GIVE LARGE AMOUNTS OF  
WATER. FOLLOW WITH DILUTED VINEGAR, FRUIT JUICE OR WHITES OF EGGS, BEATEN  
WITH WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL  
RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT  
LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

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6 - REACTIVITY DATA

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-----  
STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: MOISTURE, AIR

INCOMPATIBLES: WATER, FLUORINE, STRONG ACIDS

-----  
7 - SPILL AND DISPOSAL PROCEDURES  
-----

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE  
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.  
WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND  
COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE  
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL  
ENVIRONMENTAL REGULATIONS.

-----  
8 - PROTECTIVE EQUIPMENT  
-----

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET  
TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE  
CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP  
TO 11 PPM, A DUST/MIST RESPIRATOR IS  
RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED  
BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, UNIFORM, RUBBER  
GLOVES ARE RECOMMENDED.

-----  
9 - STORAGE AND HANDLING PRECAUTIONS  
-----

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS  
KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE  
AREA.

-----  
10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION  
-----

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

MSDS for HYDROCHLORIC ACID

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: HYDROCHLORIC ACID  
 FORMULA: HCL  
 FORMULA WT: 36.46  
 CAS NO.: 7647-01-0  
 NIOSH/RTECS NO.: MW4025000  
 COMMON SYNONYMS: MURIATIC ACID; CHLOROHYDRIC ACID; HYDROCHLORIDE  
 PRODUCT CODES: 9543, 9539, 9535, 5367, 9534, 9544, 9529, 9542, 4800, 9549, 9530, 9548  
 9540, 9547, 9546, 9537  
 EFFECTIVE: 08/07/86  
 REVISION #02

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (POISON)  
 FLAMMABILITY - 0 NONE  
 REACTIVITY - 2 MODERATE  
 CONTACT - 3 SEVERE (CORROSIVE)

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

## LABORATORY PROTECTIVE EQUIPMENT

GOGGLES &amp; SHIELD; LAB COAT &amp; APRON; VENT HOOD; PROPER GLOVES

## PRECAUTIONARY LABEL STATEMENTS

POISON DANGER  
 CAUSES SEVERE BURNS

MAY BE FATAL IF SWALLOWED OR INHALED

DO NOT GET IN EYES, ON SKIN, ON CLOTHING.  
 DO NOT BREATHE VAPOR. CAUSES DAMAGE TO RESPIRATORY SYSTEM (LUNGS),  
 EYES AND SKIN. KEEP IN TIGHTLY CLOSED CONTAINER. LOOSEN CLOSURE CAUTIOUSLY.  
 USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. IN CASE  
 OF SPILL NEUTRALIZE WITH SODA ASH OR LIME AND PLACE IN DRY CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE (CORROSIVE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
HYDROCHLORIC ACID (23 BAUME)	35-40	7647-01-0

## 3 - PHYSICAL DATA

BOILING POINT: 110 C ( 230 F)      VAPOR PRESSURE(MM HG): N/A

MSDS for HYDROCHLORIC ACID

Page 2

MELTING POINT: -25 C ( -13 F) VAPOR DENSITY(AIR=1): 1.3

SPECIFIC GRAVITY: 1.19 EVAPORATION RATE: N/A  
(H2O=1) (BUTYL ACETATE=1)

SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: 100

APPEARANCE & ODOR: CLEAR, COLORLESS OR SLIGHTLY YELLOW, PUNGENT,  
FUMING LIQUID.

---

#### 4 - FIRE AND EXPLOSION HAZARD DATA

---

FLASH POINT (CLOSED CUP N/A NFPA 704M RATING: 3-0-0

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA  
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

#### SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL. DO NOT GET WATER INSIDE CONTAINERS.

#### UNUSUAL FIRE & EXPLOSION HAZARDS

MAY EMIT HYDROGEN GAS UPON CONTACT WITH METAL.

#### TOXIC GASES PRODUCED

HYDROGEN CHLORIDE, HYDROGEN GAS

---

#### 5 - HEALTH HAZARD DATA

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PEL AND TLV LISTED DENOTE CEILING LIMIT.

THRESHOLD LIMIT VALUE (TLV/TWA): 7 MG/M3 ( 5 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 7 MG/M3 ( 5 PPM)

TOXICITY: LD50 (ORAL-RABBIT) (MG/KG) - 900  
LD50 (IPR-MOUSE) (MG/KG) - 40  
LC50 (INHL-RAT-1H) (PPM) - 3124

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

#### EFFECTS OF OVEREXPOSURE

INHALATION OF VAPORS MAY CAUSE PULMONARY EDEMA, CIRCULATORY SYSTEM COLLAPSE, DAMAGE TO UPPER RESPIRATORY SYSTEM, COLLAPSE.  
INHALATION OF VAPORS MAY CAUSE COUGHING AND DIFFICULT BREATHING.  
LIQUID MAY CAUSE SEVERE BURNS TO SKIN AND EYES.  
INGESTION IS HARMFUL AND MAY BE FATAL.

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MSDS for HYDROCHLORIC ACID

Page 3

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INGESTION MAY CAUSE SEVERE BURNING OF MOUTH AND STOMACH.  
INGESTION MAY CAUSE NAUSEA AND VOMITING.

TARGET ORGANS

RESPIRATORY SYSTEM, EYES, SKIN

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

INGESTION, INHALATION, SKIN CONTACT, EYE CONTACT

EMERGENCY AND FIRST AID PROCEDURES

CALL A PHYSICIAN.

IF SWALLOWED, DO NOT INDUCE VOMITING; IF CONSCIOUS, GIVE WATER, MILK, OR MILK OF MAGNESIA.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

WASH CLOTHING BEFORE RE-USE.

---

6 - REACTIVITY DATA

---

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, MOISTURE

INCOMPATIBLES:

MOST COMMON METALS, WATER, AMINES, METAL OXIDES, ACETIC ANHYDRIDE, PROPIOLACTONE, VINYL ACETATE, MERCURIC SULFATE, CALCIUM PHOSPHIDE, FORMALDEHYDE, ALKALIES, CARBONATES, STRONG BASES, SULFURIC ACID, CHLOROSULFONIC ACID

DECOMPOSITION PRODUCTS: HYDROGEN CHLORIDE, HYDROGEN, CHLORINE

---

7 - SPILL AND DISPOSAL PROCEDURES

---

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. VENTILATE AREA. NEUTRALIZE SPILL WITH SODA ASH OR LIME. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

J. T. BAKER NEUTRASORB(R) OR NEUTRASOL(R) "LOW NA+" ACID NEUTRALIZERS ARE RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER:

D002 (CORROSIVE WASTE)

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8 - PROTECTIVE EQUIPMENT

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MSDS for HYDROCHLORIC ACID

Page 4

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VENTILATION:

USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: HYDROGEN PEROXIDE, 3%
FORMULA: H2O2
FORMULA WT: 34.01
CAS NO.: 7722-84-1
PRODUCT CODES: 2180,2182,5102
EFFECTIVE: 06/30/86
REVISION #02

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 0 NONE
FLAMMABILITY - 0 NONE
REACTIVITY - 1 SLIGHT
CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

2 - HAZARDOUS COMPONENTS

Table with 3 columns: COMPONENT, %, CAS NO. Row 1: HYDROGEN PEROXIDE, 2-4, 7722-84-1

3 - PHYSICAL DATA

BOILING POINT: 100 C ( 212 F) VAPOR PRESSURE(MM HG): N/A
MELTING POINT: 0 C ( 32 F) VAPOR DENSITY(AIR=1): N/A
SPECIFIC GRAVITY: 1.01 EVAPORATION RATE: N/A
(H2O=1) (BUTYL ACETATE=1)
SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: 100
APPEARANCE & ODOR: CLEAR COLORLESS SOLUTION.

TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 100 PPM, A CHEMICAL CARTRIDGE RESPIRATOR WITH ACID CARTRIDGE IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM, PROTECTIVE SUIT, ACID-RESISTANT GLOVES ARE RECOMMENDED.

---

9 - STORAGE AND HANDLING PRECAUTIONS

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SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE (CORROSIVE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. STORE IN CORROSION-PROOF AREA.  
ISOLATE FROM INCOMPATIBLE MATERIALS.  
DO NOT STORE NEAR OXIDIZING MATERIALS.

---

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	HYDROCHLORIC ACID
HAZARD CLASS	CORROSIVE MATERIAL (LIQUID)
UN/NA	UN1789
LABELS	CORROSIVE
REPORTABLE QUANTITY	5000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	HYDROCHLORIC ACID, SOLUTION
HAZARD CLASS	8
UN/NA	UN1789
LABELS	CORROSIVE

-----  
4 - FIRE AND EXPLOSION HAZARD DATA  
-----

FLASH POINT (CLOSED CUP) N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

-----  
5 - HEALTH HAZARD DATA  
-----

TLV AND STEL VALUES ARE FOR SOLUTION GREATER THAN 3%.

THRESHOLD LIMIT VALUE (TLV/TWA): 1.5 MG/M3 ( 1 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 3 MG/M3 ( 2 PPM)

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

NO EFFECTS OF OVEREXPOSURE WERE DOCUMENTED.

TARGET ORGANS

NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED PERSON TO FRESH AIR. GET MEDICAL ATTENTION.

EYE CONTACT: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION.

SKIN CONTACT: IMMEDIATELY WASH WITH PLENTY OF SOAP AND WATER FOR AT LEAST 15 MINUTES.

-----  
6 - REACTIVITY DATA  
-----

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

-----  
MSDS for HYDROGEN PEROXIDE, 3%

Page 3  
-----

CONDITIONS TO AVOID: LIGHT, HEAT

MSDS for MAGNESIUM HYDROXIDE

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: MAGNESIUM HYDROXIDE  
 FORMULA: MG(OH)2  
 FORMULA WT: 58.34  
 CAS NO.: 01309-42-8  
 NIOSH/RTECS NO.: OM3580000  
 COMMON SYNONYMS: MAGNESIUM HYDRATE; MILK OF MAGNESIA  
 PRODUCT CODES: 2465  
 EFFECTIVE: 05/05/86  
 REVISION #01

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH	-	1	SLIGHT
FLAMMABILITY	-	0	NONE
REACTIVITY	-	0	NONE
CONTACT	-	1	SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

## LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

## PRECAUTIONARY LABEL STATEMENTS

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
NOT APPLICABLE		

## 3 - PHYSICAL DATA

BOILING POINT:	N/A	VAPOR PRESSURE (MM HG):	N/A
MELTING POINT:	350 C ( 662 F)	VAPOR DENSITY (AIR=1):	N/A
SPECIFIC GRAVITY:	2.36	EVAPORATION RATE:	N/A
(H2O=1)		(BUTYL ACETATE=1)	
SOLUBILITY (H2O):	NEGLECTIBLE (LESS THAN 0.1 %)	% VOLATILES BY VOLUME:	0

MSDS for MAGNESIUM HYDROXIDE

Page 2

APPEARANCE & ODOR: ODORLESS WHITE POWDER.

-----  
4 - FIRE AND EXPLOSION HAZARD DATA  
-----

FLASH POINT (CLOSED CUP N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

-----  
5 - HEALTH HAZARD DATA  
-----

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

NO EFFECTS OF OVEREXPOSURE WERE DOCUMENTED.

TARGET ORGANS

NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE  
LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED  
PERSON TO FRESH AIR. GET MEDICAL ATTENTION.

EYE CONTACT: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15  
MINUTES. GET MEDICAL ATTENTION.

SKIN CONTACT: IMMEDIATELY WASH WITH PLENTY OF SOAP AND WATER FOR AT LEAST  
15 MINUTES.

-----  
6 - REACTIVITY DATA  
-----

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: NONE DOCUMENTED

-----  
7 - SPILL AND DISPOSAL PROCEDURES  
-----

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SUITABLE PROTECTIVE CLOTHING. CAREFULLY SWEEP UP AND REMOVE.

MSDS for MAGNESIUM HYDROXIDE

Page 3

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

---

8 - PROTECTIVE EQUIPMENT

---

VENTILATION: USE ADEQUATE GENERAL OR LOCAL EXHAUST VENTILATION TO KEEP FUME OR DUST LEVELS AS LOW AS POSSIBLE.

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION IS HIGH, USE AN APPROPRIATE RESPIRATOR OR DUST MASK.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, PROPER GLOVES ARE RECOMMENDED.

---

9 - STORAGE AND HANDLING PRECAUTIONS

---

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

---

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

---

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

-----  
MSDS for NITRIC ACIDPage 1  
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1 - PRODUCT IDENTIFICATION  
-----

PRODUCT NAME: NITRIC ACID  
FORMULA: HNO3  
FORMULA WT: 63.01  
CAS NO.: 7697-37-2  
NIOSH/RTECS NO.: QU5775000  
COMMON SYNONYMS: HYDROGEN NITRATE; AZOTIC ACID  
PRODUCT CODES: 4801,9605,9602,9598,9606,9601,5371,9597,9600,5113,9616  
EFFECTIVE: 09/10/86  
REVISION #02

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (POISON)  
FLAMMABILITY - 0 NONE  
REACTIVITY - 3 SEVERE (OXIDIZER)  
CONTACT - 4 EXTREME (CORROSIVE)

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

## LABORATORY PROTECTIVE EQUIPMENT

GOGGLES &amp; SHIELD; LAB COAT &amp; APRON; VENT HOOD; PROPER GLOVES

## PRECAUTIONARY LABEL STATEMENTS

## POISON DANGER

STRONG OXIDIZER - CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE  
LIQUID AND VAPOR CAUSE SEVERE BURNS - MAY BE FATAL IF SWALLOWED  
HARMFUL IF INHALED AND MAY CAUSE DELAYED LUNG INJURY

SPILLAGE MAY CAUSE FIRE OR LIBERATE DANGEROUS GAS

KEEP FROM CONTACT WITH CLOTHING AND OTHER COMBUSTIBLE MATERIALS. DO NOT  
STORE NEAR COMBUSTIBLE MATERIALS. DO NOT GET IN EYES, ON SKIN, ON CLOTHING.  
DO NOT BREATHE VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE  
VENTILATION. IN CASE OF FIRE, USE WATER SPRAY, ALCOHOL FOAM, DRY CHEMICAL,  
OR CARBON DIOXIDE. FLUSH SPILL AREA WITH WATERSPRAY.

SAF-T-DATA(TM) STORAGE COLOR CODE: YELLOW (REACTIVE)

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2 - HAZARDOUS COMPONENTS  
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COMPONENT	%	CAS NO.
NITRIC ACID	65-75	7697-37-2

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3 - PHYSICAL DATA  
-----

BOILING POINT: 121 C ( 250 F) VAPOR PRESSURE(MM HG):

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MSDS for NITRIC ACIDPage 2  
-----

MELTING POINT: -42 C ( -44 F) VAPOR DENSITY(AIR=1):  
SPECIFIC GRAVITY: 1.41 EVAPORATION RATE: N/A  
(H2O=1) (BUTYL ACETATE=1)  
SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: 100  
APPEARANCE & ODOR: COLORLESS LIQUID, WITH CHOKING ODOR.

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4 - FIRE AND EXPLOSION HAZARD DATA  
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FLASH POINT (CLOSED CUP N/A NFPA 704M RATING: 3-0-0 OXY  
FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %  
FIRE EXTINGUISHING MEDIA  
USE WATER SPRAY.

SPECIAL FIRE-FIGHTING PROCEDURES  
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE EXPOSED CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL; DO NOT GET WATER INSIDE CONTAINERS.

UNUSUAL FIRE & EXPLOSION HAZARDS  
STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE.

TOXIC GASES PRODUCED  
NITROGEN OXIDES, HYDROGEN GAS

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5 - HEALTH HAZARD DATA  
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THRESHOLD LIMIT VALUE (TLV/TWA): 5 MG/M3 ( 2 PPM)  
SHORT-TERM EXPOSURE LIMIT (STEL): 10 MG/M3 ( 4 PPM)  
PERMISSIBLE EXPOSURE LIMIT (PEL): 5 MG/M3 ( 2 PPM)  
CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE  
INHALATION OF VAPORS MAY CAUSE NAUSEA, VOMITING, LIGHTHEADEDNESS OR HEADACHE.  
INHALATION OF VAPORS MAY CAUSE SEVERE IRRITATION OF THE RESPIRATORY SYSTEM. INHALATION OF VAPORS MAY CAUSE COUGHING, CHEST PAINS, DIFFICULTY BREATHING, OR UNCONSCIOUSNESS.  
CONTACT WITH LIQUID OR VAPOR MAY CAUSE SEVERE IRRITATION OR BURNS OF THE SKIN, EYES, AND MUCOUS MEMBRANES.  
INGESTION MAY CAUSE SEVERE BURNS TO MOUTH, THROAT, AND STOMACH. MAY HAVE ADVERSE EFFECT ON KIDNEY FUNCTION AND MAY BE FATAL.

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INGESTION IS HARMFUL AND MAY BE FATAL.  
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TARGET ORGANS

EYES, SKIN, RESPIRATORY SYSTEM, TEETH

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

EMERGENCY AND FIRST AID PROCEDURES

CALL A PHYSICIAN.

IF SWALLOWED, DO NOT INDUCE VOMITING; IF CONSCIOUS, GIVE WATER, MILK, OR MILK OF MAGNESIA.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

WASH CLOTHING BEFORE RE-USE.

6 - REACTIVITY DATA

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, LIGHT, MOISTURE

INCOMPATIBLES:

STRONG BASES, COMBUSTIBLE MATERIALS, STRONG REDUCING AGENTS, ALKALIES, MOST COMMON METALS, ORGANIC MATERIALS, ALCOHOLS, CARBIDES

DECOMPOSITION PRODUCTS: OXIDES OF NITROGEN, HYDROGEN

7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. VENTILATE AREA. NEUTRALIZE SPILL WITH SODA ASH OR LIME. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER. KEEP COMBUSTIBLES (WOOD, PAPER, OIL, ETC.) AWAY FROM SPILLED MATERIAL.

J. T. BAKER NEUTRASORB(R) OR NEUTRASOL(R) "LOW NA+" ACID NEUTRALIZERS ARE RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER:

D002 (CORROSIVE WASTE)

8 - PROTECTIVE EQUIPMENT

MSDS for NITRIC ACID

Page 4

VENTILATION:

USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 100 PPM, A CHEMICAL CARTRIDGE RESPIRATOR WITH ACID CARTRIDGE IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM, PROTECTIVE SUIT, ACID-RESISTANT GLOVES ARE RECOMMENDED.

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9 - STORAGE AND HANDLING PRECAUTIONS

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SAF-T-DATA(TM) STORAGE COLOR CODE: YELLOW (REACTIVE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. STORE SEPARATELY AND AWAY FROM FLAMMABLE AND COMBUSTIBLE MATERIALS.

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10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	NITRIC ACID (OVER 40%) POISON - INHALATION HAZARD
HAZARD CLASS	OXIDIZER
UN/NA	UN2031
LABELS	OXIDIZER, CORROSIVE, POISON
REPORTABLE QUANTITY	1000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	NITRIC ACID
HAZARD CLASS	8
UN/NA	UN2031
LABELS	CORROSIVE

MSDS for SODIUM BICARBONATE

Page 1

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: SODIUM BICARBONATE  
 FORMULA: NAHCO3  
 FORMULA WT: 84.01  
 CAS NO.: 00144-55-8  
 NIOSH/RTECS NO.: VZ0950000  
 COMMON SYNONYMS: BAKING SODA; SODIUM ACID CARBONATE  
 PRODUCT CODES: 3509, 3508, 3506  
 EFFECTIVE: 03/20/86  
 REVISION #01

## PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH	-	0	NONE
FLAMMABILITY	-	0	NONE
REACTIVITY	-	1	SLIGHT
CONTACT	-	1	SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

## LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

## PRECAUTIONARY LABEL STATEMENTS

## CAUTION

## MAY CAUSE IRRITATION

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
NOT APPLICABLE		

## 3 - PHYSICAL DATA

BOILING POINT:	N/A	VAPOR PRESSURE (MM HG):	N/A
MELTING POINT:	50 C ( 122 F)	VAPOR DENSITY (AIR=1):	N/A
SPECIFIC GRAVITY:	2.16	EVAPORATION RATE:	N/A
(H2O=1)		(BUTYL ACETATE=1)	

MSDS for SODIUM BICARBONATE

Page 2

SOLUBILITY(H2O): MODERATE (1 TO 10 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: ODORLESS WHITE CRYSTALLINE POWDER.

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4 - FIRE AND EXPLOSION HAZARD DATA  
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FLASH POINT (CLOSED CUP N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

TOXIC GASES PRODUCED

CARBON MONOXIDE, CARBON DIOXIDE

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5 - HEALTH HAZARD DATA  
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TOXICITY: LD50 (ORAL-RAT) (MG/KG) - 4220

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

DUST MAY IRRITATE SKIN OR EYES.

TARGET ORGANS

NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED PERSON TO FRESH AIR. GET MEDICAL ATTENTION.

EYE CONTACT: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION.

SKIN CONTACT: IMMEDIATELY WASH WITH PLENTY OF SOAP AND WATER FOR AT LEAST 15 MINUTES.

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6 - REACTIVITY DATA  
-----

MSDS for SODIUM BICARBONATE

Page 3

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, HUMIDITY

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE

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7 - SPILL AND DISPOSAL PROCEDURES

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STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SUITABLE PROTECTIVE CLOTHING. CAREFULLY SWEEP UP AND REMOVE.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

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8 - PROTECTIVE EQUIPMENT

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VENTILATION: USE ADEQUATE GENERAL OR LOCAL EXHAUST VENTILATION TO KEEP FUME OR DUST LEVELS AS LOW AS POSSIBLE.

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION IS HIGH, USE AN APPROPRIATE RESPIRATOR OR DUST MASK.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, PROPER GLOVES ARE RECOMMENDED.

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9 - STORAGE AND HANDLING PRECAUTIONS

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SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

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10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: SODIUM CARBONATE, ANHYDROUS
FORMULA: NA2CO3
FORMULA WT: 105.99
CAS NO.: 497-19-8
NIOSH/RTECS NO.: VZ4050000
COMMON SYNONYMS: SODA ASH; DISODIUM CARBONATE
PRODUCT CODES: 5151,4502,5134,4923,5605,5198,3605,5154,3604,5179,3602
EFFECTIVE: 11/24/86
REVISION #02

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1 SLIGHT
FLAMMABILITY - 0 NONE
REACTIVITY - 1 SLIGHT
CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

CAUTION

MAY CAUSE IRRITATION

MAY BE HARMFUL IF SWALLOWED

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

2 - HAZARDOUS COMPONENTS

Table with 3 columns: COMPONENT, %, CAS NO. Row 1: SODIUM CARBONATE, ANHYDROUS, %, 00497-19-8

3 - PHYSICAL DATA

BOILING POINT: N/A VAPOR PRESSURE(MM HG): N/A
MELTING POINT: 851 C ( 1564 F) VAPOR DENSITY(AIR=1): N/A
SPECIFIC GRAVITY: 2.53 (H2O=1) EVAPORATION RATE: N/A (BUTYL ACETATE=1)

SOLUBILITY(H2O): APPRECIABLE (MORE THAN 10 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: ODORLESS GRAYISH WHITE POWDER.

---

4 - FIRE AND EXPLOSION HAZARD DATA

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FLASH POINT (CLOSED CUP N/A

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

TOXIC GASES PRODUCED

CARBON MONOXIDE, CARBON DIOXIDE, OXIDES

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5 - HEALTH HAZARD DATA

---

TOXICITY: LD50 (IPR-MOUSE) (MG/KG) - 117

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

INHALATION OF DUST MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT.  
CONTACT MAY CAUSE IRRITATION OF SKIN, EYES, AND MUCOUS MEMBRANES.  
INGESTION OF LARGE QUANTITIES MAY CAUSE GASTROINTESTINAL IRRITATION.  
INGESTION OF LARGE QUANTITIES MAY CAUSE VOMITING, DIARRHEA AND NAUSEA.

TARGET ORGANS

NONE IDENTIFIED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

INHALATION, INGESTION, SKIN CONTACT, EYE CONTACT

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHE IN LARGE AMOUNTS, MOVE THE EXPOSED PERSON TO FRESH AIR. GET MEDICAL ATTENTION.

EYE CONTACT: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION.

SKIN CONTACT: IMMEDIATELY WASH WITH PLENTY OF SOAP AND WATER FOR AT LEAST 15 MINUTES.

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6 - REACTIVITY DATA

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1 - PRODUCT IDENTIFICATION

PRODUCT NAME: SODIUM HYDROXIDE
FORMULA: NAOH
FORMULA WT: 40.00
CAS NO.: 01310-73-2
NIOSH/RTECS NO.: WB4900000
COMMON SYNONYMS: CAUSTIC SODA; SODIUM HYDRATE; LYE
PRODUCT CODES: 3730, 3722, 5312, 5104, 3729, 3734, 3726, 5045, 3728, 3723, 5022, 3736
EFFECTIVE: 08/28/86
REVISION #02

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (POISON)
FLAMMABILITY - 0 NONE
REACTIVITY - 2 MODERATE
CONTACT - 4 EXTREME (CORROSIVE)

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES

PRECAUTIONARY LABEL STATEMENTS

POISON DANGER
CAUSES SEVERE BURNS
MAY BE FATAL IF SWALLOWED

DO NOT GET IN EYES, ON SKIN, ON CLOTHING. AVOID SPATTERING BY SLOWLY
ADDING TO SOLUTION.
AVOID BREATHING DUST. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE
VENTILATION. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE STRIPE (STORE SEPARATELY)

2 - HAZARDOUS COMPONENTS

Table with 3 columns: COMPONENT, %, CAS NO. Row 1: SODIUM HYDROXIDE, 90-100, 1310-73-2

3 - PHYSICAL DATA

BOILING POINT: 1390 C ( 2534 F) VAPOR PRESSURE(MM HG): 0
MELTING POINT: 318 C ( 604 F) VAPOR DENSITY(AIR=1): N/A

SPECIFIC GRAVITY: 2.13  
(H2O=1)

EVAPORATION RATE: N/A  
(BUTYL ACETATE=1)

SOLUBILITY(H2O): APPRECIABLE (MORE THAN 10 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: WHITE, ODORLESS SOLID.

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4 - FIRE AND EXPLOSION HAZARD DATA

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FLASH POINT (CLOSED CUP N/A

NFPA 704M RATING: 3-0-1

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FLOOD WITH WATER, DO NOT SPLATTER OR SPLASH THIS MATERIAL.

UNUSUAL FIRE & EXPLOSION HAZARDS

CONTACT WITH MOISTURE OR WATER MAY GENERATE SUFFICIENT HEAT TO IGNITE COMBUSTIBLE MATERIALS.

REACTS WITH MOST METALS TO PRODUCE HYDROGEN GAS, WHICH CAN FORM AN EXPLOSIVE MIXTURE WITH AIR.

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5 - HEALTH HAZARD DATA

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TLV LISTED DENOTES CEILING LIMIT.

THRESHOLD LIMIT VALUE (TLV/TWA): 2 MG/M3 ( PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 2 MG/M3 ( PPM)

TOXICITY: LD50 (IPR-MOUSE) (MG/KG) - 40

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

EXCESSIVE INHALATION OF DUST IS IRRITATING AND MAY BE SEVERELY DAMAGING TO RESPIRATORY PASSAGES AND/OR LUNGS.

CONTACT WITH SKIN OR EYES MAY CAUSE SEVERE IRRITATION OR BURNS.

INGESTION IS HARMFUL AND MAY BE FATAL.

INGESTION MAY CAUSE SEVERE BURNING OF MOUTH AND STOMACH.

INGESTION MAY CAUSE NAUSEA AND VOMITING.

TARGET ORGANS

EYES, SKIN, RESPIRATORY SYSTEM

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

NONE IDENTIFIED

ROUTES OF ENTRY

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

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MSDS for SODIUM HYDROXIDE

Page 3

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EMERGENCY AND FIRST AID PROCEDURES



SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE STRIPE (STORE SEPARATELY)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. STORE IN CORROSION-PROOF AREA.  
STORE IN A DRY AREA.  
ISOLATE FROM INCOMPATIBLE MATERIALS.

-----  
10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION  
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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	SODIUM HYDROXIDE, DRY SOLID
HAZARD CLASS	CORROSIVE MATERIAL (SOLID)
UN/NA	UN1823
LABELS	CORROSIVE
REPORTABLE QUANTITY	1000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	SODIUM HYDROXIDE, SOLID
HAZARD CLASS	8
UN/NA	UN1823
LABELS	CORROSIVE

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: SULFURIC ACID
FORMULA: H2SO4
FORMULA WT: 98.08
CAS NO.: 7664-93-9
NIOSH/RTECS NO.: WS5600000
COMMON SYNONYMS: OIL OF VITRIOL
PRODUCT CODES: 5030,9691,9675,5340,9679,9687,9674,9686,9694,9681,5374,9688
9673,5432,5137,9685,4802,9684,9683,5643,9680
EFFECTIVE: 09/08/86
REVISION #02

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (POISON)
FLAMMABILITY - 0 NONE
REACTIVITY - 3 SEVERE (WATER REACTIVE)
CONTACT - 4 EXTREME (CORROSIVE)

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

PRECAUTIONARY LABEL STATEMENTS

POISON DANGER
HARMFUL IF INHALED
CAUSES SEVERE BURNS
MAY BE FATAL IF SWALLOWED
REACTS VIOLENTLY WITH WATER.

DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
DO NOT BREATHE VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. LOOSEN CLOSURE
CAUTIOUSLY. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER
HANDLING. IN CASE OF SPILL NEUTRALIZE WITH SODA ASH OR LIME AND PLACE IN
DRY CONTAINER.

SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE (CORROSIVE)

2 - HAZARDOUS COMPONENTS

Table with 3 columns: COMPONENT, %, CAS NO. Row 1: SULFURIC ACID, 90-100, 7664-93-9

3 - PHYSICAL DATA

BOILING POINT: 327 C ( 621 F) VAPOR PRESSURE(MM HG): <0.3

MELTING POINT: -2 C ( 28 F) VAPOR DENSITY(AIR=1): 3.4  
SPECIFIC GRAVITY: 1.84 EVAPORATION RATE: <1  
(H2O=1) (BUTYL ACETATE=1)  
SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: N/A  
APPEARANCE & ODOR: CLEAR, COLORLESS TO LIGHT YELLOW, OILY ODORLESS LIQUID.

-----  
4 - FIRE AND EXPLOSION HAZARD DATA  
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FLASH POINT (CLOSED CUP N/A NFPA 704M RATING: 3-0-2 W  
FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %  
FIRE EXTINGUISHING MEDIA  
USE DRY CHEMICAL OR CARBON DIOXIDE. DO NOT USE WATER.

SPECIAL FIRE-FIGHTING PROCEDURES  
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED  
BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.  
DO NOT GET WATER INSIDE CONTAINERS.

UNUSUAL FIRE & EXPLOSION HAZARDS  
REACTS WITH MOST METALS TO PRODUCE HYDROGEN GAS, WHICH CAN FORM AN  
EXPLOSIVE MIXTURE WITH AIR.  
A VIOLENT EXOTHERMIC REACTION OCCURS WITH WATER. SUFFICIENT HEAT  
MAY BE PRODUCED TO IGNITE COMBUSTIBLE MATERIALS.

TOXIC GASES PRODUCED  
SULFUR DIOXIDE

-----  
5 - HEALTH HAZARD DATA  
-----

THRESHOLD LIMIT VALUE (TLV/TWA): 1 MG/M3 ( PPM)  
PERMISSIBLE EXPOSURE LIMIT (PEL): 1 MG/M3 ( PPM)  
TOXICITY: LD50 (ORAL-RAT) (MG/KG) - 2140  
CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE  
INHALATION OF VAPORS MAY CAUSE SEVERE IRRITATION OF THE RESPIRATORY SYSTEM.  
LIQUID MAY CAUSE SEVERE BURNS TO SKIN AND EYES.  
INGESTION IS HARMFUL AND MAY BE FATAL.  
INGESTION MAY CAUSE NAUSEA AND VOMITING.  
INGESTION MAY CAUSE SEVERE BURNS TO MOUTH, THROAT, AND STOMACH. MAY HAVE  
ADVERSE EFFECT ON KIDNEY FUNCTION AND MAY BE FATAL.

CHRONIC OVEREXPOSURE MAY RESULT IN LUNG DAMAGE.

TARGET ORGANS



RESPIRATORY PROTECTION: NONE REQUIRED WHERE APPROPRIATE VENTILATION  
CONDITIONS EXIST. IF THE TLV IS EXCEEDED, A SELF-  
CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM,  
PROTECTIVE SUIT, RUBBER GLOVES ARE RECOMMENDED.

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9 - STORAGE AND HANDLING PRECAUTIONS  
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SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE (CORROSIVE)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. STORE IN CORROSION-PROOF AREA.  
KEEP CONTAINERS OUT OF SUN AND AWAY FROM HEAT.

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10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION  
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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	SULFURIC ACID
HAZARD CLASS	CORROSIVE MATERIAL (LIQUID)
UN/NA	UN1830
LABELS	CORROSIVE
REPORTABLE QUANTITY	1000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	SULPHURIC ACID
HAZARD CLASS	8
UN/NA	UN1830
LABELS	CORROSIVE

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## 8.0 SIGNATORY REQUIREMENT

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA Part B Permit (EPA SCO 170 022 560) states: All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with Section 40 CFR 270.11. The certification reads as follows:

*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 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.*



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Date 7/1/97

Officer in Charge, Caretaker Site Office  
Charleston Naval Base  
Southern Division Naval Facilities Engineering Command

**APPENDIX A**

**ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION,  
AND HOLDING TIMES**

**Table A-1**  
**ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES**

Parameter	Analytical Method	Sample Matrix	Minimum Container Size/Material <sup>a</sup>	Sample Preservation <sup>b</sup>	Holding Times
Particle Size	ASTM D 422	Soil	Hydrometer and Sieve	None	None
Btu Content	ASTM D 240	Soil	50 gm	None	None
TCLP	SW846 1311	Soil	200 gm/(Glass)	None	14 days - organics 28 days - mercury 180 days - metals
Temperature	Standard Methods 2550 B	Water	10 ml	None	Analyze Immediately
		Soil	2 oz		
pH	USEPA 9040	Water	50 ml	None	Analyze Immediately
	USEPA 9045	Soil	50 gm	None	
Dissolved Oxygen	USEPA 360.1	Water/Soil	300 ml/(Glass)	None	Immediately
Methane	Mod. SW846 8015	Soil	(2) 2 oz jars	None	7 days
Atterberg Limits	ASTM D 4318	Soil	Shelby Tube	None	None
Cone Index	ASTM D3441-79	Soil	Shelby Tube	None	None
Unconfined Compressive Strength	ASTM D2166-85	Soil	Shelby Tube	None	None
Total Recoverable Hydrocarbons	USEPA 418.1 Standard Methods 5520F	Soil	4 oz. Jar (Glass)	Cool, 4 deg Celcius	28 days
Clay Content	ASTM D 422	Soil	Hydrometer and Sieve	None	None

**Table A-1**  
**ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES**

Parameter	Analytical Method	Sample Matrix	Minimum Container Size/Material *	Sample Preservation <sup>b</sup>	Holding Times
Calcium; Zinc; Copper; Iron; Manganese; Nickel; Sodium Magnesium; Potassium	SW846 - 6010	Water	1 L (Poly, Glass)	HNO <sub>3</sub>	180 days
Chloride	USEPA 325.1 SW846 - 9250-53	Water	50 ml (Poly or Glass)	None	28 days
Metals, dissolved	SW846 - 6010	Water	1 L (Poly, Glass)	HNO <sub>3</sub>	180 days
Total Nitrogen					
Nitrogen, ammonia	USEPA 350.1 - .3	Soil/Water	50gm/400 ml (Poly, Glass)	None/H <sub>2</sub> SO <sub>4</sub>	28 days
Nitrogen, nitrate-nitrite	USEPA 353.1 - .3	Soil/Water	50 gm/100 ml (Poly, Glass)	None/H <sub>2</sub> SO <sub>4</sub>	28 days
Oil and Grease	USEPA 9070	Water	1 L (Glass only)	H <sub>2</sub> SO <sub>4</sub>	28 days
Organic Carbon	USEPA 415.1 - .2	Water	25 ml (Poly, Glass)	H <sub>2</sub> SO <sub>4</sub> or HCl	28 days
Total Solids	USEPA 160.3	Water	100 ml (Poly, Glass)	Cool 4 deg Celcius	7 days
Specific Conductance	USEPA 120.1	Water	100 ml (Poly, Glass)	Cool 4 deg Celcius	28 days
Sulfate	USEPA 375.1-.4	Water	50 ml (Poly, Glass)	Cool 4 deg Celcius	28 days
Sulfide	9030 (SW846)	Water	500 ml (Poly, Glass)	Zn Acetate and NaOH pH > 9	7 days
Volatile Suspended Solids	USEPA 160.2 & 160.4	Water	100 ml (Poly, Glass)	Cool 4 deg Celcius	7 days

**Table A-1  
 ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES**

Parameter	Analytical Method	Sample Matrix	Minimum Container Size/Material <sup>a</sup>	Sample Preservation <sup>b</sup>	Holding Times
Bicarbonate	Standard Methods 4500	Water	200 ml (Poly, Glass)	Cool 4 deg Celcius	pH & Temp Immediately TDS - 7 days Alkalinity - 14 days
Organic Carbon	USEPA 415.1-.2	Water	25 ml (Poly, Glass)	H <sub>2</sub> SO <sub>4</sub> or Hcl	28 days
In-situ Density	ASTM D 2922	Soil	Nuclear Density Meter	None	None
Soil Type (USCS)	ASTM D 4318	Soil	Shelby Tube	None	None
Saturated Hydraulic Conductivity	SW846-9100	Soil/Water	Shelby Tube	None	None
Relative Permeability	USEPA 9100-SW846	Soil	Shelby Tube	None	None
Ammonia	USEPA 350.1-.3	Water	400 ml (Poly, Glass)	4 degrees Celcius, H <sub>2</sub> SO <sub>4</sub>	28 days
Acidity	USEPA 305.1	Water	100 ml (Poly, Glass)	Cool, 4 degrees Celcius	14 days
Alkalinity	USEPA 310.1-.2	Water	100 ml (Poly, Glass)	Cool, 4 degrees Celcius	14 days
Lysimeter Test	ASTM D4696	Soil	Lysimeter (not standard)	None	None
Tensiometer Test	ASTM D3404	Soil	Tensiometer (not standard)	None	None

**Notes:**

USCS = Unified Soil Classification System

TDS = Total Dissolve Solids

N/A = Not Applicable

<sup>a</sup> Soil samples collected with split-barrel samplers shall be submitted to the laboratory in stainless steel sampling sleeves.

<sup>b</sup> Any preserving agents used must be ACS Certified Reagent Grade.